JANUARY 2021 • VOLUME 47, NUMBER 1

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# Journal of EMERGENCY NURSING

OFFICIAL PUBLICATION OF THE EMERGENCY NURSES ASSOCIATION



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# 2021…Time to Elevate

**Ron Kraus, MSN, RN, CEN, TCRN, ACNS-BC**

As I sit down to write my first president's message, our world is still in the middle of fighting a pandemic caused by coronavirus disease 2019; we are strife with societal and political issues around the world; many are fighting for equality; and in the United States, the atmosphere is politically charged. All of these issues have had a major impact on our lives in some aspect.

It is the nature of nurses to help, and these recent times have left us asking, "What do I do? Where do I fit in?" Or maybe you are feeling weak and tired in the face of societal or personal struggle from the stress of it all. What is the answer?

In 2020, Emergency Nurses Association President Mike Hastings focused on the theme of the power of one. How can one person make a difference? This message is so important and continues for all of us as we begin 2021.

In 2021, I challenge each of us to focus on the word ELEVATE. Elevate ourselves: take the time to make ourselves better in some aspect. This step of elevating ourselves will have an impact not only on us but on the world around us, as doing something good and positive for ourselves reflects on those around us. Elevate your career in whatever role you fulfill in our profession. Does that mean honing a certain skill, educating yourself on a disease, or taking a leadership class, for example? Push yourself higher through the act of getting lost in the service of others. Mahatma Gandhi said, "The best way to find yourself is to lose yourself in the service of others." Elevate your professional association: help take the Emergency Nurses Association, our profession, and the specialty of emergency nursing to the next level. Get involved, volunteer to help propel us all forward as a united force. This united force will be very powerful.

To accomplish great things, we will need to lean on one another, but it all begins with us individually. On a personal note, I love to listen to music of all kinds. I use music to relax, to get hyped up for something, and also for inspiration. The idea of improving ourselves before we can improve others always reminds me to reflect on the message in the song "The Man in the Mirror" by Michael Jackson. Its main message is that, if you want to make a change, you have to start with the person you see in the mirror.[1] Another song I find to be inspirational in this aspect is by Matthew West, titled "Do Something." He tells us that if we are tired of the negative things around us then we need to do something; he challenges us to start with ourselves to make change happen. Lyrics from the song include: "If not us, then who, If not me and you…If not now, then when?"[2]

I applaud you for sitting down to read this message and this issue of the *Journal of Emergency Nursing*. You are already taking a step right now to better yourself, which translates to elevating the emergency nursing profession, your career, and ultimately the care of the patients we serve.

Now comes the homework for the next 2 months: Before you sit down to read the next issue of the *Journal of Emergency Nursing*, set a goal and accomplish something in your personal life, your professional life or profession, and your community to improve that space around you.

Stay positive, stay focused, and be the good!

ELEVATE

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J Emerg Nurs 2021;47:1.
0099-1767



https://doi.org/10.1016/j.jen.2020.10.006

# Finding My People: My Experience as an Emergency Nurse Scientist in a Research Postdoctoral Fellowship at an Academic Medical Center

Martin Mikell, PhD, RN, CEN

## What Is a Research Postdoctoral Fellowship?

Postdoctoral fellowships are excellent opportunities for doctorally prepared nurses to further their research independence.[1,2] Public agencies, such as the National Institutes of Health (NIH), National Science Foundation, the Veterans Health Administration, the Agency for Health Research and Quality, and the Health Resources and Services Administration offer postdoctoral fellowships to new researchers, including doctorally prepared nurses. Postdoctoral fellows are often supported through a Ruth L. Kirschtein National Research Service Award (NRSA), either through an F32 individual fellowship (for which the candidate submits a competitive grant application), or a T32 institutional mechanism, in which the sponsoring institution/university is awarded fellowship positions and hires trainees directly. NRSA fellows are supported for a period of 2 to 3 years.[2] Private institutions, such as the Robert Wood Johnson Foundation, the Andrew Mellon Foundation, and the Pew Charitable Trust also fund and offer postdoctoral opportunities—both for nurses and other interdisciplinary fellows. Although many emergency nurse scientists do not complete a postdoctoral fellowship, this was the path I chose to develop the necessary skills to become an independent nursing researcher. The purpose of this editorial is to share my personal journey as a postdoctoral fellow and describe how I grew from this experience.

The National Academy of Science, Engineering, and Medicine has an ambitious goal to advance the health of all United States citizens by increasing the number of nurse scientists.[3] A postdoctoral fellowship could facilitate the scholarly growth of nurses during their transition from graduate school to their next professional role: tenure-track faculty, industry researcher, consulting nurse scientist for hospitals, researcher within government agencies, instructor in nontraditional teaching environments, nonprofit leader, or public policy analyst.[1,4,5] For the postdoctoral fellowship, I set my own developmental goals in leadership, multidisciplinary collaboration, community engagement, teaching experience, grant writing, scholarship, and research. My fellowship position was time intensive, but the transition was smoothed by having generous mentors, protected time for writing and research, and freedom from the immediate expectation to secure my own grant funding.

## My Transition to a Postdoctoral Fellow

It was understood that completing a terminal degree meant that one was trained to conduct research and generate new knowledge.[6,7] Although I was interested in serving in a nurse faculty position, I had always been a clinician up to this point in my career. Being a clinically engaged researcher had become one of my core values, which may not have always aligned with the expectations of tenure-track faculty positions in nursing.[1] Reflecting on my work in the emergency department, I recognized that I was primarily focused on timeliness of care, emergency patient outcomes, and completion of ephemeral departmental tasks before the

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J Emerg Nurs 2021;47:2-5.
0099-1767



https://doi.org/10.1016/j.jen.2020.10.005

end of my shift. As a nursing researcher, I was called to address complex structural problems, such as health disparities and inequities in health outcomes.[7]

I had never heard of a postdoctoral fellowship until a mentor suggested it as a way to achieve many goals at once: publish the research from my dissertation, further my development as a researcher, expand my research networks, collaborate with scholars from other disciplines, and expand my teaching expertise. I applied for a postdoctoral fellowship in primary care research in an academic medical center. I was thrilled to be accepted in this postdoctoral fellowship but sad to take a 2-year leave from my ED position and nervous about how I would fit in as a nurse in an academic family medicine department.

## Commitment to a Postdoctoral Position

As I eagerly transitioned from my role of graduate student to full-time research fellow, I would need to step away from my position as an emergency nurse and focus my energies on my newly assumed role, that of a postdoctoral fellow. Once in the fellowship, however, I soon found myself struggling with the universal problem: balancing multiple demands with limited time. As an emergency nurse, I could leave when my shift was completed, under most circumstances. In the postdoctoral fellowship, I was now surrounded by researchers, physicians, and other nonclinical support staff in a corporate-style environment.[7] There were deadlines from department supervisors and collaborating mentors, and my own urgency to complete manuscripts and stay abreast of the literature—all while conducting my research. One of my mentors gleefully pointed out that the postdoctoral fellowship would be the last time in my career that I would be paid to think! There was little time left to disconnect completely from my research. I missed the easy comradery of emergency nursing.

I was 1 of 2 nurses in this fellowship cohort. An advantage of a fellowship at an academic medical center was receiving interdisciplinary support. Having a sounding board for my ideas enhanced the rigor of my scholarship, sharpened my research focus, and broadened my perspective on how to achieve an equitable health care system. Postdocs were quick to bond with each other in this stimulating environment, a phenomenon that reminded me of the easy collegiality that arose from the fast-paced and unpredictable nature of an emergency department. In interdisciplinary fellowships, nurse scientists have opportunities to engage in collaborative research endeavors that address the social and structural determinants of health.[8]

## Postdoctoral Activities and How They Prepare You for Independent Research

My postdoctoral fellowship activities included conference presentations, seminars, manuscript preparation, grant writing, teaching, and refinement of my program of research. My program of research is to advance the health of immigrant populations through public policy advocacy and to increase health-promoting behaviors through leveraging community resources. During my 2 years in the fellowship, I disseminated research findings at local and regional nursing conferences and international medical conferences. A highlight was presenting at the Saunders-Watkins Leadership Workshop at NIH in Washington, DC. At the workshop, I was surrounded by some of the brightest researchers in the nation. After hearing high-level scientists describe the evolution of their careers, I was inspired to publish.

When I embarked on my fellowship, one of my goals was that I would develop my skills as a writer and publish the findings from my dissertation research.[9,10] The fellowship allowed time for reflection, which provided the impetus I needed to write manuscripts for submission to peer-reviewed journals (it also provided a safe space to weather manuscript rejection).[6] When I received immediate "desk rejections" by editors, as well as rejections by reviewers who critiqued my work with enthusiasm and then rejected it, I viewed these as new opportunities to find the proper journal fit. I took each critique to heart and strengthened my manuscript. During the postdoctoral fellowship, I eventually was invited to serve as a journal reviewer for *The Journal of Emergency Nursing*. Here, I could draw on my clinical experience to evaluate emergency nursing research that could contribute valuable insights to nursing science, as well as see the publishing process from another perspective.

## Integrating Health Equity Into a Postdoctoral Fellowship

As an emergency nurse in a critical access medical center, I had long recognized that an inadequate access to health promotion education often led to an increased risk for preventable chronic illnesses. Health education could potentially diminish dependence on emergency departments for primary care, enabling them to respond more effectively to crises from emerging threats, such as the coronavirus or bioterrorism. One of my community partners was a pastor of a predominately Spanish-speaking congregation in a limited resource community. After I presented my dissertation findings to the congregation, he shared his concerns about the increasing incidence of obesity in his

congregation. I assembled a research team that included the pastor to design a health curriculum for children and adolescents that could be embedded into their current religious education classes. We applied for and were awarded funding from the local chapter of an international nursing organization to move this community-based, participatory research project forward and are currently working with our third cohort of students. Through this collaboration, I came to better understand this community's needs and the impact of their environment on health outcomes.

Through grand round and community presentations, postdocs analyzed complex issues, such as structural racism and housing inequality. Critical discussions with senior researchers and other postdocs raised my awareness of how viewing a problem through the lens of another discipline could strengthen nursing research.[8,11] Frequently, our discussions would center on how we could apply our leadership skills in research or practice in our respective communities. Senior researchers were also available to serve as mentors for the postdocs.

## Mentors Serve Many Roles

There is considerable evidence that success in a graduate program, as well as in a postdoctoral position, can be fostered through positive relationships with mentors.[1,12] In the fast-paced environment of the emergency department, I depended on experienced emergency nurses as mentors. My mentors in graduate school were emergency nursing colleagues, other doctoral students, and PhD committee members who provided support, not only as a doctoral student, but as I advanced my career.[3,13] Mentors can show you how to apply for funding to keep a research program on track and moving forward.[7] Mentors also expand professional networks by introducing young nursing scientists to others outside of nursing for collaborative research opportunities.[7]

## The Outcomes of a Postdoctoral Fellowship

The goals of a postdoctoral fellowship were to produce a deliverable that could be leveraged to attain a tenure-track position, develop leadership skills, and grow your research networks.[11] The deliverable could be negotiated, either as a published manuscript, a funded research proposal, or a mentored scholarship opportunity. The fellowship strategically positioned one for a future career through increased professional networks, additional training in statistics, and classes on how to apply for an NIH grant. We also engaged in initial phases of our career trajectory mapping.[14] This approach to career decisions was enlightening to me as I imagined my future unfolding through incremental and intentional steps. As I contemplated my evolving career trajectory, my mind returned to the advice of another mentor who said, "You are your own CEO." I have discovered there is a caveat to that freedom, though. It takes imagination to have a worthy goal and persistence to reach it.[13,15]

## What Is a T32 Center and How Can You Find It for Your Own Postdoctoral Research Opportunity?

The T32 is an institutional research training grant under the Ruth L. Kirschtein NRSA and is available for biomedical and behavioral science programs, as well as schools of nursing. Some currently funded nursing institutions with T32 grant funding are the University of Pennsylvania, Case Western Reserve, University of Utah, and Ohio State, among others. T32-funded nursing centers typically have multiple foci, with research on symptom science, improving outcomes of chronic conditions, and self- and family management. Emergency nursing is in an ideal position to collaborate with other disciplines (medicine, psychology, and social work) to improve patient outcomes. The essential work of triage in emergency nursing is currently being investigated by Dr Stephanie Frisch at the University of Pittsburg through the use of another NIH-sponsored training mechanism (an F31 training grant). Dr Frisch is using big data in the development of emergency nursing triage tools that could quickly identify acute coronary syndrome and potentially reduce patient mortality through rapid identification. Other nursing T32 centers, as well as funding opportunities, can be located on the National Institute of Nursing Research website (https://www.ninr.nih.gov/researchandfunding/desp). The National Institute of Nursing Research is a proponent of interdisciplinary nursing research and encourages incorporating biological and behavioral sciences, as well as genomic research, to better inform nursing research questions. I highly recommend T32 postdoctoral fellowships for nascent nursing scholars. They provide an environment that stimulates intellectual growth, allows for interdisciplinary collaboration, and sets you on path toward independence.

## Author Disclosure

This program is funded in part by grant T32HP10030 from the Health Resources and Services Administration (HRSA), an operating division of the Department of Health and Human Services. These contents are solely the responsibility

of the authors and do not necessarily represent the official views of the Health Resources and Services Administration or the U.S. Department of Health and Human Services.

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# Health Disparities and Emergency Nursing

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Health disparities are sustained, worsened health outcomes of a specific disadvantaged group. These health differences can be health-related quality of life, rates or severity of disease, disability, mortality, injury, or violence. Disadvantaged populations might be defined by demographic characteristics, disadvantaging environmental conditions, social vulnerability, or geography. For example, the National Institutes of Health has designated the following as United States health-disparity populations: Black/African American, Hispanic/Latino, American Indian/Alaska Native, Asian American, Native Hawaiian and other Pacific Islander, socioeconomically disadvantaged populations, underserved rural populations, and sexual and gender minorities. We also know that the health of disadvantaged populations can be affected owing to discrimination based on age, race, color, religion, sex, gender, national origin, genetic information, veteran status, and many other considerations. The nursing discipline is committed to reducing health disparities as a collective value that is clearly stated in our Code of Ethics (Provision 8).[1] Within our emergency specialty, basic and expected standards of professional performance include that "the emergency registered nurse practices in a manner that is congruent with cultural diversity and inclusion principles."[1] The purpose of this editorial is to briefly introduce the National Institute on Minority Health and Health Disparities (NIMHD) Research Framework and a collection of health disparity–relevant papers published in this issue of the *Journal of Emergency Nursing* (*JEN*).

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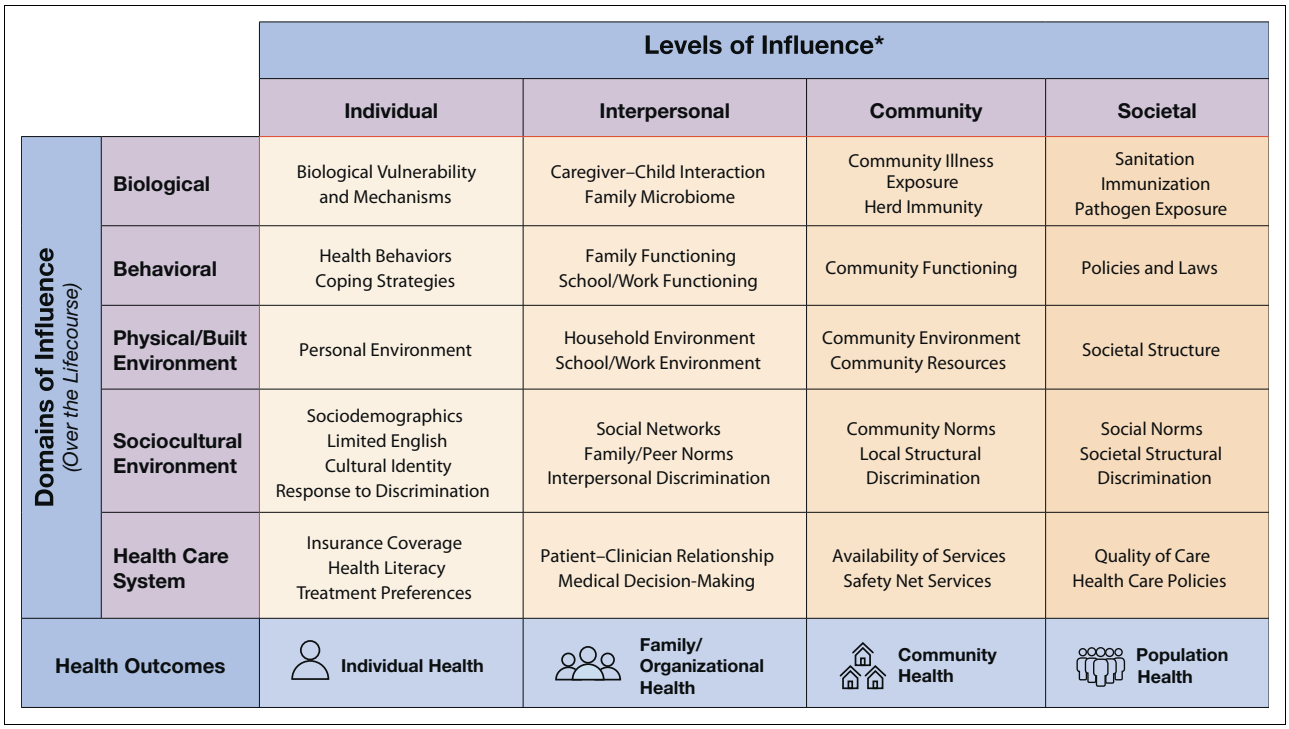
J Emerg Nurs 2021;47:6-9.
0099-1767



https://doi.org/10.1016/j.jen.2020.11.004

## NIMHD Research Framework

The NIMHD Research Framework (Figure) organizes a shared mental model that emergency care specialists can apply to understand the causes and influences of health disparities.[2] The Framework is organized by levels of influence (top rows of Figure), domains of influence (left-hand columns of Figure), and health outcomes (bottom row of Figure). The civic engagement and public dialogue during the coronavirus disease pandemic has guided us to a long overdue and poignant focus on the need for individual, interpersonal, community, and societal antiracism commitments because racism has been an unjust and centuries-long determinant of health disparities. Although there are several racial disparities that require attention in emergency nursing, such as indigenous peoples' health,[3] the following discussion applies the NIMHD Research Framework to Black or African American health disparities. Although those who identify their race as Black or African American may be more likely to share particular genetic,[4] hereditary, or biological traits (such as sickle cell trait)[5] than those with other racial identities, we also know that race is largely a social/contextual, and not biological, idea from a vast complexity of human ancestries, social structures, racial assignments, and internalized identities.[6-8] In health care, new research is needed on the potential harm and misdiagnoses created by practices such as race-based adjustments in the interpretation of biological data, such as lung function testing and glomerular filtration rate, which have largely failed to take biracial and multiracial ancestry into account.[7,9,10] Too often throughout our history, health care providers focused on individual biology or behavior as reasons for racial disparities, rather than the full multilevel range of social, community, and interpersonal influences. For example, racial health disparities are also determined by the differences in how criminal justice policy and law,[11] public education segregation,[12] and housing discrimination[13,14] as societal structures were applied, with clear evidence of long-standing structural racism and injustices. Although a full explanation and application of each level and domain of the NIMHD Research Framework is beyond the scope of this editorial, I encourage the emergency care community to use this Framework as a shared mental model for needs assessments and interventions that prioritize eliminating racial disparities in individual clinical practices, health care organizations, educational programs, research initiatives, and policies that we lead and influence. As an example of addressing quality of care ("Health Care System" domain and "Societal" level of influence in the NIMHD Research Framework) in this issue of *JEN*, Bulgin et al[15]



| | | Levels of Influence* | | | |
|---|---|---|---|---|---|
| | | **Individual** | **Interpersonal** | **Community** | **Societal** |
| **Domains of Influence** *(Over the Lifecourse)* | **Biological** | Biological Vulnerability and Mechanisms | Caregiver–Child Interaction<br>Family Microbiome | Community Illness Exposure<br>Herd Immunity | Sanitation<br>Immunization<br>Pathogen Exposure |
| | **Behavioral** | Health Behaviors<br>Coping Strategies | Family Functioning<br>School/Work Functioning | Community Functioning | Policies and Laws |
| | **Physical/Built Environment** | Personal Environment | Household Environment<br>School/Work Environment | Community Environment<br>Community Resources | Societal Structure |
| | **Sociocultural Environment** | Sociodemographics<br>Limited English<br>Cultural Identity<br>Response to Discrimination | Social Networks<br>Family/Peer Norms<br>Interpersonal Discrimination | Community Norms<br>Local Structural Discrimination | Social Norms<br>Societal Structural Discrimination |
| | **Health Care System** | Insurance Coverage<br>Health Literacy<br>Treatment Preferences | Patient–Clinician Relationship<br>Medical Decision-Making | Availability of Services<br>Safety Net Services | Quality of Care<br>Health Care Policies |
| **Health Outcomes** | | **Individual Health** | **Family/ Organizational Health** | **Community Health** | **Population Health** |

FIGURE

NIMHD Research Framework.[2] NIMHD, National Institute on Minority Health and Health Disparities. (Reproduced with permission as part of the public domain.)
* Health disparity populations: race/ethnicity, low socioeconomic status, rural, sexual and gender minority. In emergency care, disparity populations can be expanded to consider vulnerable age groups, veteran status, religion, color, national origin, genetic information. disability, literacy status, geographical region, and more.

worked to disseminate a sickle cell vaso-occlusive episode algorithm to emergency care clinicians in North Carolina. Jonassaint[16] provides commentary on research about innovative painamations assessments, which are electronic visual depictions of sickle cell pain, to strengthen medical decision-making and patient-clinician relationship ("Interpersonal" level of influence and "Health Care System" domain in the NIMHD Research Framework). The NIMHD Research Framework does not only apply to antiracism and racial health disparity interventions, but also to any health disparity for marginalized or vulnerable groups.

## In This Issue of *JEN*

The impressive collective efforts of our authors, reviewers, and editorial team allowed us to assemble papers on health disparity and vulnerable or potentially marginalized populations in this issue of *JEN* regarding emergency care or special considerations for people who are deaf;[17] transgender;[18] new immigrants;[19] reside in a low- or middle-income country;[20] children with displaced gastrostomy tubes;[21] or people who suffer from rare disease,[22] sickle cell disease,[15] or opioid use disorder.[23] Our shared value within the specialty of providing excellent care to all patients is evident in the study by Wolf and Delao[24] to ascertain the priorities for future emergency nurse triage research. From an Emergency Nurses Association (ENA) expert panel of 14 nurses, the single research question that was ranked as the highest priority was "How do cultural considerations affect triage accuracy?" We at *JEN* are committed to continuing to publish high-quality evidence to inform these cultural considerations to support personalized, compassionate care for all. This issue of *JEN* also includes 2 randomized controlled trial research papers testing interventions to reduce disparities for vulnerable groups across the lifespan on the topics of children's pain and fear during health care procedures[25] and adolescent automobile driver injury prevention.[26] In regard to gender-specific considerations and disparities in emergency care, this issue includes a manuscript on testing an external female urinary catheter as part of an organizational initiative to reduce catheter-related urinary tract infections[27] and a case review on identifying testicular torsion in teenage males.[28] Furthermore, evidence on interventions such as pictorial discharge instructions, which are promising interventions to reduce health disparities for those with low health literacy, is included here as

a systematic review of randomized controlled trials.[29] For readers who wish to test their own knowledge on the care of pediatric patients with displaced gastrostomy tubes, the authors have generously provided a copy of the knowledge assessment used in their quality improvement project.[21] Although this issue contains a collection of manuscripts aligned with the theme of health disparities, the entire issue contains our usual breadth and depth of topics to support emergency workforce health, emergency clinical practice, leadership, and research methods.

As we work collectively to reduce and eliminate health disparities, ENA members can access additional professional development and education entitled "Structural Racism in Health Care" on the ENA website with their member login.[30] Not only do we collectively value the specialty culture, knowledge, skills, and attitudes to ensure fair and equitable emergency care for our patients and their families, but our work also continues to address inequalities within the emergency nursing workforce. As a specialty workforce, we do not represent the ethnic and racial diversity of the patients we serve. In a national sample analysis, we found that 13% of emergency nurses identified as Hispanic, 73% as White non-Hispanic, 6% as Black non-Hispanic, 4% as Asian non-Hispanic, only 2% as multiracial, and <2% each as Pacific Islander, Native American, or Other.[6,31] We at *JEN* continue to welcome original research, program development and evaluation, and evidence-based commentary on achieving an ethnic and racially representative emergency nursing workforce.

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# If you Can't Assess It, How Can you Treat It? Improving Pain Management in Sickle Cell Disease

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Pain, the most frequently reported medical symptom,[1] continues to be poorly assessed in the health care setting.[2,3] Despite advances in technology and user-centered devices, pain assessment in acute care has not changed since the introduction of the 0-10 scale 50 years ago.[4] Previously, our group introduced the concept of leveraging technology to use graphical interfaces and animations (called "painimations") to help general medical patients communicate their pain experience.[5] The article by Bulgin et al[6] draws attention to the stark need for efficient and accurate assessment of sickle cell disease (SCD) pain in the ED setting. Treatment of SCD-related pain in the acute care setting may be an appropriate target for implementing novel, technology-based approaches for managing pain.

For children and adults living with SCD, pain is the number one reason for seeking medical care. Vaso-occlusive pain episodes are the hallmark of SCD and acute pain treatment for these episodes is usually sought on an emergency basis. Although sickle cell is a rare disease, disproportionately high use of acute care services by this group means that ED providers may frequently encounter patients with SCD seeking pain treatment in the acute care setting.[7] In this issue, Bulgin et al[6] appropriately highlight that despite the commonality of patients with SCD presenting with vaso-occlusive episodes in the emergency department, there is a lack of standardized, evidence-based care; pain management is often ineffective; and patient return visits are high. In fact, most ED providers are unaware of the National Heart, Blood, and Lung Institute (NHLBI) recommendations for treating vaso-occlusive episodes in SCD.[8] Owing to the unpredictable and variable quality of ED care, a population that is already underserved continues to feel increasingly marginalized and has a growing distrust for the medical system.[9,10]

## Will Disseminating the Guidelines Fill the Gap?

Bulgin et al[6] posit that this knowledge-treatment gap can be addressed by improved dissemination of the NHLBI recommendations for SCD care that include a treatment algorithm for vaso-occlusive episodes. To this end, they identified an effective strategy to disseminate the NHLBI treatment recommendations and vaso-occlusive pain episode algorithm to ED providers. The primary issue with this approach, however, is that executing the SCD pain treatment recommendations and associated algorithm relies on the ED provider first making an accurate assessment of the patient's pain. Yet no reliable, evidence-based methods exist for assessing pain in SCD.

The NHLBI treatment guidelines presented by Bulgin et al,[6] along with the recent American Society of Hematology guidelines, recommend that when a patient presents with pain, the provider must determine whether the patient is experiencing acute or chronic pain and then identify the etiology of the pain. The guidelines point out that "there are no tests to rule in or to rule out" a vaso-occlusive episode and "pain management must be guided by patient report of pain severity."[11] Thus, clinicians are tasked with determining, solely on the basis of patient report and clinical impressions, whether a patient's pain is caused by a vaso-occlusive event, another SCD complication such as acute chest syndrome or avascular necrosis, or a combination of factors. There is opportunity to improve upon the current NHLBI guidelines with evidence driven, patient-centered advances to effectively assess pain.

## Barriers to Accurate Pain Assessment in SCD

Several barriers stand in the way of making accurate assessments of pain, particularly in the acute care setting. In the absence of evidence-based methods, patients with SCD

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J Emerg Nurs 2021;47:10-5.
0099-1767



https://doi.org/10.1016/j.jen.2020.10.007

must describe to providers, a pain experience that is highly variable and can present with both acute and chronic characteristics simultaneously.[12] One adult with SCD stated, "My pain is always different…It's difficult to describe." Previously believed to be only nociceptive in nature, sickle cell pain has in the past decade been shown to have various mechanisms (eg, inflammatory, neuropathic, central sensitization), any of which may co-occur in the same patient.[13,14] Although mixed-pain phenotypes exist in which patients have pain both with and without an identifiable cause, most acute pain episodes in SCD have no clear precipitant. Even patients with purely chronic pain may experience acute "breakthrough" pain, a brief flare-up of sudden pain that is unresponsive to usual therapy.[14] Breakthrough pain can be easily confused with acute pain such as that caused by a vaso-occlusive episode. Currently there are no data showing how to evaluate or identify breakthrough pain or to differentiate this type of pain from an acute episode.[14]

Not only are decisions surrounding the initiation of treatment challenging, but deciding when to conclude treatment and discharge patients can also be problematic. Although the course of vaso-occlusive pain episodes is relatively well described, determining when a pain episode has ended is "fuzzy."[15] There are no tools for assessing when the peak of the vaso-occlusive episode has resolved and when the shift to a home pain regimen can begin. Regardless of how effective and aggressive the pain treatment, patients will continue to experience some pain after discharge and a number of patients will leave the hospital only to return days later because of unresolved pain or a new pain event.[15] An SCD pain episode can last hours or weeks, and resolution can be gradual or relatively precipitous, making planning the course of treatment a significant challenge for health care providers.[16]

## Racial Bias Dilutes Accuracy of Pain Assessment

Sociodemographic factors such as race/ethnicity add an additional layer to the complexity of assessing and treating patients with SCD. Most people living with SCD in the United States identify as Black race. It is becoming increasingly well recognized that Black people in America experience racial bias in many areas of life including treatment they receive in the health care setting. Not only health care providers but the lay public as a whole tend to perceive Black patients as being in less pain or being able to endure more pain than their white counterparts.[17] Therefore, Black patients often have their pain complaints ignored or their credibility challenged.[18] Regardless of pain etiology, Black patients are less likely to be prescribed opiate analgesics[19] and can have longer wait times in the emergency department before receiving treatment[20] than white and Hispanic patients who present with the same pain symptoms. Patients with SCD often learn that in order to receive appropriate treatment, they have to convince the ED providers that their pain is real and severe enough to warrant treatment.[21,22] Unfortunately, patients' tendency to exaggerate their pain behaviors can present as pseudo-addiction,[23] and without any objective data, providers may be more likely to perceive patients as drug seeking.[16]

## The Potential for Enabling Opioid Misuse Confuses Providers' Assessment of Pain

The NHLBI treatment guidelines address but do not present clear direction for mitigating risk of opioid misuse in SCD. To guide their practice with SCD, providers rely mostly on their experience with other pain populations that may not sufficiently resemble SCD patients, a population that is unique in that opioid pain treatment is used throughout the life course, from infancy through adulthood.[24] Providers in the acute care setting are unequipped to assess and differentiate malingering from real pain and pseudo-addiction from real addiction.[16,25] Despite the fact that only 2% of adults with SCD present with true substance dependence, which is at or below the national average,[26] biases still occur. In one study, over 60% of nurses believed that addiction was common among their patients with SCD.[27] Similarly, more than half of ED physicians believe that 1 of every 5 patients with SCD they treat has a substance use disorder.[28]

Clinicians tend to hold negative attitudes toward patients with SCD.[29] Relying on provider gestalt to determine the validity of patients' pain reports is not effective in isolation,[21,30] particularly in the midst of perceived drug-seeking behaviors and addiction concerns.[29] Without the appropriate tools and objective data for assessing pain symptoms, emergency clinicians face a unique challenge in attempting to treat pain appropriately without fear of perpetuating opioid misuse.

## No Assessments Exist for SCD Pain

For almost half a century, clinicians have used the 0 to 10 numeric pain scale, or in pediatrics, the FACES scale, to assess pain in the acute care setting.[4] With these

unidimensional measures, providers are tasked with determining sickle cell pain severity, type, and etiology in a population that has difficulty reporting symptoms, in the context of a kind of pain that often has unclear etiology, and in an environment that is rife with racial bias and stigma. For some non-sickle cell pain populations, asking the patient their pain level on a 0 to 10 scale can be effective for directing treatment. One study found that in the treatment of patients with long-bone fracture, for every 1-point increase in the 0 to 10 numeric pain score that patients reported, time to analgesic administration decreased by 5.6 minutes. However, when the authors tested this correlation in the treatment of patients with SCD, there was no relationship between patient-reported pain intensity and time to analgesic administration.[31] Here this suggests that either the patient-reported pain rating was ignored or the providers had to rely solely on their own clinical impression to determine how imminent the need for analgesics was in patients with SCD, a clinical impression that did not correlate with the patients' own perception of their medical need.

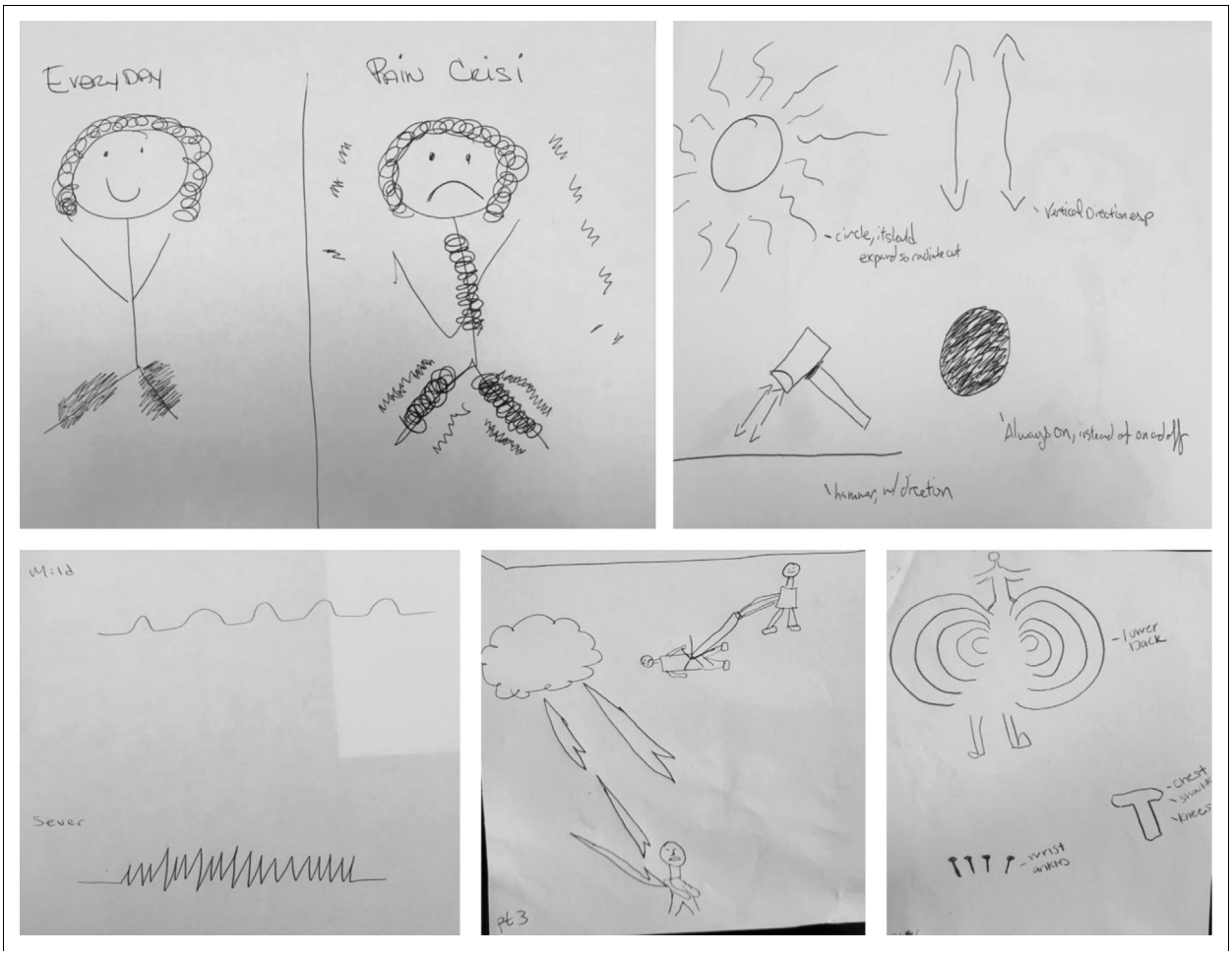
## Multimodal Pain Measurement is Necessary but Challenging in the Acute Care Setting

It is well established that unidimensional measures alone cannot capture the complex nature of the pain experience, nor provide adequate data to guide diagnosis.[32] Multimodal assessment tools are needed to fully elucidate the underlying mechanism, degree, and impact of pain.[33] Expert clinicians in emergency care commonly use the PQRST Pain Assessment (P = Provocation/Palliation; Q = Quality/Quantity; R = Region/Radiation; S = Severity Scale; T = Timing) and this approach is being more widely adopted into standard practice.[34] It is well recognized that the assessment of complex pain conditions such as SCD pain should, at minimum, include some form of multidimensional measurement to understand pain quality and etiology.[33] Unfortunately, no multidimensional pain scale has been validated in SCD. Two SCD studies implementing a more commonly used multidimensional pain scale—the McGill Pain Questionnaire, which relies on patients describing their pain using 78 different pain adjectives—found such high variability between patients' pain descriptors that it was challenging to identify consistent patterns or delineate types of SCD pain.[13,35] The measure could not conclusively determine whether patients experienced neuropathic versus nociceptive pain alone, or a mix of the 2. Furthermore, patients took 21 minutes on average and up to 57 minutes to complete the measure.[13] In the acute care setting, where providers aim to administer treatment as quickly as possible, long, intensive multidimensional patient assessments are not feasible. More important, these traditional multidimensional pain scales that rely on long lists of adjectives or complex statements about pain may perpetuate disparities in care. The use of constrictive numerical scales and esoteric words may alienate people with low literacy, cognitive impairment, or other communication limitations[18,36,37] while also failing to accurately represent racial differences in pain perception.[38] Patients who are the most vulnerable, such as those with SCD, can have their pain needs misinterpreted because of the traditional methods of pain assessment.[18]

## Can We Leverage Technology to Solve the Pain Assessment Problem?

Technology presents an opportunity to change and improve how we conduct patient assessments in the clinical setting.[39] Regrettably, the only advancement in pain assessment thus far has been the use of electronic surveys and applications that are essentially digital copies of the traditional paper-pencil scales.[40] Assessing pain using adjectives, phrases, and numeric scales has limitations and is a mismatch with the dynamic nature of the pain experience, which is better depicted visually[41] with word pictures, analogies, and metaphors.[42,43] The Figure shows drawings by adults with SCD depicting a vaso-occlusive pain episode (unpublished data). Many patients used metaphors (eg, lightning bolts, hammers and nails) and others drew images that cannot be described in words.

A potential solution to the disconnect between how patients experience pain and how they are required to communicate it to clinicians is through the use of animations, which can be highly visual, abstract, and an expressive mode of communication that cuts across cultures and languages. We previously developed and tested the concept of a pain assessment application delivered on a tablet computer, the *Painimation* app, that allows users to report the location of their pain using a paintable body image and then the quality and intensity of their pain using 8 adjustable pain animations called "painimations." In a general pain medicine population, we found that using these painimations to describe pain was not only acceptable to patients but also could differentiate between nociceptive and neuropathic pain etiology more accurately than scores from validated multidimensional scales such as the McGill Pain Questionnaire. In addition, completing the full painimation assessment took only 1.5 minutes on average.[5] A patient-centric




FIGURE

Drawings from adults living with sickle cell disease describing their chronic and vaso-occlusive crisis pain.

pain assessment that is rapid, requires limited resources, and overcomes barriers of literacy, culture, and language can be a viable point-of-care tool to help emergency medicine providers assess and treat patients' acute pain more objectively.

It is not yet clear whether the use of painimations is effective and can help determine pain etiology in SCD—pilot data with adults reporting chronic versus acute SCD pain are forthcoming. However, 6 adults with SCD reviewed the 8 painimations and were asked "Would you find this animation applicable to your pain?" Several painimations were endorsed but the only painimation selected by all 6 of patients was that most closely described as "electric shocks," which was the painimation associated with the greatest pain severity in a general pain population.[5] One adult with SCD, when they viewed the "electric" painimation, stated, "that's pain [right there], sickle cell crisis and this is the worst because it just won't stop. Like how it moves up and down. Very sudden onset." Another patient stated, "100% applies."

## Conclusions

Dissemination of the clinical guidelines for treating vaso-occlusive episodes in SCD has some merit for improving emergency clinical practice. The more immediate gap in acute pain care, however, is the ability of emergency health care providers to objectively and without bias assess pain type (acute vs. chronic) and etiology. A new approach to assessing pain is needed before the benefit of disseminating the treatment guidelines can be fully realized. Future studies may find that graphical, animation-based tools allow patients to more accurately express their pain experience and

give clinicians multidimensional symptom data that improve their ability to quickly diagnose and treat SCD-related pain. Novel assessment approaches that fully leverage the interactive features of technology such as painimations may be the next step to revolutionizing emergency clinical practice.

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# Letters To The Editor

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## Communicating With the American Sign Language User in the Emergency Department


*Dear Editor:*

Emergency nurses interact with individuals from various backgrounds every day. Some of these individuals may be part of a different culture and/or communicate through a different language. There is literature that discusses the importance of communication as well as the importance of cultural competence. Crowe[1] defines communication as "the key to nurse-patient relationships and the ability to deliver patient-centered care" (p. 316). Communication is vital for nurses to obtain relevant data, provide education, and promote general growth.[1] A patient population not commonly discussed in the literature consists of those who identify with Deaf culture. There is little guidance in the literature for nurses on how to properly communicate with individuals who are deaf and whose primary language is American Sign Language (ASL). This oversight may be due to a lack of understanding of the difference in the 2 languages (English and ASL).

In North America, adults who are deaf communicate primarily through ASL and consider themselves part of a unique culture with their own language, values, rules, and traditions.[2,3] ASL is a visual language with no vocal component, and it has the potential for hearing individuals to perceive it as a visual representation of English because it has an alphabet that correlates with English; however, ASL has its own grammar, syntax, and style.[3-7] Therefore, it is crucial for health care providers to communicate with the ASL user through a qualified interpreter to practice cultural sensitivity.

In addition to practicing cultural sensitivity, health care providers have a duty to practice safe care. Health care providers obtain data to guide the treatment of patients through communication. If a health care provider misunderstands the differences between English and ASL and chooses to communicate through written English or slang gestures, there is a potential for information to be lost in translation. Individuals who are deaf may understand the words written on a piece of paper; however, ordering the words on the paper by following English grammar rules may confuse the ASL user who has a low written English literacy level and lead to an error in communication. In addition, just because an individual has some experience with a language does not mean that that individual is qualified to interpret. Some individuals may be considered proficient conversationally rather than fluent. Therefore, a risk of error is possible if these individuals are used as interpreters. The risks of using an unqualified person include omission, addition, condensation, role exchange, or risks to confidentiality.[2] Individuals with no formal training serving as interpreters have the potential to add to the information present, remove or simplify information owing to a limited vocabulary, or answer for the patient.[2] There is also a risk of breaching a patient's confidentiality by allowing someone without a need to know to attempt to relay information. Incomplete or inaccurate information may lead to improper or unnecessary diagnostic testing. Individuals who are deaf are more likely to seek health care from the emergency department than people who have spoken English fluently since early childhood.[7] For that reason, it is paramount to ensure that communication among patients, families, and health care providers is effective to reduce the risk of errors. In 1 study regarding the chief complaint of abdominal pain, non–English-speaking patients received more diagnostic testing than English-speaking patients.[8]

Another communication technique that health care providers may be tempted to use is to force the patient to receive information from the clinician through lipreading. This, again, is an unsafe practice because of the risk of lost information. There is not much published literature on the accuracy of lipreading. The information that is available in the published literature demonstrates that the accuracy of lipreading varies significantly, from 12.4% to 50%,[9,10] with the higher accuracy value from artificial intelligence. Therefore, it can be concluded that it is unsafe to rely on this method of communication with patients.

Health care providers not only have a duty to provide an effective means of communication to be culturally sensitive and to ensure safe delivery of care; it is also the

J Emerg Nurs 2021;47:16-20.
0099-1767

law. The Americans with Disabilities Act of 1990 requires nonprofit public service providers to ensure that persons with hearing, vision, and speech disabilities have the right to effective communication.[11]

Owing to limited access to preventative services, patients who are deaf are more likely to seek care from the emergency department.[4] For this reason, emergency nurses should be cognizant of their duty to provide safe care to this population. Emergency nurses should review policies regarding communication with patients who speak a different language than their own. If proper communication resources are not available, emergency nurses should advocate for the safe delivery of care and adequate means of communication by requesting those resources. Depending on the location of the emergency department, there is a variety of options to access interpreters for patients who are deaf, from employed interpreters and contracted agencies to freelance interpreters. With the increase in technology use in health care, many companies are incorporating video-interpreting services into their interpreting services. Gone are the days of interpreting services offered only via standard telephone. Now there is an option to have the same spoken-language interpreting services with the addition of video-interpreting services via a mobile computer or tablet. Within minutes a qualified interpreter can be on a screen ready to provide an effective means of communication with a patient.

My experience as an interpreter for individuals who are deaf before becoming an emergency nurse has allowed me to have a unique perspective on the care of patients whose primary language is ASL. It is our responsibility to ensure appropriate care for the patients who seek care in our departments. It is my hope that emergency nurses who read this article will evaluate their own practice and identify ways to improve care in this population.—*Brett Pickens, DNP, MSN-Ed, RN, CEN, CPEN, CNE, ENA Mississippi State Council, Assistant Professor of Nursing, Mississippi University for Women, Columbus, MS; E-mail: bapickens@muw.edu.* ***ORCID identifier:*** *0000-0001-6319-1025.*

https://doi.org/10.1016/j.jen.2020.09.004

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## Organ Donation and the Islamic Faith


*Dear Editor:*

The first successful organ transplant surgery was performed on the kidney in 1954. Organ donation has evolved since then with successful heart and liver transplants in the 1960s.[1] Each organ donor has the potential to save up 8 lives.[2] Commonly acknowledged barriers to organ donation include financial concerns, fear of disfigurement of the deceased, and religious beliefs.[3] As an emergency nurse with more than 10 years of practice in the United States and the Middle East, as well as a practicing Muslim, I have personally seen various ways in which religious beliefs can affect organ donation. The purpose of this letter is to increase awareness regarding burial practices of the Islamic faith and discuss how these beliefs may affect patients and families who are Muslim as potential organ donors in ED settings.

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## Islam and Organ Donation

### MISCONCEPTIONS

Religion is personal and subjective to individual interpretation. There is no unanimous consensus regarding organ donation in the Muslim faith.[4] In fact, there can be a misconception, based on clinical experiences, that Muslims do not believe in cadaveric organ donation.

In 1952, the country of Egypt ruled that organ procurement is not against the religion of Islam.[5] In fact, there is no verse in the Quran that states organ donation and even an autopsy are impermissible. However, there are still Muslims who believe it is. I admit that I fall into this category. As a practicing Muslim, I assumed that organ donation was against the religion I was raised in because it wasn't a topic that was discussed. In fact, I didn't really know what my beliefs were in terms of organ donation until I was in nursing school. It wasn't until I did my own research that I fully understood that it is not against the religion and became an organ donor myself.

In the Muslim faith, there is the belief that the body belongs to God and is a gift to the individual. There can be a fear that if a body part is removed for any reason (in this case, transplantation), then the body has been desecrated and will not be at peace in the eternal resting place.

### MUSLIM BURIAL PRACTICES

(1) Very time sensitive, may not seem feasible in a hospital environment where delays are innate.
(2) Difference between if a patient is on a ventilator or not. If the Muslim has already died, delaying the care of the body for the burial is considered sacrilegious. If the Muslim is on a ventilator, there is time to engage the family in the decision-making process.

### ORGAN PROCUREMENT AGENCIES

Organ procurement agencies can continue to raise awareness by collaborating with local religious leaders and providing educational resources. Muslim families may not be open to speaking with procurement representatives when they are in the emergency department dealing with a loved one's passing. Timing is everything.

## What Can Emergency Nurses Do?

### ADVOCATE FOR CULTURALLY COMPETENT PRACTICE IN THEIR WORKPLACE BY ENGAGING IN THESE CONVERSATIONS

Advocate for education regarding the culturally sensitive considerations that are available through procurement agencies in the community before death. Encourage forums and offer individuals of different faiths the opportunity to engage in the conversation with religious leaders.

### EDUCATE COLLEAGUES AND PATIENTS

We don't learn everything there is to know about our profession in nursing school. There are culturally respectful ways of donating organs. Patients who are Muslim should be provided information on organ donation and be offered the opportunity to discuss the implications of what donating their organs mean with a religious leader such as an Imam.

Don't assume all Muslims are not organ donors.

### ENGAGE IN THE COMMUNITY

Encourage critical conversations regarding organ donation to occur outside of the hospital as much as possible. This includes diverse conversations with individuals of different faiths to better understand their religious reasons on organ donation.

Have a forum in which emergency nurses are afforded the opportunity to engage in a respectful conversation with the Imam of a local mosque to better understand the Muslim stance on organ donation. This can also initiate further conversations on other culturally specific Muslim practices as it relates to health care.

## Conclusion

There are more than 100 000 people waiting for a second chance at a better, healthier life and in need of an organ donation.[6] Understanding religious barriers can play an important role in giving these patients a second chance. As emergency nurses, we need to advocate for culturally competent practice and educate colleagues and patients regarding the organ donation process. We can also engage in community partnerships to initiate discussion around organ donation and donor registry before patients/families

are faced with this life-and-death situation. *Jamla Rizek Bergman, MSN, MBA, RN, Ascension Borgess Hospital, 315-491-7020; E-mail: jamlabergman@gmail.com.*

https://doi.org/10.1016/j.jen.2020.10.009

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## Job Stress Among Emergency Nurses

*Dear Editor:*

I would like to congratulate Karbakhsh et al[1] for their successful publication titled "The effectiveness of a time management workshop on job stress of nurses working in emergency departments: An experimental study," wherein the authors found no significant decrease in job stress among emergency nurses after a single 8-hour time management skills session.

Job stress has been well documented among emergency nurses, and numerous peer-reviewed articles have described the unpredictable work environment, job demand, lack of teamwork, and poor managerial support as contributing factors.[2-4] Karbakhsh et al[1], however, had a forseeable limitation to their study design. Specifically, they attempted to replicate 2 studies that demonstrated a decrease in job stress secondary to time management training.[5,6] However, both studies were inapplicable for, and unable to be extrapolated to, emergency nursing. The first study used 6 90-minute time management sessions and resulted in a statistically significant decrease in job stress among a random selection of nurses across numerous hospital departments and was not specific to emergency nursing.[5] This is especially notable as there is a significant difference in job demand and time requirements between general staff nursing and emergency nurses.[7] As Adriaenssens et al[7] notes, emergency nurses therefore require vastly different managerial tactics and focused education when compared with other hospital nurses.

The second study that Karbakhsh et al[1] referenced demonstrated a negative correlation between job stress and time management behaviors among 30 head nurses, as tested by questionnaires.[6] Again, not only did this study not focus on the emergency nursing population, let alone even general staff nursing, it also did not test an education strategy nor educate the head nurses on time management skills and strategies. Together, a study design that attempts to replicate these would quickly become invalidated when applied to ED floor nursing. Therefore, it was not unforeseen that a single 8-hour time management session would not produce a significant decrease in job stress among emergency nurses.

Emergency nursing job stress, burnout, and turnover rates have all been shown to have clear correlation with one another.[2-4] Even more so, Ahwal and Arora[2] found that a decrease in *both* physical and psychological stressors would significantly improve patient care and nurse retention rates in the emergency department. Adriaenssens et al[7] took this further and recommended that emergency nursing managers become aware of these stressors and proactively implement preventative measures.

Furthermore, team dynamics have been shown to have a *greater* impact on job stress than time management;[4] group cohesion and general nursing staff retention improved after implementation of team-building interventions.[8] Unfortunately, I have not found studies that explore these relationships specifically among the ED population and therefore would kindly like to call upon the emergency nursing community for further exploration of team dynamics and group cohesion on emergency nursing job stress.—*Hannah V. Wade, BSN, RN, CEN, El Paso, TX; E-mail: hannahvwade@gmail.com.*

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# Strategies to Aid Identification of Apheresis PowerFlow Ports: A Case Report

**Authors:** Janique C. Gill, BSN, RN, Darlene J. Oakley, BSN, RN, and Oluwatoyosi A. Onwuemene, MD, MS, Durham, NC

**Contribution to Emergency Nursing Practice**

- The apheresis PowerFlow port is a new implantable venous access device that is different from other commercially available ports because it is accessed, not with a Huber needle, but with a catheter-over-needle intravenous device at a 30° angle.
- The main finding of this article is that when a patient with a history of apheresis procedures presents with a long-term access port, additional investigation and evaluation should be performed to confirm the correct port type and to select the proper access device.
- In emergency clinical practice, when a new technology such as the apheresis PowerFlow port is introduced into a hospital system, special attention should be paid to the education and training of all available stakeholders, including ED providers.


## Abstract

**Introduction:** The PowerFlow implantable apheresis intravenous port is a venous access device for therapeutic apheresis procedures. In this case review article, we identify key similarities and differences between apheresis PowerFlow ports and traditional ports. We also list strategies that emergency departments can implement to aid in correct port identification.

**Methods:** Using a case review format, we describe the clinical presentation of a 33-year-old female with neuromyelitis optica who was evaluated in the emergency department for an acute exacerbation. She had a history of outpatient apheresis procedures that made use of bilateral PowerFlow ports. Mistaken for a conventional port, the right PowerFlow port was accessed with a Huber needle rather than the appropriate catheter-over-needle device. On infusion of intravenous fluids, the patient experienced pain and swelling. Ultimately, the port malfunctioned and was eventually replaced.

**Results:** A subsequent root cause analysis identified opportunities for education and aids to improve port identification. To this end, strategies were implemented to appropriately identify the PowerFlow port using at least 2 of the following methods: (1) look in the patient's chart for record of an implantable apheresis intravenous port; (2) check the port identification card, bracelet, or keychain issued at insertion; (3) palpate the port to look for the rounded top and hollow concave entry point; and (4) use x-ray or fluoroscopy to identify radiopaque port markers.

**Conclusion:** When a patient with a history of apheresis procedures presents with an implanted port, steps should be taken to ensure correct identification and access.


**Key words:** Blood component removal; Plasmapheresis; Plasma exchange; Vascular access devices; Case report

## Introduction

Approved for use in the United States in 2017, the PowerFlow implantable apheresis intravenous (IV) port (BD, Tempe, AZ) has facilitated venous access in an increasing number of patients undergoing therapeutic apheresis procedures.[1-4] To this end, PowerFlow ports are used in therapeutic apheresis outpatients undergoing scheduled courses of extracorporeal photopheresis, red blood cell exchange, or therapeutic plasma exchange. Since its introduction to the US apheresis community, the PowerFlow port has been implanted in approximately 4000 patients (BD e-mail communication, September 24, 2020). With growing adoption of the PowerFlow port,

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J Emerg Nurs 2021;47:21-7.
Available online 11 November 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.10.004

adverse effects that are typical of implantable venous access devices have been reported, including infection, thrombosis, catheter rotation, and catheter-tip migration.[4,5] However, as PowerFlow ports become more common, a potential new source of adverse events is port misidentification.

Misidentification may occur when the PowerFlow port is encountered by providers who are more familiar with conventional ports. Although conventional and PowerFlow ports have the same general functions, they are fundamentally and structurally different. Conventional ports, including the Port-a-Cath (Smiths Medical, Dublin, OH) and Vortex (Angiodynamics, Latham, NY), sit parallel to the skin. Therefore, port access is achieved with a highly specialized Huber needle, which breaks the skin and pierces the port's interior septum at an angle that is perpendicular to the skin (Figure 1).[6,7] In contrast to available commercial ports, the PowerFlow port is accessed with any 14- or 16-gauge catheter-over-needle IV device. The needle enters the skin at an approximately 30° angle, and the catheter is inserted over the needle to open the internal valve[8] (Figure 1). Not only is the PowerFlow port different in access angle, but it is also shaped differently. Instead of the palpation bumps and the triangular shape of a conventional port, the PowerFlow port has a rounded funnel top and a hollow concave funnel entry point (Figure 2).[9] As outlined in Table 1, key structural differences easily distinguish the PowerFlow port from conventional ports. However, these distinguishing features may not be obvious to the uninitiated clinician encountering a PowerFlow port for the first time.

In this article, we highlight the identifying features of PowerFlow ports, using a case review format. The objective of this case review is to identify key similarities and differences between apheresis PowerFlow ports and traditional ports as well as list key strategies that emergency departments can implement to aid in correct port identification.

FIGURE 1

Manufacturer pictures of the PowerFlow port (left) and conventional port (right). The PowerFlow port is accessed with an intravenous catheter at a 30° access angle compared with the conventional port, which is accessed with a Huber needle at a 90° angle.

## Case Report

A 33-year-old female with a history of neuromyelitis optica presented to the emergency department with an acute exacerbation. Over the preceding 24 hours, she had developed the sudden onset of right (R) lower extremity numbness and weakness, beginning in her toes and extending to her thigh. At baseline, she transferred with assistance and used a wheelchair outside the home. At the time of presentation, she was experiencing difficulty with transfers, even with assistance. Her symptoms were consistent with a previous neuromyelitis optica exacerbation, for which she had been treated in the emergency department 1 year prior. As summarized in the timeline in Table 2, she had recently been initiated on long-term immunosuppressive therapy and therapeutic plasma exchange once monthly. Approximately 1 year prior, because of poor venous access and the need for chronic therapeutic plasma exchange, she had undergone placement of bilateral PowerFlow ports, which were used during her once monthly therapeutic plasma exchange. The PowerFlow ports were last used for therapeutic plasma exchange 1 month before presentation.

On physical examination, her vital signs showed a normal temperature of 36.2 °C (97.2 °F). Her blood pressure was 125/68 mm Hg with a pulse of 90 beats per minute. Her respiratory rate was 18 with a corresponding oxygen saturation of 100% on room air (fraction of inspired oxygen 21%). A detailed neurologic examination showed the following key findings:

(1) Motor: An assessment of motor strength of the left (L) and R upper and lower extremities showed decreased strength in the bilateral hip flexors (2 of 5), knee flexors (1 of 5 L; 3 of 5 R), knee extensors (1 of 5 L; 3 of 5 R), plantar flexors (2 of 5), and dorsi flexors (2 of 5).
(2) Sensation: A sensory examination showed decreased sensation to light touch and pinprick in the R lower extremity from the toes to the upper thigh. Sensation was intact in the L lower and bilateral upper extremities.
(3) Coordination: The finger to nose examination was intact bilaterally. Owing to weakness, the heel-to-shin examination was unable to be assessed.
(4) Reflexes: Reflexes were 2+ throughout the bilateral upper extremities and 3+ throughout the bilateral

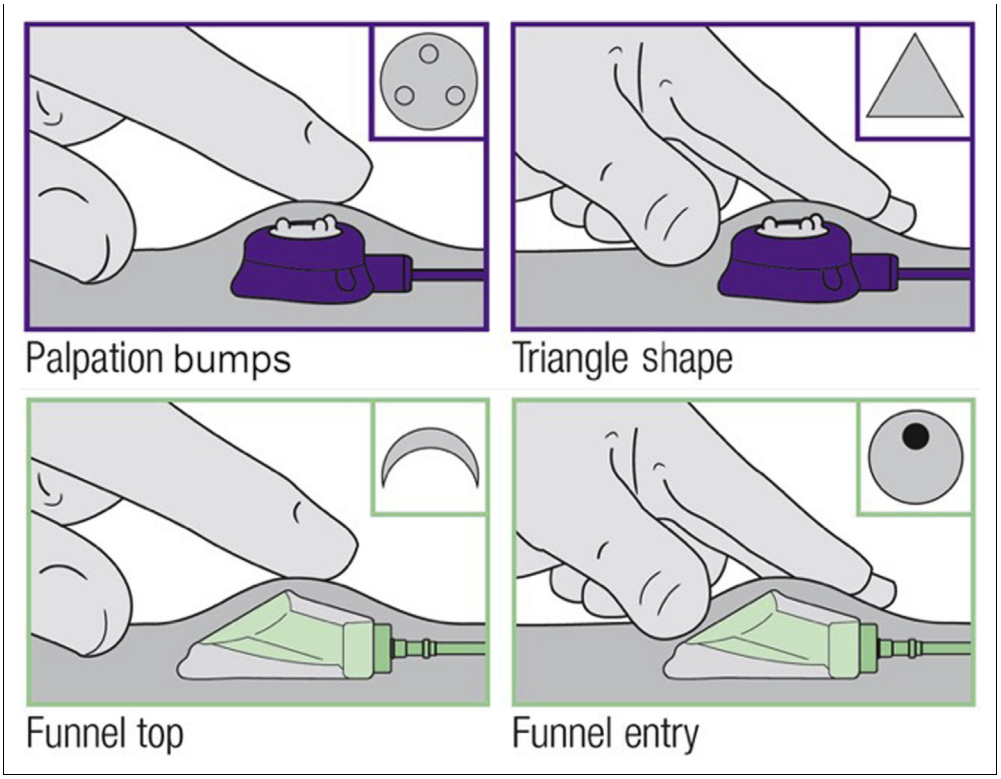


FIGURE 2

Comparison of conventional port and the PowerFlow port. The top panel shows that the conventional port has 3 palpation bumps and a triangular shape, which is different from the PowerFlow port, shown in the bottom panel, with a funnel top and funnel entry.

lower extremities. She was noted to have sustained ankle clonus bilaterally with bilateral upgoing toes.

(5) Gait: Owing to her baseline weakness, the gait examination was deferred.

After the initial evaluation, the ED provider placed a consult to neurology. For acute treatment, the neurologist recommended IV fluids and methylPREDNISolone, 1000-mg IV administered over 60 minutes. Therefore, vascular access was desired; however, peripheral venous access was difficult. Because of the presence of an implantable venous access device, the port was accessed with a Huber needle. With good blood flow and return through the Huber needle, medications were administered, and a fluid bolus was given. However, within minutes of the infusion, the patient experienced unexplained access site pain and swelling.

The patient was admitted to the neurology service and therapeutic plasma exchange was requested. When the apheresis nurse came to the room to initiate the procedure, she noticed the access site swelling and saw that the right PowerFlow port had been incorrectly accessed with a Huber needle. Further investigation with a chest x-ray confirmed that the Huber needle was inserted perpendicular to the port, away from the port lumen (Figure 3). This placement resulted in the delivery of the IV fluids to the port pocket and not the intended vein. The Huber needle was removed safely and, over a few days, the port-site pain and swelling resolved. However, the R port developed progressive resistance to aspiration. Evaluation with fluoroscopy revealed that the catheter tip was "retracted and angled" posteriorly. Thus, the patient underwent port replacement. Over the course of a 14-day hospitalization (Table 2), the acute neuromyelitis optica symptoms resolved, and the patient was discharged home safely. A postdischarge follow-up revealed that the patient was doing well. The patient gave informed consent regarding the case review and use of the de-identified x-ray image.

## Discussion

First described in 1894, neuromyelitis optica refers to a spectrum of inflammatory disorders causing immune-mediated demyelination of the central nervous system.[10,11]

TABLE 1
**Key differences between PowerFlow and conventional ports**

| Catheter parameters | PowerFlow port | Conventional ports |
|---|---|---|
| Apheresis indication | FDA approved in 2017 | Off-label use |
| Radiopaque identifier | Radiographic shape is like a round bottom flask | Radiographic shape is a triangle |
| Differences in palpation | Funnel-shaped top and entry point | Triangular shape with palpation bumps |
| Access device | 14- or 16-gauge catheter-over-needle | Huber needle |
| Access angle | 30° | 90° |
| Entry method | Intravenous catheter opens a valve | Huber needle pierces a septum |
| Apheresis procedure flow rates | Up to 100 mL/min | Up to 50-60 mL/min |

FDA, Food and Drug Administration.

Neuromyelitis optica affects up to 1 in 10 000 people,[12] with a median age of onset in the early 30s and 40s.[13,14] Neuromyelitis optica primarily affects the spinal cord and optic nerves, leading to clinical features of optic nerve inflammation (optic neuritis) and/or spinal cord inflammation (transverse myelitis).[15,16] In up to 90% of cases, neuromyelitis optica presents with a relapsing course of acute attacks with alternating episodes of optic neuritis, transverse myelitis, or both,[17] leading to vision loss, paralysis, and/or bladder dysfunction. Patients can also present with brainstem syndromes characterized by intractable nausea, vomiting, and/or hiccups.[18,19] Because the primary pathogenic feature of neuromyelitis optica is an immunoglobulin G autoantibody against aquaporin 4,[20] patients are treated with long-term immunosuppressive therapy. However, acute attacks are managed with high-dose steroids and/or therapeutic plasma exchange.[15]

As an important neuromyelitis optica rescue therapy, therapeutic plasma exchange works by removing plasma and plasma-based antibodies, replacing diseased plasma with donor plasma or albumin.[21] During therapeutic plasma exchange, 1.0 to 1.5 plasma volumes are processed to achieve a median of 4 to 5 treatments over a period of 1 to 2 weeks.[22-24] Within 1 to 3 days of initiating therapeutic plasma exchange, patients experience moderate to marked improvement in symptoms and functional status. Thus, early therapeutic plasma exchange initiation is recommended in acute neuromyelitis optica exacerbations that are unresponsive to steroids.[15] In addition to its role as a rescue therapy, intermittent therapeutic plasma exchange may also be used as a preventative or maintenance therapy.[21]

When therapeutic plasma exchange is used intermittently, it is essential to have stable vascular access. The preferred therapeutic plasma exchange vascular access strategy is peripheral access using a large-bore IV in the wrists or the forearm.[25] Over time, however, peripheral access difficulties may arise, requiring more advanced and/or permanent access. Available access options include arterial lines, central venous catheters, arteriovenous fistulae or grafts, and ports.[9,25] Conventional ports have been used off-label for therapeutic plasma exchange with the primary limitation of low procedural flow rates of approximately 50 to 60 mL/min.[9] With faster flow rates of up to 100 mL/min, the PowerFlow port achieves faster procedural times. In addition, the PowerFlow port's decreased tendency to form fibrin clots avoids time-wasting preprocedural clot lysis, making the PowerFlow port the preferred port for therapeutic plasma exchange access.[3,8,9]

Because the PowerFlow port is the first commercially available port to have a different access strategy from preceding ports, there does not yet exist any literature to distinguish the PowerFlow from other ports. Nevertheless, identifying the presence of a port has previously been established using radiopaque markers.[26,27] Until this case, venous access device identification protocols were not previously established at our institution. Therefore, it was determined that the sentinel access error event warranted a root cause analysis (RCA).

An RCA is a systematic approach to understanding the nonhuman factors and systems-wide issues that may contribute to an adverse event.[28] Because it looks beyond human errors to find systems vulnerabilities that are actionable, the RCA plays an important role in performance improvement. In our case, the RCA assembled all stakeholders involved in accessing and managing implantable venous access devices, including representatives from apheresis, bone marrow transplant, the emergency department, interventional radiology, vascular access, oncology infusion, nursing education, and nursing informatics.

TABLE 2
**Timeline of history, presentation, and hospital course**

| Time | | Event |
|---|---|---|
| Before presentation | 4 y earlier | Neuromyelitis optica diagnosis |
| | 2 y earlier | Intermittent TPE initiated |
| | 9 mo earlier | PowerFlow ports placed for monthly TPE |
| | 1 mo earlier | Received scheduled TPE |
| | 24 h prior | New numbness and weakness |
| ED presentation with acute neuromyelitis optica exacerbation | | |
| After presentation | 7-8 h later | Neurology evaluation and acceptance for admission |
| | 12 h later | R port accessed with Huber needle |
| | 14 h later | Patient complained of access site pain |
| | 18 h later | Imaging evaluation and Huber needle removed |
| | Hospital d 1 | TPE #1 aborted owing to access difficulty |
| | Hospital d 4 | TPE #1 (access facilitated by IR) |
| | Hospital d 6 | TPE #2 |
| | Hospital d 8 | TPE #3 |
| | Hospital d 11 | TPE #4 aborted owing to access difficulty |
| | Hospital d 12 | TPE #4 after R port replacement |
| | Hospital d 13 | TPE #5 |
| | Hospital d 14 | Discharged |

ED, emergency department; TPE, therapeutic plasma exchange; R, right; IR, interventional radiology.

During the RCA, vascular access policies were reviewed. Apheresis vascular access devices are typically reserved for access by apheresis nurses, with back-up access provided by a vascular access nurse, when the apheresis nurse is not available. Hospital policy does not permit an apheresis port to be used for common IV access without the consent of the apheresis team. In this case, an apheresis nurse should have been contacted for access; however, existing processes failed because the port was not immediately recognized to be an apheresis access port. Therefore, the RCA team recommended the use of identification alerts to notify providers of the presence of an apheresis-designated port. To this end, the informatics team implemented an identification system in the electronic health record to trigger a best practice advisory pop-up banner, which alerts providers that the PowerFlow port is present.

Secondly, the issue of appropriate training was reviewed. Consistent with hospital guidelines, when the PowerFlow port was introduced to the health system, training had been given to both the apheresis and vascular access nurses. However, because the device was in use in only a minority of patients,[29] the apheresis nurses were the most experienced users. The vascular access nurses, although trained, had not had enough opportunity to practice identifying and using the ports. To this end, it was recognized that education was needed to alert all providers that a history of therapeutic apheresis procedures should prompt providers to further investigate the presence of a PowerFlow port.

Thirdly, the issue of both provider and patient education was raised. When the patient's perspective was solicited, she indicated that she knew her port was "special," but was unable to articulate how. During the port access procedure, she had been concerned that her port was being accessed in an unfamiliar manner; however, she deferred to the provider's expertise. This perspective helped emphasize the importance of the patient's role in provider education. Noting the power differential that often exists between patients and providers,[30,31] patients undergoing apheresis are now encouraged to share their port identification card with providers who may be unfamiliar with the PowerFlow port.

For the providers, the RCA team targeted education strategies to make them aware of the availability of a new port. Furthermore, whenever providers encountered any port, the RCA team supported strategies to encourage

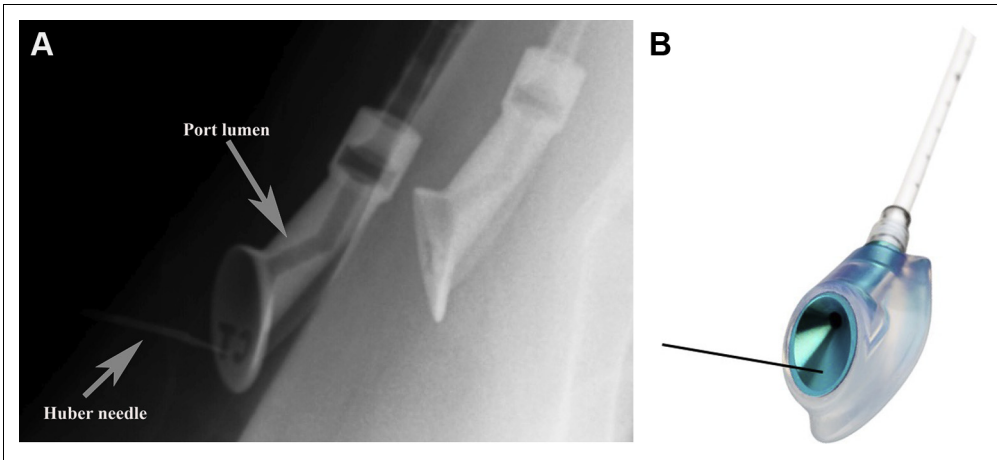


FIGURE 3

Images of Huber needle inserted in PowerFlow port. (A) A magnified image of the lateral chest x-ray shows the Huber needle inserted perpendicular to the patient's PowerFlow port, away from the lumen. (B) A representative image of the PowerFlow port demonstrates that the Huber needle (represented by a straight line) was inserted far from the catheter lumen. To this end, infused fluids would end up in the port pocket and not the intended vein.

introspection whenever a history of apheresis is present. Thus, the RCA team established a new port identification protocol, encouraging providers to identify ports using a minimum of 2 of the following methods:

(1) Look in the patient's chart for record of an implantable apheresis IV port;
(2) Check the port identification card, bracelet, or keychain that was issued at insertion;
(3) Palpate the port to look for the rounded top and hollow concave entry point; and
(4) Use x-ray or fluoroscopy to identify radiopaque port markers.

With the implementation of these strategies, incorrect access of a PowerFlow port has not recurred at our institution. Other institutions may need to tailor their strategies to their patients and their providers, including consideration of the use of a Medic Alert bracelet to inform providers of the presence of the PowerFlow port.

The strengths of this case review lay in its presentation of a novel, and yet unrecognized, catheter complication, which may become more commonplace as the use of the PowerFlow port becomes more widespread. Nevertheless, the primary limitation of the case report was that it likely highlights process challenges unique to our institution that may not be seen at other centers. Regardless, an increased awareness of the use of the PowerFlow port in patients undergoing apheresis and a working knowledge of the differences between the PowerFlow and conventional ports may help prevent similar errors as institutions work to establish their own port identification protocols.

## Conclusion

As illustrated in the case review, problems may occur when new, unfamiliar technology is introduced into hospital practice without the requisite education and training of all stakeholders, including ED providers. A history of apheresis should prompt the provider to further investigate the type of port before access. Until apheresis PowerFlow ports become more widespread in use, port identification strategies should be implemented and tailored to the institution's need.

## Author Disclosures

Conflicts of interest: none to report.

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# Dermal Hydrofluoric Acid Toxicity Case Review: Looks Can Be Deceiving

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CE Earn Up to 10.5 Hours. See page 206.

**Contribution to Emergency Nursing Practice**

- The current literature on the management of dermal hydrofluoric acid exposures indicates that there is limited information on how to rapidly prepare topical preparations of calcium salts.
- This article contributes a description of the successful management of a dermal hydroflouric acid exposure using a compounded preparation of calcium gluconate injection.
- Key implications for emergency nursing practice found in this article include a review of the identification and treatment of dermal hydroflouric acid exposure, and extemporaneous compounding of calcium salts.

**Abstract**

Hydrofluoric acid is a caustic compound found in a wide variety of items for household and industrial uses. Dermal exposures can be visually unimpressive on presentation but still have fatal complications. This case review includes a description of a patient presenting with a dermal hydrofluoric acid burn that was effectively treated with topical calcium gluconate gel. Also highlighted are the challenges faced with recognizing the severity and appropriately treating dermal hydrofluoric acid burns in the emergency department.

**Key words:** Clinical pharmacology; Clinical pharmacy services; Emergency Services, Hospital; Toxicology; Chemical burn; Hydroflouric Acid

## Introduction

Hydrofluoric acid (HF) is used across a diverse set of trades, including the glass-etching, semiconductor, rust removal, and dental industries. In addition to its industrial uses, HF is found in lower concentrations in household items such as toilet bowl cleaners, automobile wheel cleaners, and insecticides.[1] Given the ease of accessibility to HF, exposures are bound to occur. Unlike burns caused by other caustics, HF burns may not appear visually impressive, but they can be acutely life-threatening. The patient reviewed in this case sustained an HF burn to the hand and presented twice to the emergency department.

## Case Report

An otherwise healthy 33-year-old man presented to the emergency department after spilling a 47% HF solution on his left hand. He was treated with topical calcium carbonate paste, provided a prescription for topical calcium on discharge, and educated on when to return. The next day, the patient returned complaining of increased pain at the site of exposure and persistent fever.

On physical examination, the tips of his second and third digits were blanched with blisters and underlying white fluid, and there was bluish discoloration underneath the fingernails. He had normal radial pulses, and movement

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J Emerg Nurs 2021;47:28-32.
Available online 9 November 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.08.005

of the hand was intact. Further work-up revealed a fever of 38.6°C (101.4°F), white blood cell count of 19.1 k/mm$^3$, and an anion gap of 19. All other initial results were unremarkable, including the QTc interval (413 msec) and serum calcium (9.5 mg/dL). An X-ray showed no acute osseous abnormalities, and ultrasound revealed fluid collections in the area of exposure on the second and third digits.

Empiric vancomycin was given for suspected cellulitis, and he was admitted for further management. The poison control center staff recommended topical calcium to manage the patient's persistent pain. They suggested compounding a 32.5% calcium carbonate paste using 100 g of calcium carbonate (10 10-g oral tablets) and 20 mL of a water-soluble lubricant. The only crushable calcium product available in the local formulary was in the form of 500-mg calcium carbonate tablets, which complicated the preparation. Alternatively, 25 mL of 10% calcium gluconate injection was mixed with 75 mL of a water-soluble lubricant to achieve a 2.5% calcium gluconate gel. This gel was applied to the area before placing the patient's hand in a glove.

The patient required multiple applications of the gel to alleviate his pain. On physical examination the following day, the affected second and third digits appeared dark gray, but the blanching had resolved. During his admission, his serum calcium further decreased, but did not result in any clinically significant events. The patient received a total of 3 doses of vancomycin until the underlying cellulitis was ruled out. Orthopedic surgery determined that there was no need for surgical aspiration, revascularization, or debridement. The patient was discharged after approximately 30 hours of observation, with topical calcium gluconate, nonopioid analgesics, and instructions to follow up with outpatient providers.

## Mechanism of Toxicity

Aqueous HF is a weak acid with a permeability coefficient of $1.4 \times 10^{-4}$ cm per second that allows it to penetrate deeply into the tissues.[2] Once dissociated, the highly electronegative fluoride ion complexes with positively charged ions such as calcium and magnesium, both intracellular and extracellular, to form insoluble salts.[3,4] Although this results in local tissue injury after dermal exposures, life-threatening electrolyte imbalances resulting in ventricular dysrhythmia and cardiac arrest are also possible.[3,4]

## Dermal Manifestations

The caustic burns that manifest after most HF exposures will not appear visually impressive.[4] Unlike other caustics that result in a coagulative necrosis limiting further absorption, HF rapidly and deeply penetrates the dermal layers owing to its high permeability coefficient to cause cellular damage and/or death.[4,5] The site of exposure may initially appear benign, but as time passes the skin will become blanched, and a white discoloration will form as the calcium precipitates.[4,6] Ulceration may develop in exposures to high concentrations or after prolonged exposures to HF.[4]

Although dermal HF burns may initially appear nontoxic, the patient will complain of seemingly incongruent levels of pain. The formation of insoluble calcium fluoride causes a disruption of calcium homeostasis, causing neuroexcitation and neuropathic pain at the burn site.[6,7] In addition, the abrupt change in serum and local calcium results in vasospasm-related ischemia, which may also contribute to the pain experienced by patients exposed to HF.[6,7]

Both the onset and severity of symptoms vary depending on the duration, percentage of body surface area, and the concentration of HF to which the patient was dermally exposed.[1,6] After dermal exposure to low or moderate concentrations of HF, there can be up to a 24-hour delay in pain and erythema; high concentrations (>50%), in contrast, will result in immediate tissue damage and pain.[1,4,6,8] Patients exposed to HF concentrations of 20% or higher should be monitored closely because they are at significant risk for systemic toxicity.

## Systemic Toxicity

Systemic toxicity should be anticipated after dermal exposures to HF concentrations of 20% or higher, particularly if the exposure involves more than 2.5% of the body surface.[4,9] Because systemic toxicity may first manifest with hypocalcemia, hypomagnesemia, and hyperkalemia, laboratory test results should be obtained quickly and monitored hourly.[8] These electrolyte imbalances may precipitate ventricular arrhythmias, including ventricular fibrillation, and are almost always present in fatal HF exposures.[4] The resultant arrhythmias are suspected to be the primary cause of death in systemic HF toxicity, although direct myocardial damage has also been reported.[4,5] The decrease in serum calcium stores may also affect the coagulation cascade, placing patients with HF toxicity at increased risk of hemorrhage.[5] Although beyond the scope of this article, it should be noted that oral ingestions of HF are almost invariably fatal.[10]

## Management

The mainstay of treatment is to limit systemic absorption with decontamination, neutralize fluoride ions, rapidly correct electrolyte imbalance, and assess for systemic

TABLE
**Extemporaneous compounding recipes for topical calcium gels**[4,11,12]

| Source of calcium | Amount of calcium | Amount of water-soluble lubricant, mL | Final concentration, % |
|---|---|---|---|
| Calcium gluconate powder | 3.5 g | 150 | 2.2 |
| Calcium gluconate injection 10% | 25 mL | 75 | 2.5 |
| Calcium carbonate tablets, 10 g | 10 tablets | 20 | 32.5 |

toxicity.[4] Intravenous access, and serum calcium, magnesium, and potassium concentrations should be obtained. An electrocardiogram should also be evaluated for the characteristic indicators of electrolyte imbalance such as QTc prolongation in the setting of hypocalcemia. Adjunctive analgesics can be administered to control pain; they should be used cautiously, however, because pain is the main indicator of treatment failure.[11]

Decontamination is the first step of any HF exposure treatment, regardless of the concentration of HF, duration of exposure, or the severity of symptoms.[4,5,8] All contaminated clothing, jewelry, and other garments should be rapidly removed to avoid continued exposure. The site of exposure should be thoroughly irrigated with water or saline for a minimum of 15 minutes to 30 minutes, with special attention paid to easily overlooked areas of exposure such as skin folds.[1,11]

Local neutralization of fluoride ions is typically achieved with topical calcium preparations.[4,11] If a commercially available topical calcium product is unavailable, 1 can be compounded using an available source of calcium (Table).[4,11,12] Although calcium gluconate is the preferred calcium salt, calcium carbonate may also be used.[4] Topical gels should be applied directly to the affected area, or mixed in a sterile surgical glove and placed on the patient's hand for 30 minutes.[1,4] Topical applications can be repeated every 4 to 6 hours for 3 to 4 days.[1] On reaction with the fluoride ions, the gel turns white, and pain relief should be apparent almost immediately after application.[1,4] It is worth noting that exposures occurring 12 to 24 hours before treatment may experience limited benefit from topical therapy.[4]

Intradermal calcium injections may be considered if topical therapy provides inadequate pain relief. This should be reserved for more severe exposures owing to the increased risk of tissue damage, compartment syndrome, and infection.[4] Intra-arterial calcium gluconate infusions may be considered in the case of severe burns, pain despite topical treatment, exposure to large surface areas, or when intradermal therapy is not an option (ie, HF under the nail beds).[1,4,5] Calcium chloride is contraindicated for both intradermal and intra-arterial injections owing to increased risk of tissue damage and lack of observed benefit over calcium gluconate.[8,11] Surgical debridement should also be considered to remove blisters, and necrotic and contaminated tissues, and to trim or remove affected nails.[1,11]

In the event that systemic toxicity develops, patients should immediately receive intravenous calcium and magnesium repletion. Acidemia should be corrected with hydration and intravenous sodium bicarbonate.[4] In severe cases, hemodialysis may be warranted.[1,4] Airway status and the potential need for intubation should also be evaluated because some patients may not be able to protect their own airway.[4] It is reasonable to avoid succinylcholine if an alternative paralytic is available to avoid the potential for hyperkalemia.[4]

## Discussion

The patient discussed here was discharged on his first visit to the emergency department without any laboratory monitoring despite being exposed to 47% HF. The lack of visually appreciable tissue damage at that time may explain not only his quick discharge, but also why laboratory monitoring was not performed during this initial visit. The potential for a delayed onset of severe tissue damage and life-threatening manifestations of systemic toxicity should have prompted a longer observation period for this patient. When evaluated on his second visit, there was no evidence of any clinically significant electrolyte abnormalities or cardiac toxicity.

The patient was provided a prescription for topical calcium on discharge from his initial ED visit. Because there was no evidence that the prescription was filled, it would be inappropriate to consider this a treatment failure. Furthermore, the effect of topical therapy on pain control may have been limited because it had been more than 12 hours since the exposure. Because the presentation was within 24 hours of exposure, however, it would be reasonable to continue topical treatment and not advance to intradermal

or intra-arterial routes, which are reserved for true topical-treatment failure owing to the inherent risks.

When the patient presented to the emergency department for the second time, the burn was more visually impressive, which prompted laboratory monitoring, imaging, and consultation. It is worth noting that intradermal or intra-arterial calcium therapy were likely justifiable in this patient owing to the discoloration of the fingernails. Because of the high permeability coefficient, this discoloration may have suggested deeper tissue involvement; therefore, one could argue that alternative treatment strategies were warranted. Given its limited transdermal absorption, failure to supply exogenous calcium to the deeper tissues could have resulted in a progression to systemic toxicity. Because there was no evidence of electrolyte imbalance or cardiac instability it was, again, reasonable to proceed with topical therapy.

Because calcium carbonate has limited water solubility, there was some concern that the crushed calcium carbonate tablets might not disperse throughout the available water-based lubricant, and thus have limited efficacy. In addition, the facility only had 500-mg tablets available. To achieve the final concentration recommended by the poison control center staff, this would have required the crushing of 200 tablets. This was not only a time-consuming option, but it was also surmised that there would have been poor dermal absorption of the remaining solid particulates, given the low likelihood that all of the powder would have solubilized in the lubricant.

## Implications for Emergency Nurses

Patients with dermal HF burns may initially present with minimal visible tissue damage, and complain of pain seemingly disproportionate to the injury. It is imperative to appreciate the low likelihood of coagulative necrosis manifesting shortly after low-concentration HF exposures. Nonetheless, treatment should proceed with aggressive decontamination, ion neutralization, and monitoring for electrolyte imbalance. The early obtainment of an electrocardiogram can help identify life-threatening electrolyte imbalances before laboratory results become available.

The poison control center should be contacted at 1-800-222-1222. Analgesics should be used cautiously because pain is an early indicator of treatment failure. Topical calcium preparations should be used to mitigate pain at the site of exposure. Because commercially available topical calcium products may not be readily available, ED staff should know how to quickly compound a topical gel using available calcium products.

## Conclusion

HF is a widely accessible caustic that can cause potentially fatal consequences if exposure is not treated promptly. Dermal exposures require immediate attention and should not be underestimated, despite the benign appearance. Fluoride ions quickly permeate the deep tissue layers to cause not only severe local tissue damage, but also potentially fatal systemic toxicity. Although there are no definitive guidelines for the management of HF exposure, calcium gluconate remains the mainstay of therapy. A 2.5% calcium gluconate gel can be easily compounded if commercial preparations are unavailable.

## Author Disclosures

Conflicts of interest: none to report.

The authors certify that all elements of this case review conform to both the local and Elsevier's patient consent policies.

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# Emergency Care Considerations for the Transgender Patient: Complications of Gender-Affirming Treatments

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CE Earn Up to 10.5 Hours. See page 206.

**Contribution to Emergency Nursing Practice**

- The current literature on the complications of gender-affirming treatments indicates that emergency nurses lack proper education on the subject.
- This article contributes knowledge regarding the pathophysiological complications of transgender-related treatments and procedures that may be encountered in the emergency department.
- Key implications for emergency nursing practice found in this article are an understanding of transgender anatomic variations, hormone therapy adverse effects, and complications of surgical manipulation.

**Abstract**

The transgender population presents a unique challenge for the emergency nurse. There are types of surgeries, medications, complications, and differences in laboratory testing that are unique to transgender people. In addition, emergency nurses are increasingly encountering more transgender patients in the emergency department for care, referrals, and education. Yet, many emergency nurses lack the formal training to care for transgender patients and their families. A complete understanding of the terminology, gender-transforming surgeries, hormonal suppression and augmentation of sexual characteristics, adverse effects, complications of surgeries, and ongoing health risks owing to the altered hormonal milieu and potential risk for acquiring sexually transmitted diseases is important to provide the necessary emergency care for this emerging population.

**Key words:** Transgender persons; Gender identity; Sexually transmitted diseases; Emergency care

As is the case with many other at-risk and disadvantaged populations, transgender individuals belong to a marginalized segment of the United States population and experience disparities in health care. For many transgender patients, emergency departments serve as their health care safety net. Traditionally, consideration of health care in the emergency setting for the transgender population has been largely overlooked. Consequently, education regarding the unique terminology and pathophysiological considerations of the transgender patients in the emergency department is crucial.

## Terminology

Effective communication with patients of gender and sexual minorities improves outcomes and increases adherence to the treatment regimen. The terminology used in gender and sexuality discussions is in a state of rapid evolution and can lead to awkward interviews with patients if used

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J Emerg Nurs 2021;47:33-9.
Available online 3 October 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.07.009

TABLE 1
**Gender terminology**

| Term | Definition |
|---|---|
| Cisgender | A term used to describe a person whose gender identity aligns with the sex assigned to them at birth. "Cis" is the opposite of "trans." |
| Gender dysphoria | Clinically significant emotional distress caused when the birth gender is not the same as the gender identity. |
| Gender-expansive | Conveys a wider, more flexible range of gender identity and/or expression than typically associated with the binary gender system. |
| Gender expression | External appearance of one's gender identity, expressed through behavior, clothing, haircut, or voice; may not conform to socially defined feminine and masculine behaviors and characteristics. |
| Gender-fluid | A person who does not identify with a single, fixed gender; rather, has an unfixed or fluctuating gender identity. |
| Gender identity | One's innermost concept of self as male, female, a blend of both or neither—and what they call themselves. It may be the same as or different from their sex assigned at birth. |
| Gender nonconforming | A broad term referring to people who do not behave in a way that conforms to the traditional expectations of their gender, or whose gender expression does not fit neatly into a category. |
| Genderqueer | Genderqueer people typically reject notions of static categories of gender and embrace a fluidity of gender identity and often sexual orientation. They may see themselves as being both male and female, neither male nor female, or as falling completely outside these categories. |
| Gender transition | The process that some people go through as they strive to more closely align their internal gender with its outward appearance. Some people socially transition—by dressing and using names and pronouns—and will be socially recognized as another gender. Others undergo physical transitions in which they modify their bodies through medical and surgical interventions. |
| Intersex | An umbrella term used to describe a wide range of natural bodily variations. In some cases, these traits are visible at birth, and in others, they are not apparent until puberty. Some chromosomal variations of this type may not be physically apparent at all. |
| Nonbinary | An adjective describing a person who does not identify exclusively as a man or a woman. Nonbinary people may identify as being both a man and a woman, somewhere in between, or as falling completely outside these categories. Many also identify as transgender. |
| Transgender | An umbrella term for people whose gender identity and/or expression are different from cultural expectations based on their sex assigned at birth. Being transgender does not imply any specific sexual orientation. Therefore, transgender people may identify as straight, gay, lesbian, bisexual, and so on. |

Adapted from Glossary of Terms, by Human Rights Campaign, https://www.hrc.org/resources/glossary-of-terms.

inappropriately. When discussions relating to gender and sexual identity are necessary, an understanding of the correct terminology, as well as terms and phrases to avoid, can lead to more appropriate care (Tables 1 and 2).

Although nurses often use the terms interchangeably, sex and gender are not synonymous. Sex refers to the individual's biological attributes that are identified at birth. The person's external genitalia, reproductive organs, and chromosomes define sex. Gender is more abstract and often grounded in culture and personal belief. Gender identity is the internal feeling of being male, female, a combination of the 2, or neither. Gender expression is the external manifestation of an individual's gender identity. For nurses, it is important to understand that unlike gender expression, gender identity is not visible to others and may not align with socially defined behaviors and characteristics. Therefore, assuming a patient's gender identity on the basis of their appearance or behavior can lead to miscommunication, incorrect treatment, and a missed diagnosis.

## Clinical Considerations

### ANATOMY

An integral part of the patient history involves determining the patient's anatomy and whether the patient has undergone any gender-affirmation surgery. Gender-affirming

TABLE 2
**Affirming language**

| |
|---|
| What name would you like me to call you? |
| What sex was assigned to you at birth? |
| What pronoun should I use when referring to you? |
| May I use this name and pronoun to communicate with your visitors during this visit? |
| I need to ask you questions about your sexual health and activity because it may be related to the problem you are here for. Is this okay? |

treatment is defined as the treatment that transgender individuals pursue to make their bodies adapt to the gender with which they identify, which occurs by means of surgery or hormones.[1] Knowing the patient's surgical history will help the nurse determine risk factors and formulate a list of differential diagnoses. For example, determining the patient's gender identity and gender assigned at birth is paramount to ordering the correct diagnostic tests for abdominal pain. The differential diagnosis may change vastly on the basis of the patient's gender assigned at birth as opposed to their gender identity. It is important to note that some transgender patients may not use any medical or surgical interventions but identify as transgender.

Regardless of transgender status, this does not necessarily correlate with a choice of romantic or sexual partner. Thus, the risk of sexually transmitted infections is based on which body orifice is used for sexual pleasure. Because transwomen do not have a cervix, uterus, or fallopian tubes, they cannot acquire pelvic inflammatory disease (from penile-neovagina penetration). However, they may contract gonorrhea, chlamydia, trichomonas, herpes, hepatitis, and human immunodeficiency virus (HIV) through their neovagina. Likewise, a transman who has undergone genital surgery to make a neopenis would be at risk for contracting any disease present in the receptive orifice. In response to the HIV epidemic, the World Health Organization asked for a review to identify the most vulnerable populations who are at a high risk of HIV infection. Five key populations were identified, which include people in prisons, sex workers, people who inject drugs, men who have sex with men, and transgender people. Transgender women are 49 times more likely to have HIV than other adults of similar age. In some countries, the rate is 80 times higher. The worldwide HIV prevalence is 19% among transgender women, yet there is little information known for transgender men.[2]

## HORMONE THERAPY

Given the rising number of transgender individuals seeking hormone therapy, nurses must understand the formulations, dosing, intended effects, and adverse effects of estrogens, antiandrogens, and testosterone. Using hormone therapy to align the individual's gender identity with their physical appearance has been shown to reduce mental health problems such as gender dysphoria in the transgender population.[3] According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, gender dysphoria is the discomfort or distress caused by a discrepancy between a person's gender identity and their sex assigned at birth, that is, genital anatomy.[4] However, the diagnosis of transgender is no longer considered a mental health condition.[5] Some transgender patients may obtain hormone therapy through illicit means without a prescription and self-medicate for a variety of reasons, including the cost of treatment, lack of insurance coverage, and fear of rejection by health care providers.

## LABORATORY VALUES

The emergency department is rarely the place where serum hormone levels will be ordered, but they may be a part of the patient's past medical history. Because estrogen and testosterone may alter other laboratory readings, it is often difficult to interpret whether to follow a male or female set of laboratory values. The most commonly affected laboratory values are hematocrit and creatinine readings, both of which should be close enough in value to one another that an intervention would not be undertaken unless the values were significantly above or below the normal values for either gender. As a general rule, complete blood count and blood chemistry results should reflect the gender identity of the patient rather than biological gender, depending on the use of exogenous hormones.

A transgender man on testosterone for more than 6 months is compared with a cisgender man with regard to the normal reference range for a complete blood count. Likewise, a transgender woman on estrogen therapy for more than 6 months should be compared with a cisgender woman with regard to the normal laboratory values.[6] Creatinine levels in transgender women using estrogen therapy are decreased, whereas creatinine levels in transgender men taking testosterone therapy are increased. Creatinine is directly correlated to muscle mass.[7] Awareness of the hospital's order entry system and an "intuitive" canceling of tests based on sex is essential to avoid miscommunication

downstream regarding transgender patients. A transgender man presenting with abdominal pain may need a pregnancy test to rule out ectopic pregnancy, but the test may be canceled by the system because of the presenting sex on file.[6]

## ESTROGEN THERAPY

For transgender women, estrogen therapy causes an elevated risk of venous thromboembolism (VTE), such as pulmonary embolism and deep venous thrombosis. The degree of increased thrombogenic effect is related to the estrogen formulation, duration of estrogen use, method of delivery, and other risk factors such as obesity and smoking. Transdermal estrogen tends to confer less risk.[7] Estrogen obtained from nonprescription sources, such as underground or illicit dealers, has a higher risk for complications. When determining the risk for VTE and the need for VTE prophylaxis, classic risk-assessment models such as the Padua tool (used to determine the risk for venous thromboembolism) may not be applicable because it is not clear if the validation of such instruments included transgender individuals. There is no evidence supporting the routine cessation of estrogen therapy in transgender women for potential complications such as VTE. However, a change in dose or mode of delivery should be considered. Regardless of the reason, abrupt cessation of estrogen therapy can cause substantial discomfort, but no serious adverse events have been reported.[7] The effects of estrogen therapy in the transgender woman are highly variable. The changes include breast growth, increased body fat, decreased testicular size, and poor erectile function.[8]

## ANTIANDROGEN THERAPY

For complete feminization in transgender women who have not had an orchiectomy, antiandrogen agents help block the effects of androgenic hormones released by the testes. Multiple medications are used for their antiandrogen properties and can be associated with a multitude of adverse effects. Spironolactone, a potassium-sparing diuretic and mineralocorticoid receptor antagonist commonly used to treat congestive heart failure, has antiandrogen properties and is the most widely used medication in gender-affirmation therapy. Spironolactone, when used as an antiandrogen agent, requires doses 2- to 4-fold higher than the dosage range for congestive heart failure and liver disease.[7] These high doses of spironolactone may cause hyperkalemia, severe dehydration, and acute kidney injury. Spironolactone should be immediately discontinued if any of these complications develop.

In pediatric transgender patients, antiandrogen therapy may be used to suppress puberty or stop menstruation. Gonadotropin-releasing hormone analogues such as leuprolide acetate (Lupron) are commonly used to suppress the hypothalamic-pituitary-gonadal axis.

Leuprolide acetate is used in men to treat prostate cancer because it lowers testosterone production, and in women to treat uterine fibroids and endometriosis by lowering estrogen levels. Gonadotropin-releasing hormone agonists are typically a second-line agent owing to their high cost.

## TESTOSTERONE

Just as in cisgender men, the use of testosterone in transgender men may confer potential adverse effects related to polycythemia, elevated serum triglycerides, higher low-density lipoproteins, and lower high-density lipoproteins. For the emergency nurse, thrombosis from erythrocytosis and vascular disease from altered cholesterol and triglyceride levels should be a priority concern when treating transgender men. In the emergency department, testosterone therapy should be stopped in transgender men with significant erythrocytosis or its associated complications. Abrupt cessation of chronic testosterone therapy may cause mood fluctuation, hot flashes, and extreme fatigue. Although no study has indicated an increased risk of poor cardiovascular outcomes, there is an increased risk of metabolic syndrome in transgender men undergoing testosterone therapy.[1]

Furthermore, certain preexisting medical conditions such as migraine headaches and acne may be exacerbated by hormone therapy. The initial effects of testosterone therapy are seen within 3 months and include cessation of menses, increased body hair, increased muscle mass, acne, and changes in fat distribution.[8]

## SURGICAL MANIPULATION

It is recommended that patients who wish to undergo an irreversible surgery such as metoidioplasty, phalloplasty, or vaginoplasty should live 12 months in their gender identity per standards of care guidelines and must take their gender-specific hormones for reversible estrogen or testosterone suppression for 12 months.[9] Transgender individuals may augment their bodies in a number of ways. Transgender women may undergo a vaginoplasty (creation of a vagina and vulva that are functional), orchiectomy (removal of testes), female chest reconstruction (breast augmentation), and/or facial feminization (reshaping of the face to achieve more feminine features).[6] Furthermore, transgender men may undergo a phalloplasty (creation of a functional penis), metoidioplasty (creation of a penis from the clitoris—may

not be functional), hysterectomy and salpingo-oophorectomy (removal of uterus and ovaries), and/or male chest reconstruction (removal of breast tissue to appear more masculine).[6]

Surgical augmentation of the body can result in a number of complications. Illicit silicone injections into any part of the body have the potential to result in silicone embolization, silicone migration, bleeding, pain, and necrosis.[10] Management of these issues related to silicone injections is the same as for non–gender-related augmentation and is primarily supportive and guided by symptoms.[10] Transgender men may undergo masculinizing breast augmentation or top surgery. Regardless of indication, complications of mastectomy are managed the same as for nontransgender patients. Early complications that may be seen in an emergency setting are hematoma, seroma, and nipple complications.[10] These complications must be managed by a plastic surgeon as soon as possible. Furthermore, transgender women who undergo feminizing breast surgery may have complications, including swelling, pain, erythema, and deformity, that should be managed by a plastic surgeon.[10] All complications after mammoplasty should be managed in close consultation with a plastic surgeon who has experience in the procedure. Inappropriately managed mammoplasty complications may cause malposition, asymmetry, and capsular contracture leading to dissatisfaction with the cosmetic appearance.

Genital augmentation, often referred to as bottom surgery, is rare but can have unique complications. Transgender women may elect to have a vaginoplasty by penile inversion or with the use of a segment of the sigmoid colon or large intestine and scrotal skin. The length of the neovagina depends on the degree of dissection, the bony anatomy, and the amount of tissue available in the form of flaps. The urethra must be shortened and constructed to avoid cephalad urine flow.[11]

Complications of vaginoplasty depend on the type of surgery performed. Complications of penile inversion for vaginoplasty include bleeding, infection, skin or clitoral necrosis, suture line dehiscence, urinary retention, or vaginal stenosis or prolapse.[10] Bleeding can usually be controlled with applied pressure; however, if bleeding continues despite pressure, placing a large Foley catheter (at least 20 Fr) and inflating the balloon or a vaginal pack will normally stop the bleeding. Postoperative rectovaginal or pararectal abscess may also occur and should be considered in the differential. Vaginal spotting can occur in the neovagina owing to granulation tissue forming but is not a cause for alarm and can be removed or dissolved in the office. These patients require lifelong dilation of the neovagina with vaginal dilators, in addition to regular sexual activity. In addition, a small number of patients may develop fistulae between the rectum and neovagina because the dissection carries the risk of injury or devascularization to the anterior rectum. Owing to the lack of original pelvic support that cisgender women will possess at birth, the transgender woman, after surgery to create a neovagina, will be at risk for vaginal prolapse, particularly as time goes on. Approximately 4% of neovaginas will prolapse, which will require surgical repair in the form of a sacrocolpopexy or sacrospinous fixation.[12] Yeast vaginitis may occur and can be treated with standard-dose fluconazole.

Phalloplasty and metoidioplasty are surgical options for transgender men. Phalloplasty is a more complex procedure that allows for increased penile length so that it can accommodate a penile prosthesis to aid in penetrative intercourse. Phalloplasty has been described using various local skin and muscle flaps.[13] Transgender men undergoing phalloplasty also require the creation of neourethra because of their desire to have the ability to urinate while standing.[14]

Complications of transmasculine genital reconstruction usually involve the regions of urethral anastomoses. Although the complication rate has decreased from approximately 80% to approximately 40%, urethral strictures and fistulae are still widespread.[11] Complications for phalloplasty include wound infections, wound breakdown, urinary catheter difficulties, flap loss, pelvic or groin hematomas, and rectal injury.[10]

Complete blockage of the entire phallic urethra from scarring can lead to decreased urinary stream, hesitancy, and urinary retention. Patients with these complications may be initially treated with suprapubic catheter drainage if necessary because a Foley catheter requires blind placement. Ultimately, if the patient desires repair, a urethroplasty will be required.[15]

If the vulvectomy or colpocleisis is not complete, a pelvic cavity remnant may be left behind. This remnant can become a reservoir for urine, which can result in a urethral diverticulum. This can cause total urinary incontinence or severe postmicturition dribbling. These persistent vaginal cavities may increase the risk of urethrocutaneous fistula formation.[15] Complications for metoidioplasty include wound breakdown, infection, urethral stricture, and fistula.[10] All complications should be immediately reported to the surgeon who performed the procedure.

## NONSURGICAL MANIPULATION

If transgender men choose not to alter their bodies surgically, binding may be used as a way to reduce chest dysphoria and promote mental health. Binding is the

practice of wrapping the chest to give the appearance of a flat chest. Transgender men may present to the emergency department with musculoskeletal, neurologic, and pain-related concerns secondary to chest binding.[16] Emergency nurses may find that a patient is using duct tape and Ace bandages (3M) that are wrapped so tightly that skin breakdown results. Binding with tape and Ace bandages can also restrict breathing, thus limiting tidal volume. Similar chest binders were historically used as a treatment for rib fractures. Binding also has the potential to break ribs if a patient binds their chest too tight. Transgender patients are encouraged to give their chest a break and only bind their chest for 8 hours to 12 hours maximum at a time. Binders should never be worn during sleep. Washing the binder frequently helps to prevent skin breakdown. If patients are experiencing skin breakdown owing to binding, they should stop binding for a while and use skin barrier protection.

## Implications for Emergency Nurses

Gender identity can heavily affect a patient's overall health and the manner in which they seek emergency medical care. With the evolution and advancement of transgender medical care, emergency nurses are more likely to encounter transgender minority patients. Emergency nurses should know how to engage and communicate with transgender patients regarding their unique health care needs. Anatomical variations and hormone therapy are prevalent in the transgender population, and the emergency nurse must be prepared to manage their complications. Knowledge in these areas will improve effective and appropriate care for transgender patients.

## Conclusion

Emergency nurses can help play a vital role in the care of transgender patients by learning about the health challenges they face and offering nonjudgmental care and education about their risk factors such as sexually transmitted diseases, specifically HIV. Understanding the effects of hormones and surgical complications, and applying the appropriate use of tests, nurses in the emergency department are the first-line health care workers who have the highest potential to have a favorable impact on the health of transgender people and make sure that they are getting the most advanced evidence-based medicine, comparable to their "cis" cohorts. Their knowledge and triage role can be the link to other health care professionals for ensuring that the complete physical and mental health issues of transgender patients are addressed, and appropriate follow-up care is arranged.

## Author Disclosures

Conflicts of interest: none to report.

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# An Interrupted Time Series Analysis of the Dissemination of a Sickle Cell Vaso-Occlusive Episode Treatment Algorithm and a Case Management Referral Form for Individuals With Sickle Cell Disease in the Emergency Department

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CE Earn Up to 10.5 Hours. See page 206.

**Contribution to Emergency Nursing Practice**

- The current state of scientific knowledge on care of individuals with sickle cell disease in the emergency department indicates that emergency department providers are not aware of National Heart, Lung, and Blood Institute published evidence-based recommendations for care of individuals with sickle cell disease.
- This article contributes to the efforts to disseminate these tools in North Carolina and beyond.
- Key implications for emergency nursing practice from this study are strategies to increase awareness and use of evidence-based tools to treat individuals with sickle cell disease in the emergency department.

## Abstract

**Background:** Sickle cell disease is associated with frequent vaso-occlusive episode and emergency department visits. Our group developed (1) a vaso-occlusive episode treatment algorithm based on the National Heart, Lung, and Blood Institute recommendations, and (2) a case management referral form to identify social behavioral health needs of patients with sickle cell disease in the emergency department. The aims of this project were to (1) disseminate the vaso-occlusive episode algorithm and case management referral form, and (2) to evaluate the individual provider-reported awareness, use, and preferred method of access to each tool among emergency department providers in North Carolina.

**Methods:** An interrupted time series analysis was used to study the impact that an educational effort had on the awareness of a sickle cell vaso-occlusive episode treatment algorithm and a case management referral form. A targeted list was developed to identify the providers working in emergency departments with the largest number of sickle cell disease patient visits. In-service education was provided to targeted emergency departments in North Carolina over a period of

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J Emerg Nurs 2021;47:40-9.
Available online 18 August 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.06.001

3 years. The vaso-occlusive episode algorithm and case management referral form were put up on the websites of professional organizations. Surveys were provided to emergency department providers at these targeted emergency departments with a baseline and post dissemination at 20 and 32 months for assessing the provider awareness, use, and preferred method of access of the tools. Additional feedback could be given by the participants through telephone interviews. Descriptive statistics were obtained, and content analysis was performed on interviews.

**Results:** We received survey responses for the following periods: baseline (T1, n = 190), post dissemination at 20 (T2, n = 142), and 32 months (T3, n = 93). Awareness of the tools was between 42% (baseline) and 41% (post dissemination at T2, T3) for the vaso-occlusive episodes algorithm and 25% (baseline) and 29% (post dissemination at T2, T3) for the case management referral form. However, use of these tools was found to be low as only 19% of the emergency department providers used the vaso-occlusive episode algorithm at T1 and 13% T2, while 5% of emergency department providers used the case management referral form at T1 and 6% at T2. With further education about the tools, an increase in the usage of the tools was observed T3, which was 29% for the vaso-occlusive episodes algorithm and 9% for the case management referral form. Lack of incorporation of the decision support tools into emergency department processes was observed to be an overarching barrier to dissemination of the tools identified in interviews (n = 8).

**Conclusions:** This study can be used to inform future strategies on dissemination of evidence-based tools to emergency department providers.

**Key words:** Sickle cell disease; Decision support tools; Emergency department; Vaso-occlusive episode; Case management; Dissemination and implementation science

## Background

Sickle cell disease (SCD) is a genetically inherited disorder of the red blood cells that primarily affects individuals of African descent and results in multiple complications related to impaired oxygen perfusion.[1] In 2006, approximately 100,000 individuals were found to have SCD in the United States,[2] and they accounted for approximately 232,382 visits to the emergency department annually.[3] Approximately 5,500 individuals with SCD live in North Carolina.[4] A cohort of 2,790 North Carolinian Medicaid eligible patients with SCD accounted for 69.86% of the 9,075 emergency department encounters.[5] Individuals with SCD primarily visit the emergency department for vaso-occlusive episodes (VOEs), which are the hallmark symptom of SCD and are characterized by acute pain that is difficult to treat and can lead to severe complications and impaired quality of life.[1,3,6] Furthermore, VOEs are the leading cause of ED visits and hospital admissions related to SCD.[3] Despite pain and VOEs being the most common reasons for ED visits,[3,7] currently there is no consistent approach to the management of VOEs in the emergency department.[8] Also, there is a high proportion of unmet medical and social behavioral health needs of patients with SCD, including lack of transportation, unemployment, and difficulty in accessing and affording medical care.[9-11] Treating patients in the emergency department involves evidence-based pain management, and also provides an opportunity to screen and refer their unmet social behavioral health needs. In 2014, the National Heart, Lung, and Blood Institute (NHLBI) published evidence-based recommendations for care of SCD and for addressing the need for more standardized care of SCD.[1]

In our previous work, decision support tools were developed for use in the emergency department. Adult and pediatric treatment decision support tools, containing a total of nine tools including a vaso-occulsive episode algorithm, were created based on the NHLBI recommendations, to assist providers treating individuals with SCD.[12] A case management referral form was also created for identification of patients with SCD who have unmet social, behavioral, and medical health needs.[10] In collaboration with the North Carolina (NC) Emergency Nurses Association, NC College of Emergency Physicians, and Community Care North Carolina (a managed care organization), our group developed a strategy to disseminate a VOE treatment algorithm based on NHLBI recommendations and a screening and referral process which included a case management referral form that could be administered in the emergency department. In 2019, 32.4% of 111 ED providers were found to be aware of the NHLBI guidelines on the treatment of SCD.[8] Further dissemination of these guidelines is needed to improve care of patients with SCD in the emergency department.

This paper reports the strategy used to disseminate the VOE algorithm and case management referral form to ED providers in NC. This project aimed to disseminate the VOE algorithm and case management referral form to emergency departments throughout NC, and evaluate individual provider-reported awareness, use, and preferred method of access to tools among ED providers.

### DESCRIPTION OF DECISION SUPPORT TOOLS

The following recommendations were included in the VOE algorithm: Assignment of Emergency Severity Triage level 2, treatment with individualized intravenous push opioid pain protocols when required, treatment with a standard SCD protocol when individualized opioid doses are not available (many emergency departments use a weight-based opioid protocol as the standard protocol), administration of the opioid within 60 minutes of arrival at the emergency department, re-administration of opioids every 15 minutes to 20 minutes until pain subsides, consideration of opioid dose escalation by 25% for inadequate relief, caution with aggressive fluid management in the presence of renal or kidney failure, and administration of oral versus intravenous anti-histamines. The case management referral form was previously designed to identify the unmet medical, social, and behavioral health needs and to assess health services issues. The form was designed to be simple and administered by an ED provider, social worker, or case manager. The referral process consisted of 2 components which included the administration of the case management referral form and faxing of the completed case management referral form to Community Care NC, who would identify the patient's care manager (Medicaid patients) or a SCD state educator (all patients other than Medicaid). The patient's care manager would follow up with the patient within 72 hours to link the patient to resources for unmet services. The VOE algorithm was made available through a website (sickleemergency.duke.edu and NC Emergency Nurses Association website), on paper, and as an app (SCD Toolbox, Android and iOS). The case management referral form was available on a website (sickleemergency.duke.edu) and on paper.

## Methods

### CONCEPTUAL FRAMEWORK: RE-AIM

The Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) model was used as the organizing framework for this dissemination strategy. This framework is commonly used to organize, facilitate, and sustain changes in health care systems.[13,14] As this project was designed for dissemination and not implementation, it was not possible to evaluate all components of the RE-AIM. The following components of RE-AIM were used to guide the dissemination of the tools: Reach (number of ED providers in NC who underwent training), Effectiveness (unable to evaluate), Adoption (proportion of the ED survey respondents who reported using the tools), Implementation (unable to evaluate), Maintenance (unable to evaluate).

### DESIGN

An interrupted time series analysis was used to study the impact of an educational effort on the awareness of a sickle cell VOE treatment algorithm and case management referral form. Surveys and interviews were used to evaluate the awareness and use of the VOE algorithm and case management referral form, at baseline (T1) and over the course of the dissemination (20 months [T2] and 32 months [T3]). The Duke Health Institutional Review Board (Pro00076048) approved the project and granted a waiver of written consent. Surveys and interviews were conducted anonymously to improve participation.

### SETTING AND DISSEMINATION STRATEGY AND CONTENT

All emergency departments in NC were eligible for in-person dissemination and in-services. While the goal was to disseminate the tools to as many ED providers across NC as possible, a list of 19 hospital emergency departments was developed for targeting for dissemination of the VOE algorithm and case management referral form. A targeted list was developed to identify providers working in emergency departments with the largest number of SCD patient visits. A short PowerPoint presentation that focused on a brief overview of the epidemiology and common complications of SCD, the VOE algorithm and case management referral form was developed and used for dissemination of the materials. Inclusion criteria were based on (1) the (high) number (the emergency departments with the highest number of visits at the time of dissemination) of SCD visits to the emergency department (based on Medicaid claims data) and/or (2) patient stakeholder expression to the study team of the emergency department's lack of adherence to a care protocol for individuals with SCD, or (3) individual ED requests. Several attempts were made to set up in-service educational sessions in all 19 emergency departments. Dissemination occurred throughout the course of the project. Targeted centers that did not receive education were either unresponsive, uninterested, or reported time constraints.

Our team also partnered with the NC Emergency Nurses Association to disseminate the algorithm and case management referral form via the NC Emergency Nurses Association website (https://ncena.nursingnetwork.com/page/60871-resources). Monthly calls were held with leadership members of the NC Emergency Nurses Association State Council throughout the research project to increase the visibility of the project and identify additional emergency departments for participation. Through this

TABLE 1
**Awareness, use, and preferred format over time**

| Variable | T1 (n = 190) n (%) | T2 (n = 142) n (%) | T3 (n = 93) n (%) |
|---|---|---|---|
| Awareness of tool | | | |
| "Are you AWARE of the CCNC ED SCD Case Management Referral Form?" Responded Yes | 48 (25) | 40 (29) | 27 (29) |
| "Yes" to "Are you AWARE of the algorithm to treat vaso-occlusive episode based upon the NHLBI recommendations?" Responded Yes | 80 (42) | 58 (41) | 38 (41) |
| Use of tool | | | |
| "Yes" to "Have you ever USED the CCNC ED SCD Case Management Referral Form?" Responded Yes | 10 (5) | 9 (6) | 8 (9) |
| "Yes" to "Have you USED the algorithm for vaso-occlusive episode?" Responded Yes | 37 (19) | 19 (13) | 27 (29) |
| Preferred format of tool | | | |
| Which format would you PREFER to use to access these vaso-occlusive episode tools? | | | |
| Paper version | 29 (20) | 7 (5) | 2 (2) |
| A website | 46 (32) | 40 (31) | 36 (42) |
| A mobile app | 45 (32) | 18 (14) | 14 (16) |
| All of the above | 22 (15) | 66 (50) | 34 (40) |

ED, emergency department; SCD, sickle cell disease; NHLBI, National Heart, Lung, and Blood Institute.

collaboration, specific Chapter and State meetings were identified to disseminate the materials, and strategies were also determined to disseminate materials and surveys through the NC Emergency Nurses Association website. In partnership with the NC College of Emergency Physicians, the algorithm and case management referral form were posted on their website (https://nccep.org/wp-content/uploads/Sickle-Cell.pdf). The overall goal was to disseminate these to as many ED providers in NC as possible.

As the project progressed, a 15-month series of monthly webinars were conducted to increase the visibility of the project with a focus on improving the care of individuals with SCD in the emergency department. Webinars were open to participation across the United States and Canada. Finally, in partnership with the Lifepoint hospitals consortium (a network of health care facilities dedicated to facilitating the delivery of high quality care) of ED nursing directors, a one-time webinar was provided on the algorithm and case management referral form.

## AWARENESS AND USE OF TOOLS - SURVEY DEVELOPMENT AND DISTRIBUTION

To assess provider awareness and use of the tools, a short survey was included with questions about awareness and use of the tools (Table 1). Surveys were disseminated at baseline before dissemination activities (T1) and post dissemination at 20 months (T2) and 32 months (T3). These timelines were chosen to assess for changes in tool awareness and use across the timeline of the project and to assess changes based on continued dissemination activities. Surveys were made anonymous to encourage participation. A convenience sample was used as the surveys were anonymous and it was not possible to track the respondents each year. This was a descriptive study and the goal was to obtain as many responses as possible from emergency providers with a focus on using a variety of ways to disseminate the survey. Thus, sample size calculation was not performed. At baseline, surveys were distributed at NC Emergency Nursing Association

TABLE 2
**Number of Attendants at in-service educational sessions**

| Date | Site | Length of session (min) | # of physicians (n = 90) | # of nurses (n = 274) | # of case managers (n = 2) # of educators (n = 3) |
|---|---|---|---|---|---|
| February 23, 2017 | Site 1 | 30 | NR | 50 | NR |
| March 3, 2017 | Site 2 | 240 | NR | 21 | NR |
| November 21, 2017 | Site 3 | 60 | 20 | NR | NR |
| November 4, 2018 | Site 4 | 60 | 22 | NR | NR |
| January 3, 2018 | Site 5 | 60 | 15 | NR | NR |
| May 15, 2018 | Site 6 | 60 | NR | 9 | NR |
| May 22, 2018 | Site 4 | 60 | NR | NR | NR |
| July 9, 2018 | Site 1 | 30 | NR | 25 | NR |
| July 9, 2018 | Site 1 | 30 | NR | 25 | NR |
| July 13, 2018 | Site 1 | 30 | NR | 45 | NR |
| July 19, 2018 | Site 1 | 30 | NR | 31 | NR |
| July 19, 2018 | Site 1 | 30 | NR | 49 | NR |
| April 17, 2018 | Site 7 | 30 | NR | 7 | NR |
| April 17, 2018 | Site 7 | 30 | NR | 8 | NR |
| August 6, 2019 | Site 8 | 30 | NR | NR | NR |
| September 4, 2019 | Site 9 | 30 | 30 | NR | NR |

NR, not reported.

Chapter meetings and via emails to emergency departments that expressed interest in in-service educational sessions. At T2 and T3, a link to complete the survey was distributed via e-mail by key stakeholders at emergency departments who had participated in the dissemination trainings. The link to complete the survey was also posted on the NC Emergency Nursing Association website after baseline. Surveys were not distributed to attendees of the monthly webinars.

### INTERVIEWS

Clinicians who participated in the survey at T2 and T3 were able to participate through a telephonic interview to provide additional feedback on the use of the tools. Interviews were scheduled at a time convenient to the participant, conducted telephonically, and recorded digitally. The interview guide (Supplementary Appendix) was developed by the study team and included questions that assessed awareness, use, barriers, facilitators, and recommendations for future dissemination of the decision support tools.

### DATA ANALYSIS

Descriptive statistics were used to analyze survey data. Additional analytic statistics could not be generated as the samples were not identical between time cohorts. Quantitative analysis of the data was carried out using SAS version 9.4 (SAS institute, Cary, NC) and the qualitative data analysis was carried out using NVivo 12 (QSR International).

Recordings of the interviews were transcribed, and transcripts were verified by listening to the original recording. A list of a priori codes was developed by the study team using the interview guide. Two investigators independently coded the transcripts using NVivo 12 and the weighted kappa value was 0.98.

## Results

Over the 3-year period of the study, 16 in-person 30-minute to 60-minute educational sessions were conducted for 7 out of the 19 targeted emergency departments in NC. Four brief educational sessions were conducted at the NC Emergency Nurses Association Chapter meetings because of time constraints. We were only able to track in-person dissemination; it was not possible to account for the number of times the tools may have been downloaded from websites or the SCD Toolbox app. The VOE algorithm and case management referral form were disseminated in person to a total of 90 physicians, 274 nurses, 2 case managers, and 3 educators across the centers

TABLE 3
**Emergency department provider demographics**

| Demographics N (%) | T1 year 2017 (n = 190) | T2 year 2018 (n = 142) | T3 year 2019 (n = 93) |
|---|---|---|---|
| Age - Mean (SD) | 40 (9) | 40 (21) | 37 (10) |
| Sex | | | |
| Unknown or NR | NR | NR | NR |
| Male | 86 (45) | 50 (35) | 39 (42) |
| Female | 101 (53) | 89 (63) | 53 (57) |
| Race | | | |
| White | 164 (86) | 121 (85) | 78 (84) |
| Unknown or NR | NR | NR | NR |
| Native Hawaiian or other Pacific Islander | NR | NR | NR |
| More than 1 race | NR | NR | NR |
| Black or African American | NR | 7 (5) | 7 (8) |
| Asian | 11 (6) | NR | 7 (8) |
| American Indian/Alaska Native | NR | NR | NR |
| Ethnicity | | | |
| Unknown/NR | 22 (12) | NR | NR |
| Non-Hispanic/Latino | 156 (82) | 130 (92) | 88 (95) |
| Hispanic/Latino | 13 (7) | 6 (4) | NR |
| Professional training | | | |
| RN | 57 (30) | 81 (57) | 33 (35) |
| PA | 29 (15) | 13 (9) | 8 (9) |
| NP | NR | 5 (4) | NR |
| MD | 101 (53) | 43 (30) | 52 (56) |
| Has cared for a patient with sickle cell disease | 187 (98) | 140 (99) | 92 (100) |
| Geographic description of where majority of providers' patients live | | | |
| Urban | 99 (53) | 90 (65) | 62 (67) |
| Suburban | 64 (34) | 40 (29) | 29 (31) |
| Rural | 23 (12) | 9 (6) | NR |

NR, not reported; RN, registered nurse; PA, physician assistant; NP, nurse practioner; MD, Doctor of medicine.

(Table 2). The tools were also disseminated electronically to 2 additional emergency departments. The VOE algorithm and case management referral form were made more widely available on the web by collaboration with NC Emergency Nurses Association and NC American Academy of Emergency Medicine. It was not possible to track how often the materials were accessed. A total of 425 individuals responded to the survey across the 3 years. However, it was not possible to verify whether the survey respondents attended the in-person educational sessions or reviewed the decision support tools online. Participant characteristics of attendees at the in-person sessions are provided in Table 3.

We received survey responses for the following periods: T1 (n = 190), T2 (n = 142), and T3 (n = 93). Descriptive statistics of awareness, use, and preferred method of access to tools are presented in Table 1. Due to the variety of dissemination methods of the surveys (websites etc.), it was not possible to report the overall response rate or reasons for non-response.

No change was observed in awareness of either the VOE algorithm or case management referral form over the course of the project, or use of the case management referral form. Awareness of the VOE algorithm and case management referral form remained at about 40% and 30% throughout the project. An increase in self-reported

use of the VOE algorithm from T1 to T3 was observed, with 29% of the providers reporting that they used the VOE algorithm in their emergency departments. Use of the case management referral form remained low, between 5% to 9% over the course of the project. Respondents endorsed the desire for all formats of the tools throughout the course of the project. Finally, 15 webinar sessions were conducted with the participation of 20 to 35 ED providers per session. Approximately 100 ED nursing directors from across the United States attended a webinar hosted by a health care services company, which described the VOE algorithm and case management referral form.

A total of 8 interviews were conducted (4 interviews at T2 and 4 at T3) with emergency department nurses and physicians in NC. Participants described facilitators and barriers to dissemination in their ED settings and recommended future dissemination of the VOE algorithm and case management referral form. Analysis of individual interviews with ED providers revealed themes about barriers and facilitators to dissemination.

## BARRIERS TO DISSEMINATION

The overarching barrier to the dissemination of the tools was identified as the lack of incorporation of the decision support tools into the ED processes. The tools were not embedded in the electronic health record and there were no existing workflows or protocols for standardization of SCD care in the emergency departments, which was also reported by the ED providers.

The ED providers were also acutely aware that not having a standardized protocol contributed to the disease stigma that individuals with SCD faced. One ED provider stated, "I feel like by not having a consensus for this patient population, we almost created this epidemic of overutilization of the emergency department for their care and perpetuated and maintained the stigma that goes along with their disease." Providers identified that the decision support tools could fulfill this need only when the tools were embedded into the ED processes, and guidelines were incorporated into new graduate education and new hire training.

During the T2 interviews, several providers stressed that it would be easier for the providers to access and use the tools if they were embedded into the electronic health records. The electronic health record was reported to be a more effective method of dissemination of the VOE algorithm because of the high patient volumes and demanding ED environment. Providers stated that embedding the tools into existing health care provider apps (ie, JournalFeed, UpToDate) in addition to the electronic health record, would lessen the barriers to using the tools.

With reference to the case management referral form, ED providers noted that it was difficult to determine the ownership of the referral process because of the high workload that ED providers experienced. One of the ED providers reflected, "The resistance that we've met in my emergency department, being that we're a busy emergency department, we're roughly 85,000 visits a year, was who was going to take ownership of the referral process." Other ED providers stated that they were unaware of the case management referral form and believed that case management was the responsibility of social workers, though they were not certain.

## FACILITATORS TO DISSEMINATION

Facilitators of dissemination were identified as the educational sessions, availability of the surveys in multiple formats, easy usage of the tools, and having a site champion. After being educated about the tools, ED providers were able to select their preferred format of the tools. One of the participants reflected on the ease of using the tools after attending an in-person educational session:

"The last [SCD patient] that I had, our emergency department physician, because we'd just had the meeting [in-person educational session], was very aware of the algorithm and put in orders right away for this particular patient, so it was nice just because there was no added education."

Providers also reported that the tools were easy to use. One of the ED nurses also explained how the simplicity of the tools also allowed her to easily disseminate evidence-based information to providers who had not received the education.

"It was very helpful for me in terms of collaborating with the providers that I was working with to give them a framework as to why I was making the recommendations about a dosage of pain medicine and why it seemed aggressive in implementing pain reductions quickly rather than later."

Providers also mentioned that differentiation in the format of the tools would make them more accessible. For instance, 1 ED nurse noted that nurses were more likely to use a paper format, whereas other ED providers (physicians, nurse practitioners, physician assistants) found the electronic health record format more efficient, "We, as nurses, can say 'hey, look at this, look at this,' but if it's not built into physician processes in the way that they treat patients you know, whether that is through an electronic medical record or what not, that's where we're meeting our resistance."

A major facilitator of dissemination of the tools was having an ED physician as a champion for the project at 1

emergency department. His efforts led to widespread dissemination of the tool and the incorporation of these tools into processes at that site including embedding of the tools into the electronic health record. On interviewing the participants at that site, it was observed that many were unaware of the tools; however, on further probing, they were able to accurately detail the contents of the tools and affirm that their clinical decisions were based on the tools. The VOE algorithm and case management referral form had been incorporated so thoroughly into their processes that it was not readily apparent to them that they have been using the tools. This was mainly due to the efforts of the physician champion at that site.

## Discussion

The overall aim of this study was to disseminate the decision support tools to emergency departments throughout NC and to evaluate individual provider-reported awareness, use, and the preferred method of access to the tools. Based on descriptive data collected across a 3-year-period, little or no change was observed in the awareness and usage of the tool over the course of the project. Despite this, several key stakeholder interviews were conducted for better understanding of the meaning of the survey results.

At the baseline, awareness of both the VOE algorithm and case management referral form were considered moderate at 42% and 25% respectively. This indicated that many of the respondents were already aware of the tools to some extent. Respondent bias was possible for those working at institutions already familiar with the tools as previously disseminated at 3 large emergency departments in NC. These tools were disseminated by local champions at the hospital emergency departments. In particular, there was an effort to disseminate the case management referral form that began in 2014. This moderate baseline awareness led to lesser improvement.

Valuable knowledge about the preferred format for the tools was gained. Survey results indicated that providers preferred to access the tools in a variety of formats including paper, websites, and mobile app. These data support the need for future dissemination efforts to adopt multiple formats. During the interviews, the ED providers stated that incorporating the tools into the electronic health record could improve their access. For example, owing to the efforts of a physician champion at 1 emergency department, the tools were embedded into the electronic health record, and interview respondents reported having used the tools and incorporated the NHLBI guidelines into their practice even without receiving any formal education about the tools and the guidelines. Systematizing change is an effective way of changing practice. Future dissemination efforts can be strengthened at individual sites by using ED site champions to support the use of best practice alerts, implementation of SCD VOE guidelines within electronic health records, and having a process to screen for unmet social needs and refer patients for follow-up.

In spite of the challenges of survey dissemination, there were several aspects of this project there were considered to be successful and could be useful to others when conducting dissemination activities. These included the remarkable efforts of site champions, the close collaboration with NC Emergency Nursing Association, the opportunity to develop and conduct the webinar, and the partnership with a health care services company. We also were able to successfully broaden the reach of dissemination by partnering with the NC Emergency Nurses Association and Community Care North Carolina. Community Care NC improved accessibility of the tools by adopting the VOE algorithm on their website.[12] Our 15-month series of monthly webinars and the 1-time webinar with a health care services company allowed us to provide education about the decision support tools to ED providers and leaders across the United States and Canada. While it was not possible to assess the impact of these webinars, we consider the extended reach of our educational sessions as a success because the ultimate intention was to promote evidence-based approaches to care for individuals with SCD regardless of their location. Finally, in September 2019, 87.6% of the delegates at the National Emergency Nurses Association General Assembly approved a resolution to disseminate the NHLBI evidence-based guidelines of management of VOE in children and adults with SCD in the emergency department, to disseminate the existing education about treating SCD in the emergency department, and to explore the need for additional educational materials (GA-10-09).[15] This resolution supports the dissemination to all emergency departments in the United States. This landmark resolution and partnership with the Emergency Nurses Association allows the forum to truly transform the care of individuals with SCD in the United States. Results of this study are being used to inform the next steps that the Emergency Nurses Association will take to act on this resolution.

It is important to disseminate these evidence-based tools to ED providers for improving ED care for patients with SCD. Several suggestions have been derived from this experience for future dissemination of these tools.

During the dissemination efforts, information about the ED tools was promoted through a series of educational events directed at the provider level. Future dissemination should explore implementing the use of the tools into standard practice and operating procedures of emergency departments organizationally and leverage both provider and organizational level interventions. Ideally, site champions should lead the implementation of evidence-based SCD care into standard practice in the emergency department. In future dissemination efforts, the use of organizational change champions should be considered in addition to project champions. Organizational change agents have a greater ability to influence the institutional environment, mobilize internal resources for widespread dissemination, and create policies to make changes sustainable.[16] Finally, there are implications for the integration of these tools into practice through policy implementation. Further translation of these tools into practice using policy, such as the Emergency Nurses Association resolution, could be the impetus needed to incentivize dissemination among emergency departments.

## Implications for Emergency Clinical Practice

The information presented has multiple implications for emergency clinical practice at the individual, institutional, and policy-wide levels. First, individual ED providers can use these findings and knowledge of the decision support tools to champion evidence-based care of SCD in their emergency departments. Secondly, the institutional health care leaders inside and outside of NC can use this article to: (1) design a system for addressing the unmet social needs of individuals with SCD using the case management referral form, (2) embed evidence-based decision support tools into their electronic health records, and (3) design dissemination activities. Finally, this article provides valuable information about disseminating evidence-based decision support tools to guide ED care for individuals with SCD. With the approval of the National Emergency Nurses Association General Assembly's resolution to disseminate NHLBI evidence-based guidelines for management of SCD, this study has poignant implications for Emergency Nurses Association (ENA) leaders who wish to replicate this study in their states to promote the use of evidence-based SCD care.

## Limitations

Several limitations affected the results of this study. It was not possible to control the direct users and responders of the survey. Surveys were made anonymous to increase their response rate. Each emergency department sent out a link to the survey via e-mail and the survey was posted on the NC Emergency Nurses Association website. It was also not possible to accurately ascertain the awareness and use owing to the convenience sampling method. The response sample was also most likely affected by nursing staff turnover at individual emergency departments as the turnover is high nationally.[17] It was not possible to verify whether the survey respondents attended the in-person educational sessions or reviewed the decision support tools online. Some of the ED providers reported not having attended an in-person educational session or reviewing the tools online in their interviews. Finally, qualitative data were collected to evaluate barriers and facilitators of dissemination of the ED algorithm. There are limitations in the qualitative approach owing to the use of the convenience sampling method. These limitations included the generalizability of these findings as the interview participants from all ED settings did not volunteer for interviews and data saturation was not obtained.

## Conclusion

An evidence-based algorithm for the treatment of VOE and a case management referral form for emergency departments throughout NC were successfully disseminated. Despite the widespread dissemination efforts, awareness of these tools did not increase over the course of the project. Use of the VOE algorithm, however, was reportedly higher over time. Importantly, it was possible to identify several facilitators to embed these tools in practice, including the use of a site champion, incorporating the tools into routine practice by embedding them in the electronic health record, and adopting the decision support tools as an ED standard of care.

## Author Disclosures

Conflicts of interest: none to report.

This study was funded by the Agency for Healthcare Research & Quality (R18 RHS024501A). Support for this publication was provided by the Duke National Clinician Scholars Program, the Duke School of Nursing, and the Duke Clinical and Translational Science Institute.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.06.001.

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## Supplementary Appendix

INTERVIEW GUIDE: EMERGENCY DEPARTMENT CLINICIANS

**Instructions: For each of the decision support tools we have distributed to you and your practice, please answer each of the questions below**.

Thank you for your time. As you may or may not be aware, CCNC and NCENA developed an algorithm to treat vaso-occlusive episode (VOE) in the ED, based off of the NHLBI Recommendations for the care of persons with sickle cell disease. The algorithm makes recommendations for use of an ED observation unit and a process for case management referral. This algorithm was designed to help EDs improve the treatment of patients with sickle cell disease. The purpose of this interview is to get your feedback on if you have had the opportunity to use the algorithm and if you have found the app or website where it is housed useful. Please feel free to give us suggestions on how these tools may be more helpful to you, or other recommendations related to the algorithm or website.

1. Do you remember seeing the VOE algorithm? Via app, paper, website?
2. Have you had the opportunity to use the VOE algorithm? How did you access it?
3. If you have used the VOE algorithm, can you comment on whether or not it was helpful in managing patients with SCD?
4. Do you the prefer web, app or paper to access the VOE algorithm?
5. Do you have any suggestions as to how we could improve the tools or websites? Improve our dissemination of these tools?
6. What is your ED's current protocol for pain management of SCD patients?
7. Has your ED changed the pain management of SCD patients based on the algorithm?
8. Has your ED changed the admission process for SCD patients?
   a. Transfer to observation status more frequently?
   b. Triage category
9. Does your ED screen SCD patients with the case management referral form?
10. Do you remember seeing the Case Management referral form?
    a. Do you recall seeing it or personally using it?
    b. Other comments about the referral form? Any questions about the process?
11. If you have used the case management referral form, can you comment on whether or not it was helpful in managing patients with SCD?
12. Do you think there are opportunities for improvement of the care of individuals with SCD in your ED?
13. Are you, or do you think your colleagues would be, interested in additional education? (Learning collaborative, Dr. Tanabe present at staff or leadership meetings)
14. Do you have any other comments for us?

# Establishing Research Priorities for the Emergency Severity Index Using a Modified Delphi Approach

**Authors:** Lisa A. Wolf, PhD, RN, CEN, FAEN, and Altair M. Delao, MPH

CE Earn Up to 10.5 Hours. See page 206.

**Contribution to Emergency Nursing Practice**

- The Emergency Severity Index (ESI) is the most widely used triage system in the United States; correct use of the ESI to assign acuity varies on the basis of training, education, experience, and workplace environment.
- The main finding of this paper is that research priorities, as established by a group of clinical experts around the ESI, align well with known gaps in the literature.
- Recommendations for translating the findings of this paper into emergency clinical practice include a wide dissemination of established priorities, support for researchers working in this area, and continual update of the ESI using the findings from these studies.


## Abstract

**Introduction:** The accuracy of an initial ED triage decision has been reported to drive the clinical trajectory for ED patients, and, therefore, this assessment is critical to patient safety. The Emergency Severity Index—a 5-point score assigned by a triage nurse and based on disease acuity, patient potential for decompensation, and anticipated resource use—is used both in the United States and internationally. In the US, the Emergency Severity Index is used by up to 94% of the academic medical center emergency departments. In 2020, the Emergency Nurses Association acquired the intellectual property rights to the Emergency Severity Index and is responsible for its maintenance and improvement.

**Objective:** The purpose of this study was to establish a research agenda for the improvement of individual and institutional understanding and use of the Emergency Severity Index.

**Methods:** Modified Delphi process was used with 3 rounds of data collection.

**Results:** Round 1 yielded 112 issues, which were collapsed into 18 potential research questions in 4 general categories: education and training (6 questions), workplace environment (3 questions), emergency care services (7 questions), and special populations (2 questions). These questions were used in round 2 to establish importance. Round 3 yielded a rank ordering of both categories and research questions.

**Discussion:** The research priorities as set through the use of this modified Delphi process align well with current gaps in the literature. Research in these areas should be encouraged to improve the understanding of educational, environmental, and process challenges to emergency nurses' triage decisions and accuracy of Emergency Severity Index assignments.


**Key words:** Emergency Severity Index; triage; emergency nursing; modified Delphi process

## Introduction

Triage is derived from the French "trier" (to sort) and is a crucial component of proper acuity assignation and resource allotment in the emergency care setting. Triage nurses generally perform initial assessment and a focused physical examination and may order initial diagnostic studies according to standing orders or protocols. The process of triage and acuity assignment is dynamic and should involve multiple reassessments focused on identifying the patient who is decompensating.[1] In practice, however, the criteria used to assign patient acuity levels at the initial patient encounter

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J Emerg Nurs 2021;47:50-7.
0099-1767



https://doi.org/10.1016/j.jen.2020.09.005

in the emergency department (triage) vary among emergency nurses and their respective emergency departments. Patient acuity decisions are sometimes made in the absence of physiological data and are dependent on nursing knowledge and skills and the social context in which the decision occurs.[2-5] The correctness of the initial triage decision has been reported to drive the clinical trajectory for ED patients,[6] and therefore this step in patient care is critical to patient safety. The Emergency Severity Index (ESI)—a 5-point score assigned by a triage nurse and based on disease acuity, patient potential for decompensation, and anticipated resource use[7]—is used both in the United States and internationally. In the US, the ESI is used by up to 94% of the academic medical center emergency departments.[8] Originally, a group of emergency physicians and nurses devised the ESI concept; later, the Agency for Healthcare Research and Quality funded the initial research on the application of the ESI in emergency care settings. In recent years, the Agency for Healthcare Research and Quality has maintained and supported this evidence-based system, now in its fourth edition; in 2020, the Emergency Nurses Association acquired the intellectual property rights to the ESI and is responsible for the index's maintenance and improvement. The ESI classification implicitly allows for variation and relies heavily on individual triage judgment by emergency nurses and other clinicians, and thus the triage decision is reliant on the nurse's education, experience, and expertise in identifying patients classified as high risk. The ambiguities in the ESI algorithm[9-12] make it particularly susceptible to variability in clinician training and experience as well as to other human and institutional biases, ultimately leading to under-triage (risk to patients) and over-triage (inappropriate use of resources). In reliability studies, the highest agreement measured between triage nurse and expert nurse was at sites that reported initial ESI training, ongoing ESI training, and quality monitoring of triage decisions,[8] suggesting that a consistent approach to training and quality follow-up is important to safe and accurate triage processes.

Errors in triage can challenge safe patient care; specifically, under-triage (assignment of an inappropriately low acuity score) can result in dangerous delay of necessary medical care, and over-triage (when patients who are less critical are assigned a higher priority) can lead to resource overuse and delays in providing care for those with more urgent needs. Research findings[11-14] suggest that not only do emergency triage nurses demonstrate high error rates on average, but that the nurses' errors are also clustered around specific presentations, including those that would be high risk. More research needs to be conducted on both the process and application of the ESI when making a triage assignation to improve the use of the ESI.

The purpose of this study was to develop a research agenda for the improvement of individual and institutional understanding of, and use of, the ESI.

## Methods

We used a modified Delphi process with 3 rounds of data. The Delphi technique has 4 main characteristics: anonymity, iteration with controlled feedback of group opinion, statistical aggregation of group response, and expert input.[15] The Delphi method is recommended for use in the health care setting as a reliable means of determining consensus for a defined clinical problem.[16-19] Before the first round of the Delphi process, a literature review was circulated to a work group of emergency nursing triage experts.

### SAMPLE

The study sample (N = 14) was recruited from expert emergency nurses participating in a work team on ESI triage (Table 1). Expertise was determined by the work group selection committee as a function of engagement, education, teaching, and scholarship on the ESI. The sample of 14 comprised the entire work team.

### PROTECTION OF HUMAN SUBJECTS

This protocol was reviewed by the Advarra Institutional Review Board (Pro00044686) and designated as exempt from institutional review board oversight. The participants were given a description of the study, noting that their return of the online questionnaires constituted consent.

### DATA COLLECTION

Data were collected using 3 rounds of questions in a modified Delphi process and entered into an online form by the participants using Qualtrics (Qualtrics LLC, Salt Lake City, UT); the data were then analyzed using SPSS version 27 (IBM Corp, Armonk, NY). The 3 rounds of questions sought to identify general areas of need, followed by scoring the importance of statements about the process and application of the ESI and, finally, a rank ordering of research questions.

TABLE 1
**Respondent demographics**

| Variable | Round 1 (N = 13) | Round 2 (N = 14) | Round 3 (N = 14) |
|---|---|---|---|
| Highest nursing degree, % | | | |
| BSN | 15.4 | 14.3 | 14.3 |
| MSN | 69.2 | 71.4 | 64.3 |
| Doctorate | 15.4 | 14.3 | 14.3 |
| Missing | 0.0 | 0.0 | 7.1 |
| Primary role in emergency department, % | | | |
| Staff nurse | 15.4 | 14.3 | 14.3 |
| Charge nurse | 7.7 | 7.1 | 7.1 |
| Manager | 7.7 | 14.3 | 7.1 |
| Clinical educator | 7.7 | 35.7 | 35.7 |
| Other ED role | 7.7 | 7.1 | 7.1 |
| Non-ED role | 23.1 | 21.4 | 21.4 |
| Missing | 0.0 | 0.0 | 7.1 |
| Mean years of emergency nursing experience, mean (SD) | 16.3 (8.4) | 16.9 (8.7) | 18.1 (8.9) |
| Mean years of emergency nursing experience in current emergency department, mean (SD) | 7.0 (7.9) | 8.1 (7.7) | 7.8 (7.8) |
| Emergency department currently uses ESI, % | | | |
| Yes | 76.9 | 78.6 | 71.4 |
| No | 0.0 | 0.0 | 0.0 |
| Primary role not in emergency department | 23.1 | 21.4 | 21.4 |
| Missing | 0.0 | 0.0 | 7.1 |

Percentages may not equal 100 owing to rounding.
BSN, Bachelor of Science in Nursing; MSN, Master of Science in Nursing; ESI, emergency severity index.

*Round 1: Open-ended Questions*

Q1: What do you see as the most pressing research gaps in the process of ESI triage?
Q2: What do you see as the most pressing research gaps in the application of the ESI algorithm?
Q3: What do you see as the most pressing research gaps in the triage of ED populations?
Q4: Are there any other emergency care issues related to ESI that you weren't able to address in the previous questions?

*Round 2: Agreement With Research Questions*

Four categories emerged from the answers to the round 1 questions: education and training, workplace environment, emergency care settings, and special populations. These 4 categories were converted to research questions (Table 2). The second round asked the participants to indicate how strongly they agreed that the question was important to investigate. Statements that had the most "agree/strongly agree" (cutoff 4.0) answers were used in the third round.

TABLE 2
**Mean ranking of emergency severity index triage research needs by topic area, N = 14**

| Mean rankings by topic area | Mean (Highest priority = 1, lowest priority = 4) |
|---|---|
| Education | 1.38 |
| Special populations | 2.46 |
| Emergency care services | 2.54 |
| Work environment | 3.15 |

*Round 3: Rank Order*

The participants were asked to rank order the statements within each category to determine priority research areas.

## Results

Round 1 (N = 13) yielded a total of 112 issues (Q1 = 34; Q2 = 39; Q3 = 24; and Q4 = 15). These 112 issues were examined by the research team for repetition and similarity and ultimately collapsed by consensus into 18 potential research questions in 4 general categories: education and training (6 questions), workplace environment (3 questions), emergency care services (7 questions), and special populations (2 questions). In round 2 (N = 14), the participants reported their agreement with the importance of each research question. In round 3 (N = 14), the participants rated the categories as a whole as well as the questions within each category (Table 3), yielding a rank order of both categories and questions that focused on the factors that affect educational efficacy and competency. These factors centered around environmental conditions, staffing, and the length of shifts for triage nurses.

TABLE 3
**Mean ranking of emergency severity index triage research needs by specific questions within topic areas**

| **Education (6 questions)** | **Mean (Highest priority = 1, lowest priority = 6)** |
|---|---|
| What are the effects of emergency nursing experience and triage-specific education on triage accuracy? | 3.23 |
| What constitutes "competency" in triage assessment? | 3.23 |
| What is the minimal standard for triage education to ensure competency? | 3.23 |
| How can competency in triage be measured? | 3.54 |
| What are common cognitive errors in triage decision-making? | 3.85 |
| What is the effect of a pathophysiologically-based triage education course on accuracy? | 3.92 |
| **Special populations (2 questions)** | **Mean (Highest priority = 1, lowest priority = 2)** |
| How do cultural considerations affect triage accuracy? | 1.38 |
| What is the process of assigning acuity to special populations (eg, pediatric, obstetric, geriatric, and psychiatric patients)? | 1.62 |
| **Emergency care services (7 questions)** | **Mean (Highest priority = 1, lowest priority = 7)** |
| How is a standard assessment process maintained regardless of process? | 2.77 |
| What are the conditions under which inaccurate triage occurs? | 3.23 |
| Where in the process should vital signs be taken to ensure accuracy of the triage level? | 3.77 |
| What are the staffing implications for the accuracy of ESI in triage decision-making? | 4.31 |
| Do different processes (eg, "quick look," 2-step, or split triage) affect accuracy? | 4.38 |
| Is an expanded ESI algorithm useful for further delineation of acuity? | 4.38 |
| Under what circumstance should an ESI level be changed? | 5.15 |
| **Work environment (3 questions)** | **Mean (Highest priority = 1, lowest priority = 3)** |
| What is the relationship of nurse attitude about triage and accuracy? | 1.77 |
| What is the impact of cognitive fatigue on triage accuracy? | 1.92 |
| What is the relationship between nurse staffing in triage and accuracy? | 2.31 |

ESI, emergency severity index.

## Discussion

The purpose of this study was to develop a research agenda for the improvement of individual and institutional understanding and use of the ESI.

Using a modified Delphi process, we were able to develop a rank-ordered list of priorities. The focus of the list is on education and training, ranked as the highest priority category (1.38/4), which aligns with much of the extant literature.

Studies of triage education are well represented in the literature. Delnavaz et al[20] report in their review of literature that, in a number of studies, triage education is reported as inadequate for the depth and breadth of the knowledge required to make a clinical decision in a patient population that is unknown and potentially acutely ill. A scoping review[21] suggests that there are more problems with under-triage in rural areas and also in control groups that have no triage-specific training. We suspect that an educational approach may be necessary that focuses on both the breadth and depth of the knowledge required for accurate decision-making and the environmental challenges of the emergency care environment. This educational approach was supported by our Delphi participants who rated education as the highest priority topic area. Some literature suggests that along with triage-specific education, a breadth and diversity of nursing experience may be more useful than ED experience,[21] and 1 of the top educational priorities noted by our Delphi participants recommends exploration of the components of triage competency. A concept analysis by Moon and Park[22] suggests that triage competency in emergency nurses comprises 5 attributes: clinical judgment, expert assessment, management of medical resources, timely decision, and communication. "Competency" is defined as the comprehensive ability to prioritize patients' urgency and allocate limited medical resources. Further work in this area can be framed using this concept as defined.

It has been reported that periodic refresher education may also be of use to maintain triage skills throughout a nurse's career.[23] Most importantly, the ESI Handbook (2012) states the following: (1) "Nurses who participate in an ESI educational program are expected to be experienced triage nurses and/or to have attended a separate, comprehensive triage educational program" (page vi); and (2) "triage nursing staff will need a full orientation to the ESI" (page 55).

The second-highest priority topic area (2.46/4) focused on special populations (pediatric, geriatric, obstetric, and psychiatric) and, specifically, the process of assigning a triage score to those groups. Historically, these groups can be viewed as somehow being "outside" the ESI algorithm. Although there are no specific considerations for these populations in the ESI Handbook itself (with the exception of pediatric-specific vital signs), perceptions of stability should be congruent with adult medical or surgical patients. It is known that considerations of physiological and development processes, immune response, medications, chronic conditions, and past medical history create conditions in these special populations under which challenges to physiological and psychological stability can present differently.

The literature suggests that pediatric triage resources and education are inadequate;[24] the only study to look specifically at the use of the ESI algorithm with pediatric patients found a 27% rate of mis-triage.[25] There is clearly a need to examine the use of the algorithm in this population and develop educational interventions to improve the triage of children.

Similarly, at the other end of the lifespan, geriatric triage is also challenging. Wolf et al[26] report a lack of geriatric readiness in US emergency departments. Older patients may present with subtle and atypical signs complicated by medication and impaired immunity.[27] Ageism and provider bias also can complicate triage decision-making in this population. Currently, geriatric-specific triage education is not common.

There are few studies examining accuracy in patients who are pregnancy-capable. As with pediatric and geriatric triage, a lack of knowledge may underlie challenges to accuracy; Rashidi Fakari and Simbar[28] and Wolf et al[29] both identify knowledge and process challenges. Further research is warranted to clearly identify actionable factors.

Finally, special populations include patients with psychiatric/behavioral health issues. The ESI does not specifically have criteria for behavioral health/mental health triage, aside from the idea of "psychological instability." Wolf et al[30] reported that emergency nurses describe almost no postlicensure education in the triage or care of the patient presenting in a behavioral health crisis. Further work in this area[3,5,31] describes a patchy understanding of the risks of patients who are suicidal. There is a clear need to develop specific triage criteria for patients presenting with behavioral health complaints.

The third-highest priority topic area was emergency care services (2.54/4), identified as triage processes outside the ESI algorithm. This category included questions about the assessment process, the effect of 2-step and "split triage" processes on triage accuracy, the impact of staffing on triage accuracy, and other conditions under which inaccurate triage may occur.[3,5,29] Wolf et al report that some triage processes can have a negative impact on accuracy, citing specifically "pull to full" and 2-step practices where a full

assessment cannot be made.[3,29] Ponsiglione et al[32] conclude that formal procedures and guidelines may be useful for newer nurses to build their confidence when making decisions, whereas expert nurses find these guidelines chafing. In addition, maintaining the structure of triage through policies and the process of triage through procedures may bolster the effectiveness of the ESI.[8] The formality of the decision-making process, then, may contribute in some way to the "goodness" of the triage decision. The ESI Handbook also addresses the importance of quality assurance and improvement, stating that "at a minimum [for evaluation and quality improvement], always monitor accuracy of the triage level" (page 64).

The lowest priority focus area is the work environment and its effect on triage accuracy and processes (3.15/4). The work of Wolf,[2,4] Zavala et al,[33] and Cannavacciuolo et al[34] focuses on the intersection of the workplace environment and clinical decision-making processes; the general conclusions of these studies are that the socioclinical environment can affect both triage decision-making and other clinical decision-making processes and the way in which nurses and physicians act on their clinical judgment. Other researchers[35,36] also report the effect of the emergency care environment on triage decision-making. Resources such as adequate staffing and appropriate ongoing training[8,29,32,37] are also important to accurate triage decision-making. The literature highlights the potential negative effect of nurses' workload and continual interruptions on their assessment function.[38-40] ED crowding and patient volume[4,41] could significantly affect the level of stress experienced by triage nurses and, consequently, the accuracy of patient acuity assignment. Our priorities results suggest that further examination of the relationships between environment and triage accuracy are warranted to further explicate the research conclusions reached in these mostly qualitative and mixed-methods studies.

## Limitations

The participants in this study were a self-selecting group who applied to be part of a work team focused on how the Emergency Nurses Association can best maintain and improve the ESI scale. The participants had varying levels of nursing expertise and experience in triage. However, some of the limits imposed by the variety of expertise and triage experience may be mitigated by the fact that they work in different areas of the US and in different hospital settings, thus bringing a broad range of views on current needs in the practice and application of the ESI. The incompleteness of round 1 of the Delphi process (N = 13/14) may also be a limitation.

## Implications for Emergency Clinical Care Nurses

Establishing priorities for research into the use of the ESI delineates a necessary knowledge base for clinical nurses using the ESI as they perform triage functions.

## Conclusions

The research priorities as set through the use of this modified Delphi process align well with current gaps in the literature. Research in these areas should be encouraged to improve the understanding of educational, environmental, and process challenges to emergency nurses' triage decisions and accuracy of ESI assignments.

## Author Disclosures

Both authors are employees of the Emergency Nurses Association.

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# Assessment of Interrater Reliability of the Emergency Severity Index After Implementation in Emergency Departments in Jamaica Using a Learning Collaborative Approach

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**Contribution to Emergency Nursing Practice**

- The current literature indicates that ESI is a validated triage system, used over 70% of emergency departments in the USA where it was developed.
- This article contributes to the growing body of literature revealing that the reliability of the Emergency Severity Index triage algorithm has not yet been established outside of the US.
- Key implications for emergency nuring practice found in this article include special considerations that can be considered when implementing the Emergency Severity Index triage algorithm outside of the US. Implementation of this algorithm outside of the US could be enhaced by sustainable support measures for new practicioners, as well as knowledge of local triage practices.

## Abstract

**Introduction:** In 2016, the Ministry of Health in Jamaica selected the Emergency Severity Index as the triage tool to be used nationally. This study evaluated the effectiveness of this approach by assessing the interrater reliability among new users trained with minimal resources by 2 experienced trainers, 1 local and 1 international.

**Methods:** A retrospective case series review was conducted within an online learning collaborative framework. After completion of the training, the participants from each of the 19 clinical sites were asked to submit 2 triage cases per month for blinded review by the expert trainers. The triage categories assigned by each reviewer were compared with those assigned by the newly trained Emergency Severity Index providers. A weighted kappa value was calculated to assess the degree of agreement between the sites and the expert trainers.

**Results:** A total of 166 cases were received over the study period. Participation in the learning collaborative was consistently below 50%. The interrater reliability between the expert trainers ($\kappa = 0.48$) as well as between each scorer and each accident and emergency department site ($\kappa_{SF} = 0.33$, $\kappa_{PT} = 0.26$) was low,

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J Emerg Nurs 2021;47:58-65.
Available online 20 October 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.07.003

although there was improvement over the study period. Incomplete triage documentation limited raters' ability to assign triage categories and assess interrater reliability.

**Discussion:** Despite a rigorous implementation process, the interrater reliability of the Emergency Severity Index skills of Jamaican emergency nurses and doctors when compared with that of the 2 experts was poor. Several areas were identified for strengthening. Considerations for the implementation of the Emergency Severity Index in countries outside of the US were also discussed.

**Key words:** Emergency Severity Index; triage; Jamaica; learning collaborative

## Introduction

The Emergency Severity Index (ESI) is a 5-level triage tool validated and used in more than 70% of emergency departments in the United States.[1] The reported interrater reliability (agreement among different raters) of the ESI ranges from 0.69 to 0.89 in the United States.[2-4] In Jamaica, there is variability across sites, and triage may be performed by physicians and/or nurses. Not all doctors and nurses engaged in triage are trained in emergency medicine. Triage training is quite variable across the island. We previously reported the implementation process of the ESI at 19 emergency departments across the island of Jamaica in 2016.[5] To improve maintenance of ESI skills posttraining, ongoing support was provided through a learning collaborative, held as monthly webinars. All 19 accident and emergency departments were trained, included in the webinars, and asked to review triage cases each month and report triage levels before the monthly webinar. Cases were discussed during the webinar. The scores for the same cases were then reviewed (blinded to the triage nurses' scores) to determine the interrater reliability. The aim of this project was to assess the interrater reliability of triage levels among new users of the ESI trained with minimal resources by 2 experienced ESI trainers, 1 local (SF) and 1 international (PT).

## Methods

A retrospective case series review design was used as part of an educational program, using a learning collaborative approach. The project was approved by the Institutional Review Boards at Duke University (Pro0079666), the University of the West Indies (ECP- 90 16/17), and the Ministry of Health in Jamaica. Data were collected monthly for 9 months from October 2017 to June 2018.

### SUMMARY OF ESI TRAINING

The Ministry of Health in Jamaica played a strong role in the support of the design and implementation of the training throughout the island. The Ministry of Health required participation from each accident and emergency department. Briefly, the training was conducted by PT and SF with participants from 19 local accident and emergency departments across the 5 geographical health regions over a 4-day period from June 6 to June 9, 2017. A detailed account of the training was previously published.[5] PT was a member of the original ESI Triage Research Team, LLC, and has published extensively on its use. SF is a local advocate for the ESI and has championed its use in the teaching hospital where it was introduced in 2004. The training teams consisted of a minimum of 4 persons at each accident and emergency department. Physicians and nurses across the island of Jamaica were trained over the course of 4 days. Most of the participants completed online training in the ESI before attending the workshop.

### CASE REVIEWS AND INTERRATER RELIABILITY ASSESSMENTS

The study team worked closely with the Ministry of Health to determine a feasible method to obtain triage case reviews at each of the 19 sites. They also determined the number of cases deemed acceptable to ask the sites to complete per month. After completion of the training, the participants from each of the 19 clinical sites that participated in the training were asked to submit 2 triage cases per month for review by PT and SF. The Ministry of Health determined that asking for more cases would be perceived as too burdensome. The cases for discussion were selected by random assignation of a specified date and time by a research assistant (KK) who did not participate in assigning an ESI level. A case report form was developed, and each site prepared the case report form with the information from the triage note. A champion at each site was responsible for overseeing the process and submitting the case forms to the designated contact from the research team at the University of the West Indies in Kingston. Triage nurses were not required to complete the case report form. All cases were anonymous. Triage personnel and patient identifiers were removed. The study investigators were blinded to the sites and medical staff submitting cases, and received only triage data

reported on the case report form. Triage data included the age and gender of the patient, vital signs, pain score, and clinical information obtained only from the triage note, inclusive of the narrative assessment of the patient presentation at triage. The ESI level assigned at the clinical site was also recorded. SF and PT were each provided with a form with all the clinical data. The information regarding the site submitting the case and the triage level assigned at that site was removed. SF and PT independently reviewed each case report form and assigned a triage level. The study staff entered the accident and emergency department–assigned triage level, as well as the level assigned by SF and PT, blinded to the accident and emergency department and each other's assigned triage level.

### LEARNING COLLABORATIVE

For 9 months after the training (October 2017 to June 2018), monthly learning collaborative webinars were led by SF and PT on the first Friday of each month from 9 AM to 10 AM. Persons from all 19 sites were invited to the learning collaborative, and all participants in the learning collaborative signed a consent form. Before the monthly webinar session, and after assigning independent triage levels, SF and PT reviewed and discussed the cases, and selected specific cases for discussion during the monthly learning collaborative webinar sessions. The sessions were intended as a space where ESI providers could review real cases and discuss how they were triaged. The discussion was guided by SF and PT. The aim was to optimize the use of the ESI in the Jamaican context across multiple sites while maintaining the integrity of the instrument. The cases were presented in a PowerPoint (Microsoft Corporation) format, and the participants were asked to report how they would rate the case and why. At the end of each case discussion, the participants and trainers would come to an agreement about the ESI rating. The learning collaborative framework also allowed discussion of the quality of the information presented in terms of vital signs and triage note. Not all cases were discussed in the learning collaborative sessions; however, all submitted cases were included in the analysis for this article.

### DATA ANALYSIS

Each rater submitted the triage level for the submitted cases separately to a research assistant (KK) before each learning collaborative. All submitted cases were rated; however, cases with missing data were excluded from statistical analysis. The ESI levels assigned at the sites were compared with the ratings assigned by PT and by SF, and these data were used to calculate a weighted kappa value to assess the degree of agreement among the sites. In addition, the raters (PT and SF) were compared with each other to assess the degree to which they agreed. $P < 0.05$ was deemed significant.

## Results

Fifty-seven physicians and 44 nurses were trained in the initial phase at 19 sites, all of which were eligible for participation. Table 1 reports the number of clinical sites submitting cases and the number of cases submitted for review whether they could be rated or not, as well as the level of participation each month in the learning collaborative. A total of 166 cases were submitted over the 9-month period. The level of participation in the learning collaborative was consistently below 50% of the 19 sites. The case submission rate decreased over the course of the 9 months, from 73% in October 2017 to 31% by June 2018. Table 2 reports the interrater reliability between the scorers (SF and PT), as well as between each scorer and each accident and emergency department ESI site. SF and PT had the strongest agreement ($\kappa = .482$), with SF having stronger overall agreement with the ESI sites than PT. Although vital signs are not a part of the ESI for levels 1, 2, 4, or 5, they are used to determine the need to uptriage from level 3 to level 2. Table 3 reports the frequency of documentation of vital signs and pain scores in the triage note. Heart rate (98.2%) was the vital sign that was recorded most frequently, whereas pain score (12.7%) was the least commonly recorded. Pain scores are an important ESI criteria and are considered when determining assignment of ESI level 2. The poor documentation of pain scores contributed to the difficulty in reviewing cases and rating them. Table 4 shows the cases that could not be rated owing to incomplete triage notes by month for SF and PT. This was particularly high for SF in December 2019, for PT in May 2018, and for both reviewers in April 2018. These cases were not included in the calculation of the interrater reliability.

## Discussion

This study examined the results on the interrater reliability of the ESI, after implementation through a structured train-the-trainer program across the island of Jamaica. After in-person train-the-trainer sessions, all accident and emergency departments that participated in the learning collaborative

TABLE 1
**Total number of sites that reported and cases submitted each month**

| Month | Sites that submitted cases n (%) | No. of cases submitted (N = 166) | Sites that participated in learning collaborative n (%) |
|---|---|---|---|
| October 2017 | 14 (73.7) | 28 | 9 (47.4) |
| November 2017 | 11 (57.9) | 22 | 4 (21.0) |
| December 2017 | 13 (68.4) | 25* | 9 (47.4) |
| January 2018 | 11 (57.9) | 22 | 6 (31.5) |
| February 2018 | 9 (47.4) | 18 | 6 (31.5) |
| March 2018 | 6 (31.6) | 12 | 5 (26.3) |
| April 2018 | 8 (42.1) | 15* | 1 (5.3) |
| May 2018 | 6 (31.6) | 12 | 3 (15.7) |
| June 2018 | 6 (31.6) | 12 | 2 (10.5) |
| Total | | 166 | |

* Odd number of cases received because 1 site sent only 1 case that month.

were invited to participate in a monthly webinar for 9 months. If all sites had submitted 2 cases per month, then each month 38 cases would have been received. At no point in the 9-month study period did all the sites submit cases. Participation in the learning collaborative was lower than anticipated, falling as low as 5% (1 site) and not exceeding 50% of the sites trained at any time. Many attempts to encourage participation were used, including frequent e-mail, WhatsApp messages, and telephone reminders to participants and team leaders, as well as encouragement for participation by the Ministry of Health. We did not assess the cause of low participation formally; however, during the sessions, some factors reported to the investigators included an inability to release staff to attend sessions owing to staff shortages, persons being on leave, reassignment of some of the persons initially trained to areas outside of the accident and emergency department, and technological challenges preventing persons at work from logging on. During the learning collaborative sessions, the cases submitted by the accident and emergency departments were reviewed and discussed. Although there was initial enthusiasm and a robust discussion of cases in earlier sessions, this enthusiasm dampened and participation declined over time.

The overall interrater reliability between the expert raters ($\kappa = 0.48$) and the accident and emergency department sites was weak.[6] A kappa statistic range of .40 to .59 corresponds to weak interrater reliability.[6] SF consistently agreed more with the sites ($\kappa = 0.33$) than PT ($\kappa = 0.26$). This likely reflects better knowledge of local institutional practices, which include the practices related to resources that strongly influence the assignment of ESI

TABLE 2
**Interrater reliability among ESI trainers***

| Comparison | No. of valid cases | Weighted kappa | *P* value |
|---|---|---|---|
| SF vs PT | 164 | 0.48 | <.05 |
| SF vs ESI sites | 163 | 0.33 | <.05 |
| PT vs ESI sites | 163 | 0.26 | <.05 |

SF, Simone French; PT, Paula Tanabe; ESI, Emergency Severity Index.
* SF and PT served as ESI trainers.

TABLE 3
**Vital signs recorded from triage note to case report form**

| Vital sign | Cases | Vitals completed (%) |
|---|---|---|
| Heart rate | 163 | 98.2 |
| Blood pressure | 126 | 75.9 |
| Temperature | 145 | 87.3 |
| Respiratory rate | 143 | 86.1 |
| $O_2$ saturation | 129 | 77.7 |
| Pain score | 21 | 12.7 |

TABLE 4
**Cases that could not be rated each month for each reviewer**

| Month | No. of cases submitted | Cases that could not be rated by SF n (%) | Cases that could not be rated by PT n (%) |
|---|---|---|---|
| October 2017 | 28 | 0 (0.0) | 2 (7.1) |
| November 2017 | 22 | 1 (4.8) | 2 (9.5) |
| December 2017 | 25 | 7 (28.0) | 2 (8.0) |
| January 2018 | 22 | 1 (4.5) | 2 (9.1) |
| February 2018 | 18 | 1 (5.9) | 1 (5.9) |
| March 2018 | 12 | 0 (0.0) | 0 (0.0) |
| April 2018 | 15 | 4 (26.7) | 3 (20.0) |
| May 2018 | 12 | 1 (8.3) | 3 (25.0) |
| June 2018 | 12 | 1 (8.3) | 1 (8.3) |
| Total | 166 | 9.8 | 9.8 |

SF, Simone French; PT, Paula Tanabe.

levels 3, 4, and 5. The agreement between PT and the sites increased over the study period, perhaps because PT became more familiar with local practices through the learning collaborative discussions.

There are many possible reasons for the poor interrater reliability, which could offer valuable lessons. The first is the challenge of retrospectively assigning a triage score based solely on the written triage note. Both SF and PT were unable to assign scores for 9.8% of the cases reviewed. Initially, PT had a lower threshold and attempted to assign a triage level when perhaps all documentation was not present. Over time, PT altered this practice, as evidenced by an increase in the number of cases that she did not score in the last 2 months. We believe that several factors contributed to the inability to score cases. First, the notes varied significantly in both quantity and quality, severely limiting the ability to assign a score. Many notes did not provide sufficient history of the complaint and were extremely short. Pain scores and an objective assessment of the patient were often excluded. Vital signs were often incomplete. Although the recording of vital signs is not absolutely necessary in all cases, all patients classified as ESI level 3 should have vital signs assessed to identify danger zone vitals that may result in uptriage to level 2. Vital signs—in particular, respiratory rate and heart rate—are important in determining the need to uptriage patients from level 3 to level 2.[4] Oxygen saturation (recorded in 77% of the cases in this study) was responsible for uptriage in 2% of the cases. Uptriage owing to pain is the most subjective component of the ESI. Data from the Netherlands found little correlation between documented pain scores and triage.[7] Poor documentation of vital signs and pain scores, and poor-quality triage notes (lack of any narrative describing an objective assessment of how the patient appeared, or any other assessment) affected the ability to accurately rate cases.

Second, both nurses and physicians perform triage in Jamaican hospitals. Significant differences in the notes between these 2 types of ESI providers were detectable. Although the reviewers were blinded to the type of provider who completed the note, it was often obvious. For example, many notes included a treatment plan for medications to be administered in the accident and emergency department rather than the list of medications the patients take at home, indicating that a physician triaged the patient. Third, there are differences between Jamaica and the United States in terms of the use of resources. For example, many local accident and emergency departments do not have oral pain medications at triage. Very often, parenteral analgesia is ordered from triage. This results in a higher triage score because this counts as 1 resource. Neither SF nor PT was able to assess resource capacity because they were blinded to the accident and emergency department when reviewing the triage cases. There is also variation in resource use among different hospital accident and emergency departments across Jamaica. Rapid staff turnover and staff shortages are common in Jamaican accident and emergency

BOX

**Lessons Learned for Global Implementation of Emergency Severity Index**

All new Emergency Severity Index (ESI) providers (regardless of whether they are physician or nurse or advanced practice provider) should be required to complete ESI training online before practicing at triage. This training should be included as part of their assigned work hours.

All existing providers who conduct triage should also complete the required training, and, again, during assigned work hours.

Consideration should be given to embedding ESI in basic nursing curriculum. It is possible that ESI could be offered as an elective for students who are pursuing either emergency or critical care after graduation.

ESI providers and trainers should receive abbreviated refresher training every year.

The Ministry of Health and local accident and emergency department administrators must ensure that only trained ESI providers perform triage. This can be accomplished through provision of ongoing training, resource materials, and regular audit to ensure compliance. The Ministry of Health could ensure that a minimum of 2 ESI trainers were always available at every accident and emergency department.

Training on the evaluation of pain, use of pain scales, and documentation of pain score and use of analgesia are needed.

Maintenance of ESI training should be kept up to date by logging nurses and physicians who received training. ESI triage training and passing of a course should be a minimum competency.

Ongoing quality improvement and review of triage notes and levels should be conducted monthly.

Additional education should be provided for overall and individual triage nurse and physician trends seen in mistriage.

Training in critical components of an objective assessment of the patient should be included in triage training.

Training should include the importance of obtaining vital signs per ESI triage criteria, and an objective assessment of the patient.

Any local practices that may affect resource allocation should be discussed during training.

Any training must be done during assigned work hours to ensure compliance.

An online learning collaborative model requires participants to log on from sites with a stable Internet connection.

departments. Staff who were initially trained in the ESI may have moved to other duties or left the institution. It is likely that some of the persons who performed triage during the study period did not receive training by the ESI trainers.

The intent of the train-the-trainer session was that the participants would be competent in the use of the ESI and be able to teach the nurses and physicians in their accident and emergency department how to use the ESI. The participants in the learning collaborative reported that staffing limitations and high staff turnover affected many training teams over the study period. We were unable to track turnover or how many additional nurses and physicians were trained at each accident and emergency department.

Our project had many strengths. We used a structured model of training physicians and nurses in the ESI and reinforced the training with monthly webinar sessions of case reviews from accident and emergency departments. These sessions allowed discussion of a wide range of issues that were not the subject of this study but provided important feedback for the Ministry of Health. The issues included the lack of staffing and erosion of training teams, difficulty maintaining ESI-trained persons in triage, and variations in practice. As such, the model allowed for a useful exchange of ideas.

## LESSONS LEARNED AND RECOMMENDATIONS

Many lessons were learned from this implementation of the ESI in Jamaica that can be used globally. Suggestions for improvement are included in the Box.

Specific to Jamaica, additional lessons can be learned that may be applicable to other countries. The Ministry of Health conducts regular audits of emergency departments in Jamaica. The use of pain scores at triage, adequately documented vital signs, an objective assessment of the patient, and documentation of completion of triage training teams should be added to the existing audit tool. The stability of the training teams is paramount to success. This could help ensure constant reinforcement at each site. The model used in our project centered on creating training teams at each hospital. However, many training teams were

significantly eroded over the study period and were not replenished. It may be more sustainable to create a centralized team within the Ministry of Health Training Unit that moves from hospital to hospital in a scheduled manner to conduct and monitor ESI training. Moving forward, the cases collected during the learning collaborative will be used to create a slide set that can supplement existing resources and enhance local ESI training.

It is possible that the ESI is simply not reliable in countries outside of the United States. One evaluation of the ESI in Brazil[8] reported low interrater reliability similar to that reported in this study. Silva et al[8] conducted a multicenter comparison of nurse-performed ESI triage at 3 hospitals in Brazil, the United Arab Emirates, and the United States and found a mean accuracy of only 59.2% and high variability in triage.[9] More stable ED staffing, which is present in the United States, and a higher proportion of specialist emergency-trained nurses and physicians allowing more stable staffing may be necessary factors for successful use of the ESI. Although this may be true, we are unable to directly relate our poor interrater reliability to the ESI owing to the difficulties in conducting a retrospective review of incomplete triage notes.

There have been suggestions to use technology to enhance the reliability of the triage process. Machine learning was incorporated into an electronic triage system and found to be equivalent or better than traditional ESI triage, particularly for patients classified as ESI level 3.[10] The use of mobile ESI has also been shown to improve the accuracy of ESI triage.[11] Such applications may be particularly beneficial in resource-limited settings.

## Limitations

Our project has several limitations. The attrition rate among training teams at each accident and emergency department was not assessed. The feedback during the webinars suggests that this attrition is a significant factor mitigating success because the participants reported significant attrition of accident and emergency department training teams over the 9-month period. Attendance and attrition may have been affected by scheduling the sessions on the same day/time each month. To encourage attendance, the sessions can be rotated among different days/times. The use of a retrospective case review to assign triage scores and assess interrater reliability was problematic because the information provided was often too limited. We were unable to determine if the provider who triaged the reviewed cases was actually trained by the trainer on how to use the ESI. Although this is a significant limitation, it also represents the real world. There may also be differences in how nurses and doctors perform triage; however, this was not assessed.[12]

## Implications for Emergency Nurses

This study provides useful guidance to persons seeking to implement the ESI in low-resource settings outside of the United States. The finding of low interrater reliability between Jamaican doctors and nurses and the ESI experts reinforces the need for practical and sustainable measures to support new practitioners of the ESI. Triage note quality, completeness of vital-sign assessment, and high attrition rate among triage nurses and doctors need to be improved in Jamaican emergency departments as part of the overall program to improve ED triage. The stronger agreement between the local ESI expert and the sites as compared with that between the US-based ESI expert and the sites reflects the impact of knowledge of local triage practice in evaluating performance. These factors should be carefully considered by those implementing ESI in non-US settings.

## Conclusions

Despite a rigorous implementation process, the interrater reliability of the ESI among Jamaican accident and emergency department nurses and doctors was poor. Recommendations are made to improve implementation of the ESI that can be used to support other programmatic implementation in Jamaican accident and emergency departments and emergency departments globally.

## Acknowledgments

Funding for this project was obtained from the Pan-American Health Organization and we thank the Ministry of Health for Jamaica for their support of this initiative, as well as all the participants for their involvement. P.T. and S.F. received funding from the Jamaica Ministry of Health for the project. P.T. has received research funding and is supported by NHLBI (UH3 -HL137856-01, U01HL133964) and AHRQ (R18 RHS024501A), unrelated to this project. P.T. is a member of the ESI Triage Research Team LLC.

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# The Effectiveness of Pictorial Discharge Advice Versus Standard Advice Following Discharge From the Emergency Department: A Systematic Review and Meta-Analysis

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### Contribution to Emergency Nursing Practice

- The current literature on discharge advice indicates that a lack of understanding of discharge instructions can lead to poor compliance with instructions, postdischarge complications, and hospital readmissions. The use of pictorial discharge advice has the potential to improve these outcomes for patients.
- This paper contributes to practice by showing that pictorial discharge advice improves comprehension, compliance, and patient satisfaction with discharge advice compared with standard advice alone.
- Key implications and recommendations for translating these findings into emergency clinical practice include the ongoing use of pictorial discharge where it is currently available. Clinicians in the emergency department who plan to introduce pictorial discharge advice should do so in the context of evaluation research to assess the full range of clinical and cost-effectiveness outcomes.


## Abstract

**Introduction:** Failure to provide adequate discharge advice to patients on leaving the emergency department can lead to poor understanding of and noncompliance with discharge instructions and consequently postdischarge complications or hospital readmissions. The use of pictographs to complement discharge advice has the potential to enhance patient recall and comprehension. The purpose of this paper was to determine the effectiveness of pictorial discharge advice compared with standard discharge advice in the emergency department.

**Methods:** A systematic review and meta-analysis was conducted. CINAHL, MEDLINE, ASSIA, and EMBASE were searched from inception to March 1, 2020, combining terms related to the emergency room, pictogram, and randomized trials as appropriate. Randomized trials reporting on the use of pictorial discharge advice in the emergency department were eligible for inclusion. Outcome measures were comprehension, compliance with advice, satisfaction with advice and the ED visit, and reattendance rates. The Cochrane risk of bias tool was used to assess bias in the included studies.

**Results:** Four studies were identified as eligible and included in the review. Pictorial discharge advice improved comprehension, compliance, and patient satisfaction with the advice, but not satisfaction with the ED visit when compared with standard discharge advice. None of the included studies measured reattendance rates.

**Discussion:** The results of this systematic review support the use of pictorial discharge advice. However, few studies exist; none had a low risk of bias overall, and 3 were published over 12 years ago. This finding highlights a need for further research to inform evidence-based best practices on optimal methods for providing quality discharge advice in the emergency department.


**Key words:** Pictorial discharge advice; Pictograms; Emergency department; Systematic review

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J Emerg Nurs 2021;47:66-75.
Available online 19 September 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.07.005

## Introduction

Clinicians working in the emergency department regularly engage in patient education and discharge advice. The volume of patients being discharged home from the emergency department is ever-increasing and turnaround is rapid, with the time available to provide patient education often limited.[1] The main aim of discharge advice is to provide a summary of the ED visit, educate patients to self-care at home, address any remaining concerns or questions, and inform patients about the appropriate and available community supports.[2] However, studies have found that patients often go home with a poor understanding of their discharge instructions[3-5] which can consequently lead to poor compliance with the instructions, postdischarge complications, and hospital readmissions.[6]

Discharge advice can be verbal or written and should be clear, concise, and unambiguous.[7-9] However, large populations have low health literacy levels, and up to 50% of patients potentially have difficulty in understanding their discharge instructions.[10] Therefore, it is imperative that information is provided in a simple and understandable way to allow the patient to interact and participate in their health care.[11] One method of simplifying discharge advice is to reduce the reliance on text by using pictograms as a form of information sharing.[12] Pictograms can be an effective method of providing health information as they can help engage the patient's interest and improve comprehension, particularly for the at-risk patient groups such as the elderly, children, and those with low literacy.[13,14] Pictograms can incorporate illustrations (drawings, paintings, photos) with signaling and informative graphic symbols to boost and communicate information in a clear, rapid, and straightforward way.[15]

However, findings from previous studies on pictogram use in the emergency department are conflicting[16-21] with some researchers suggesting that pictograms may only be effective if they are used as an adjunct to and not as the sole means of communicating discharge advice[20,22] and that the types of illustrations used need to be tested, evaluated, and refined to ensure their success.[21] No published systematic reviews on the topic of pictorial discharge instructions in the emergency department were found. The purpose of this review was to determine the effectiveness of pictorial discharge advice compared with standard discharge advice on comprehension in the emergency department. We also sought to determine the intervention effect of pictorial discharge instructions on compliance, patient satisfaction, and ED revisits.

## Methods

We performed a systematic review and meta-analysis of randomized trials.

### INCLUSION AND EXCLUSION CRITERIA

Randomized controlled trials (RCTs) reporting on adults or children who presented to the emergency department and were discharged home with advice involving any type of pictorial information (eg, simple line drawings, pictures, photographs, paintings, or cartoons) compared with standard discharge advice (verbal, written, or both) were eligible for inclusion. Studies that evaluated other forms of communicating discharge information (eg, text, video, automated recordings, or telephone) or in other settings (eg, out-patient, in-patient, or day-case settings) even if pictorial information was used and studies that were not in English were excluded. The primary prespecified outcome measure was patient and carer's comprehension. The secondary prespecified outcomes were compliance/adherence with discharge advice, patient satisfaction with discharge advice and with the ED visit, and ED reattendance rates within 28 days with the same complaint.

### SEARCH STRATEGY

The electronic databases of CINAHL, MEDLINE, EMBASE, and ASSIA were searched from inception dates to March 1, 2020, using a combination of key words and medical subject heading terms. These terms were developed and adapted across the databases as appropriate and were based on 3 search concepts: (1) pictorial images, (2) emergency department, and (3) RCTs. The key concept term was combined with its related synonyms using the Boolean operand "OR," and then the concept strings were combined using the operand "AND." This approach ensured both specificity and sensitivity in our search strategy. The complete search strategy is presented in the Supplementary Appendix. No limits were applied to ensure all relevant studies were captured. A search for gray literature, including policy documents and theses, dissertations, and conference proceedings, was also performed. In addition, searches of the reference lists of the included studies were performed to locate any potentially relevant studies not found during the database searches.

### STUDY SELECTION

Following the removal of duplicates, the title and abstract of all of the remaining citations retrieved from the search were assessed against the review's inclusion criteria. The full text of potentially eligible studies was further assessed by 2 reviewers independently. Any conflicts of opinion between reviewers during the screening and selection process were resolved by discussion and consensus.

### RISK OF BIAS

The Cochrane risk of bias (ROB) tool was used to assess ROB in the included studies.[23] ROB assessments were undertaken by 2 reviewers independently. Any differences in opinion were discussed until agreements were reached.

### DATA EXTRACTION AND MANAGEMENT

A data extraction form was developed and used to extract the relevant data from each included study. Information extracted included the study design, setting and participants, inclusion and exclusion criteria, description of the intervention and comparison, data related to the reviews' prespecified outcomes, and a summary of the study authors' findings. The data were extracted by 2 reviewers independently and cross-checked for accuracy. The data were subsequently entered into Review Manager Software (RevMan 5.3, Cochrane) for analysis.

### DATA SYNTHESIS

Meta-analyses were performed when more than 1 study included the same outcome measure. For dichotomous outcomes, the relative risk (RR) and 95% confidence interval (CI) were calculated to provide an overall effect estimate. For continuous measures, the mean difference with 95% CIs were calculated, where the outcome was measured across the studies in the same way. If the same outcome was measured differently (eg, using a different scale), the standardized mean difference was used. Accepting that some clinical and methodological diversity is likely in a meta-analysis, we assessed the extent of statistical heterogeneity; that is, the extent to which the results of the studies included in a meta-analysis are consistent, using the $I^2$ statistic. We quantified this based on Cochrane guidance for $I^2$ values as follows: 0% to 40%, might not be important; 30% to 60%, may represent moderate heterogeneity; 50% to 90%, may represent substantial heterogeneity; and 75% to 100%, considerable heterogeneity.[23] Meta-analyses were performed using a fixed-effects model, except when we found substantial or considerable heterogeneity. If this heterogeneity was observed, we applied a random-effects model, which weights the studies relatively more equally, taking into account between-study variations such as small-study effects, which may influence the results. As less than 10 studies were included in the review, funnel plot tests were not performed.[23]

## Results

### SEARCH AND SELECTION PROCESS

The electronic database search yielded 3,574 citations. Of these, 150 were duplicates and were removed. Of the 3,424 records screened on title and abstract, 3,405 were excluded, leaving 19 records for full-text review. Searching the gray literature yielded 559 records, none of which met the inclusion criteria. Of the 19 records assessed at full-text, 15 were excluded as 8 did not report on pictorial discharge advice,[24-31] 5 were not RCTs,[16,32-35] and 2 were duplicates.[36,37] This resulted in the inclusion of 4 studies in the review.[14,38-40] Figure 1 illustrates the search and selection process.

### CHARACTERISTICS OF INCLUDED STUDIES

Table 1 presents the summary characteristics of the included studies. All 4 studies were conducted in emergency departments in the United States. One trial, conducted in a rural level 1 trauma center, recruited 101 participants (54 in the intervention group and 47 in the control group) who presented to the emergency department with lacerations between June 1993 and July 1993.[38] The second study, involving 205 adults and children presenting to the emergency department with wounds of which 103 received wound care instructions with cartoons and 102 received instructions without cartoons, was conducted in a community hospital and tertiary care facility between April 1994 and July 1994.[14] The written text was identical on the 2 sets of instructions and was written at a seventh-grade educational level. Baseline characteristics (age, gender, level of education, and time spent in the emergency department) were similar between the groups. The third study, conducted in a large inner-city university emergency department, involved 796 participants, of which 368 were assigned the intervention, which consisted of pictures added to 2 simply

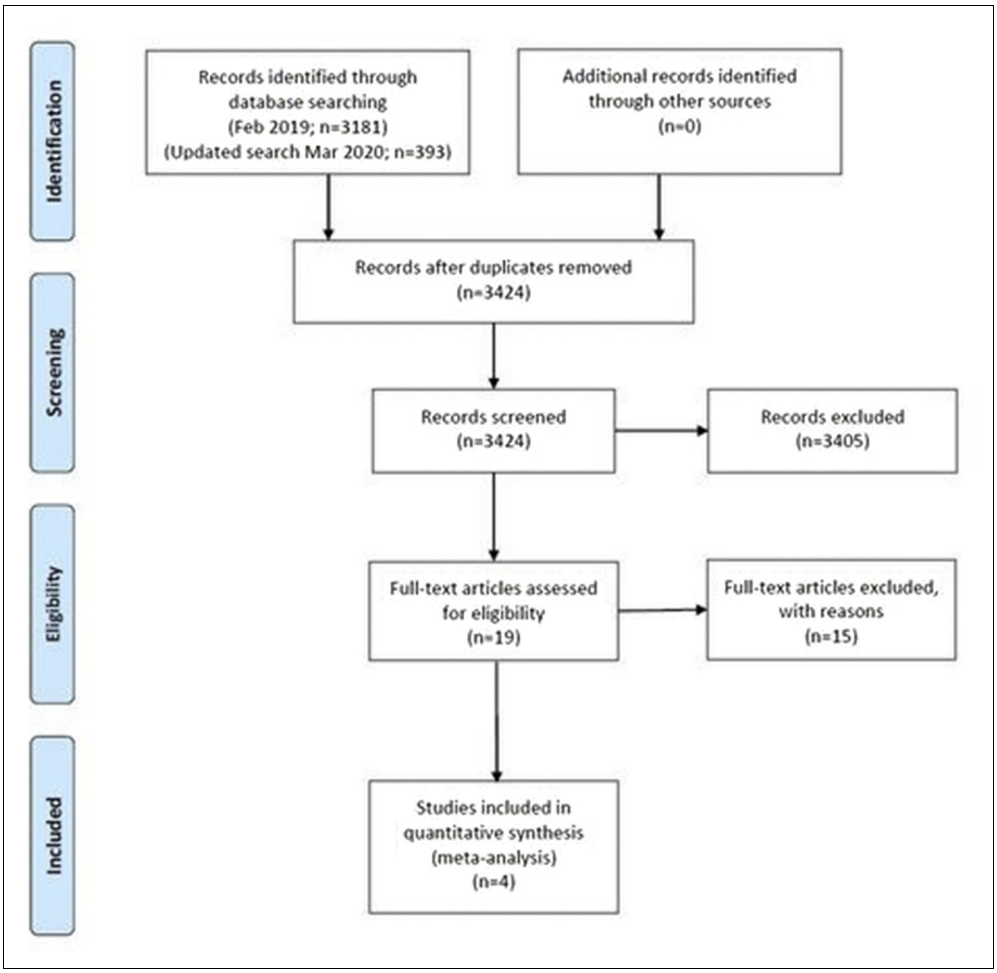


FIGURE 1
Search and selection flow diagram.

worded discharge instructions.[39] The fourth study, involving pediatric patients between the ages of 30 days and 8 years (and their parents) recruited between July 2006 and December 2006, took place in an urban public pediatric emergency department in New York.[40] Of the 245 patients included, 124 were allocated to a pictogram-based intervention and 121 to standard medication advice, although 11 and 7 from each group, respectively, were lost to follow-up. The intervention consisted of plain language, pictogram-based medication instruction sheets, in English and Spanish, used to convey information about medication name, indication, dose and dose frequency, length of treatment, preparation, and storage. The control group received standard medication discharge advice regarding prescribed medications and postvisit advice by the pediatric nursing staff. The study participants were further subdivided into those that received daily dose and as-needed medications. In the pictogram-based group, 46 received daily dose medications, and 79 received as needed. In the standard medication group, 53 received daily dose, and 79 received as-needed medications. Follow-up was completed either by telephone and/or in-person 3 days to 5 days after the ED visit for as-needed medication and within 1 day of the projected end date for daily dose medications. There were no differences between the groups in terms of the child's age, sex, or type of medication prescribed.

TABLE 1
**Summary characteristics of included studies**

| Study | Setting | Type of participants | Presentation | Number of participants | Description of the intervention |
|---|---|---|---|---|---|
| Austin et al[38] | Rural level 1 trauma center | Not specified | Patients with lacerations | 101 | Discharge instructions with or without illustrations. The written text was identical on both sets of instructions |
| Delp and Jones[14] | Community hospital and tertiary care facility | Adults and children | Wounds | 205 | Discharge instructions with and without cartoon illustrations. The written text was legible and written to be understood by a person with a seventh-grade education and was identical on both sets of instructions |
| Friedmann et al[39] | Large inner-city university emergency department | Not specified | Not specified | 796 | Pictures were added to 2 simply worded discharge sheets |
| Yin et al[40] | Urban public pediatric emergency department | Children between 30 d and 8 y, and their parents | Prescribed liquid medications (as-needed and daily dose) | 245 | Plain language, pictogram-based medication instruction sheets, in English and Spanish, which used pictograms to convey information about medication name, indication, dose, dose frequency, length of treatment, preparation and storage |

## QUALITY ASSESSMENT

Figure 2 presents the results for the ROB assessments. ROB on random sequence generation was low in 2 studies[14,40] and unclear in 2 studies because of limited information to fully assess ROB.[38,39] One study had low ROB on allocation concealment.[40] This was unclear in the remaining 3 studies because of insufficient information. It was impossible to blind the participants and personal administering instructions in all of the included studies, and we assessed ROB as unclear for this criterion in all studies because of the uncertainty surrounding this issue. Detection bias was low in 2 studies.[14,38] One study did not provide enough data to judge detection bias and was assessed as unclear.[39] In the remaining study, the researchers were involved in both intake (recruitment) and follow-up assessments and were aware of allocated groups; we thus judged the risk of detection bias as high in this study.[40] Two of the studies had a low risk of attrition bias,[38,40] and 2 were unclear. Three of the included studies had a low ROB on selective reporting, as all prespecified outcomes were reported.[14,38,40] The fourth study was judged as having a high ROB.[40] Of the 4 studies, 3 were assessed as having unclear risk of other bias, and 1 was considered as high risk because the data were collected using 2 different methods; an interview before leaving the hospital or, if the interview did not occur, contacted at home via telephone which had the potential to influence responses.[38]

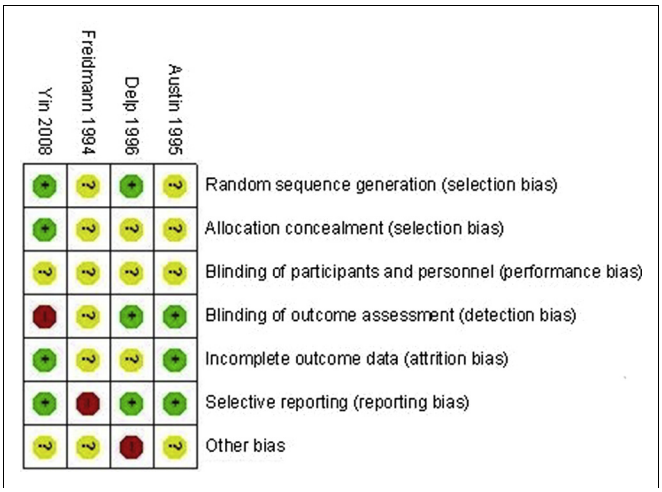


FIGURE 2
Risk of bias assessment.

## DATA EXTRACTION

Austin et al[38] measured comprehension only, based on participants answering 5 or more questions correctly. Delp and Jones[14] reported on 3 of the reviews' pre-specified outcomes; comprehension, compliance, and satisfaction. The authors subdivided comprehension into 2 categories on the basis of (1) a series of 4 questions and (2) the readability of the discharge advice instructions. The numbers that answered all 4 questions correctly in each group and the numbers in each group that reported readability as "very easy" were used for the outcome comprehension. Compliance with discharge instructions was defined as the numbers having cleaned the wound at least once per day with either hydrogen peroxide or commercial soap. Satisfaction with ED visit and with instructions/discharge advice was defined as the numbers reporting "very satisfied." Yin et al[40] reported comprehension and compliance only. Comprehension was measured in terms of error rates; that is, higher errors, less comprehension. They also subdivided comprehension into errors in the knowledge of dose frequency, incorrect medication preparation, and storage errors for both daily dose and as-needed medication. The data for comprehension, once extracted, were changed to reflect non-error rates. For compliance data, Yin et al[40] reported nonadherence rates based on more than 20% of the participants not taking the prescribed dose correctly and not completing the medication course. Similarly, for purposes of analyses, these data were converted to adherence rates based on 80% or greater taking the prescribed dose correctly and completing the medication course. Friedmann et al[39] was the only study that reported continuous data and reported on comprehension only. As there was considerable missing data, particularly relating to the control group, the results are presented narratively. None of the included studies reported on the outcome of readmission rates.

## FINDINGS

### *Comprehension*

As different categories of comprehension were assessed across the studies, effect estimates of comprehension overall and comprehension others are provided. The results demonstrate that comprehension overall was significantly improved with pictorial discharge advice compared with standard advice (RR = 2.53; 95% CI 1.19-5.35; $I^2 = 89\%$; 3 studies, n = 389) (Figure 3). As statistical heterogeneity was high, we removed Delp and Jones' study,[14] which was largely contributing to this $I^2$ and re-ran the analysis. The results remained significant in favor of pictorial advice for increased comprehension (RR = 1.70; 95% CI 1.35-2.15; $I^2 = 0\%$; 2 studies, n = 184).

The results for other measures of comprehension are presented in Table 2, with each result based on data from a single study. Readability of instructions, non-error rates in as needed medications, and accurate preparation of daily dose and as needed medications were all significantly improved with pictorial compared to standard discharge advice.

Reporting narratively on the results from Freidmann et al,[39] the mean score for correct answers from the intervention group was 4.55/5.00 compared with 4.36/5.00 in the control group, $P < 0.01$. The results, when subgrouped by education level (12th grade or less), also showed improvement with pictograms; mean scores 4.38/5.00 versus 3.89/5.00, $P = 0.001$.

### *Compliance*

Participants who received pictorial discharge advice were more likely to comply with their discharge instructions than those receiving standard advice (RR = 1.44; 95% Cl = 1.22-1.68; $I^2 = 0\%$; 2 studies, n = 298 participants) (Figure 4), and to complete their medication course (RR = 1.72; 95% CI 1.18-2.50; 1 study, n = 93 participants).

### *Patient Satisfaction*

Patient satisfaction was reported in 1 study only, and included satisfaction with discharge instructions and satisfaction with the ED visit. The results indicate higher

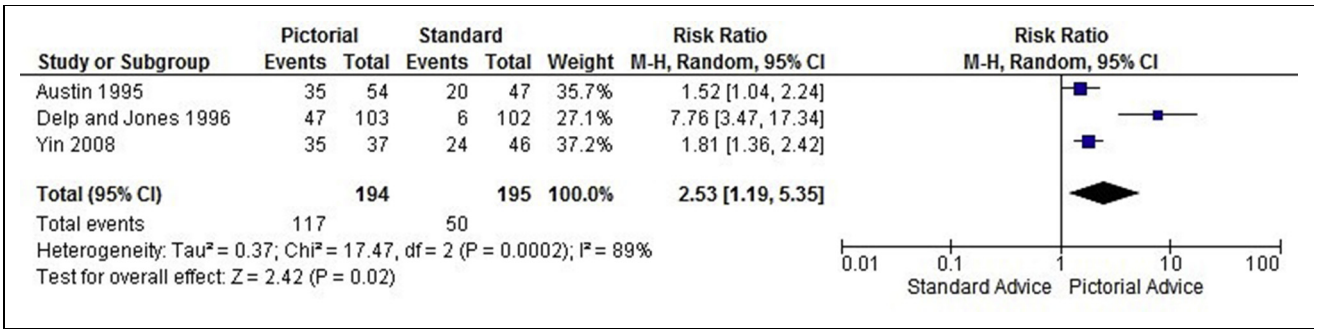


FIGURE 3

Comprehension overall. CI, confidence interval; M-H, Mantel–Haenszel.

satisfaction with discharge instructions in the pictorial group (RR = 1.48; 95% CI 1.28-1.71; n = 205), but no difference between groups in satisfaction with the ED visit (RR = 1.02; 95% CI 0.92-1.14; n = 205).

## Discussion

All 4 studies included in this review demonstrated favorable outcomes with pictorial discharge advice, in particular, increased comprehension and compliance. Satisfaction with discharge instructions, although reported in only 1 study, was also higher when pictograms were used, whereas there was no difference in satisfaction with the ED visit. The former might be linked to patients feeling more prepared or ready for discharge as a result of understanding their home-care instructions, but not necessarily with the visit overall as receiving discharge occurs toward the end of their visit. The studies all evaluated the use of pictorial advice as an adjunct to written and/or verbal advice and not as a replacement; therefore, the impact of using pictorial instructions may vary depending on the level of verbal and written instructions that are also provided. Furthermore, although reattendance rates were considered an important outcome for the review, none of the included studies measured this outcome. This finding may reflect the small numbers of included studies or the complexity in collecting data on reattendance rates as prolonged follow-up and/or retrospective data collection may be required.[41]

TABLE 2

**Results for other measures of comprehension**

| Comprehension measure | Pictorial Events/Total | Standard Events/Total | RR (95% CI) |
|---|---|---|---|
| Readability of instructions 'very easy' | 101/103 | 65/102 | 1.54 (1.33-1.79) |
| Frequency of observed non-error rate of at least 80% in as needed medications | 54/64 | 36/60 | 1.41 (1.12-1.77) |
| Numbers who accurately prepared daily dose medication | 41/46 | 38/53 | 1.24 (1.02-1.51) |
| Number who accurately prepared as-needed medication | 62/79 | 45/79 | 1.38 (1.10-1.72) |
| Numbers who accurately stored daily dose medication | 41/46 | 43/53 | 1.10 (0.93-1.29) |
| Numbers who accurately stored as needed medication | 57/79 | 56/79 | 1.02 (0.84-1.24) |

RR, relative risk; CI, confidence interval.

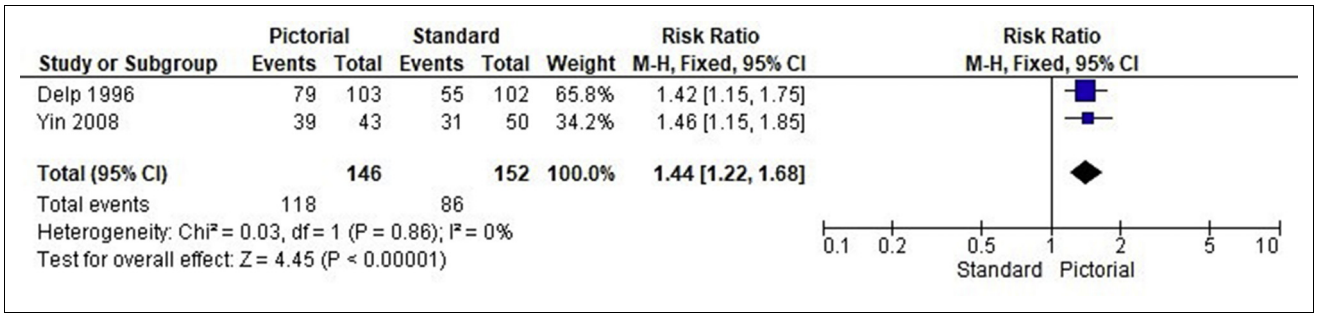


FIGURE 4

Compliance with discharge instructions. CI, confidence interval; M-H, Mantel–Haenszel.

One of the goals of this systematic review was to generate higher-level evidence relating to pictorial discharge advice in the emergency department and make recommendations for practice based on this evidence, to potentially improve the quality of care provided to patients in the emergency department. Although the evidence is convincing for using pictorial discharge advice, particularly for comprehension and compliance, this evidence is based on a few studies, which are of variable quality, and were published between 12 and 25 years ago. Furthermore, no studies reported on reattendance rates, which is an important outcome when considering widespread practice change, and cost analysis on the use of pictorial discharge advice compared with standard advice would be required. Based on findings from only 4 studies, further research to substantiate the use of pictorial aids in the emergency department is required, a finding that resonates with recommendations from other systematic reviews of pictorial aid interventions.[22,42]

Although promising, the findings of this review highlight the limited evidence on the use of pictorial discharge advice in the ED setting, indicating that contemporary high-quality RCTs, with larger sample sizes, are needed. Future research should also consider other elements such as the varying conditions that patients present to the emergency department with and the effect of pictorial discharge advice on reattendance rates. The lack/absence of studies conducted in Europe indicates the need for research in different settings internationally.

## Limitations

The lack of comparable studies for analysis is a limitation in this review. The overall quality of the included studies also limits the findings, as none were considered to have a low ROB overall. All of the studies were completed in American institutions leading to a potential risk of cultural bias and possible challenges for the transferability of the findings to other countries and settings. The lack of diversity in the conditions that were assessed using pictograms may also affect the validity of the findings. Although our search strategy was comprehensive, including a search for both published and unpublished studies, the search protocol was not preregistered, which may be considered a limitation of the review. However, the findings of the review are informative and are underpinned by a robust review process, including a thorough search strategy. As such, the findings of this review provide the basis for considering the use of pictograms to enhance discharge information in the emergency department.

## Implications for Emergency Clinical Nurses

Although the findings of this review are based on meta-analyses of outcomes from only 4 studies, the findings are still convincing for the positive effects of using pictorial discharge advice, particularly for comprehension and compliance. However, preparing pictorial discharge advice may have cost implications beyond those of standard discharge advice. These may include, in addition to the potential increased paper and printing costs for lengthier pamphlets, the need for specialist personnel such as a cartoonist to develop the illustrations, an educationalist to ensure the pictographs are age and literacy (lay language) appropriate, and a clinician to ensure the illustrations are relevant and appropriate for the health care condition or topic. Acknowledging this, we recommend ongoing use of pictorial discharge advice in the emergency department where it is currently available, while also advising the need for robust contemporary research to determine if the use of pictorial discharge advice is a viable widespread practice change option. Thus, we recommend that clinicians in the emergency department should consider the use of pictorial

discharge advice, but if newly implementing their use, they should do so in the context of evaluation research or quality improvement projects whereby the full range of important clinical and cost-effectiveness outcomes can be thoroughly assessed.

## Conclusions

The evidence of effect for using pictorial discharge advice in the ED setting appears promising, especially for increased comprehension and compliance with discharge advice. However, further contemporary research is required, particularly in determining the effect of pictorial discharge advice on reattendance rates and cost-effectiveness. Nurse practitioners, scientists, and researchers in emergency nursing specialties are well-positioned and should be encouraged to conduct high-quality, rigorous research on the topic, using prospective randomized trials. This research will assist in expanding the contemporary evidence base, optimizing ED discharge care, and ensuring nurse leaders engage in quality improvement projects at their practice sites.

## Author Disclosures

Conflicts of interest: none to report.

The systematic review was conducted in partial fulfillment of an MSc undertaken at Trinity College Dublin by the lead author (S.D.), and who also received funding from the Office of the Nursing and Midwifery Services Director to support her College course. The funding body was not involved in planning the review, or in review methodology, data management or analytics, or manuscript preparation.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.07.005.

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## Supplementary Appendix

SEARCH STRATEGY

*Concept 1: Pictorial images*

CINAHL: (MH "Pictorial Methods") OR (MH "Graphics") OR (MH "Picture Archiving and Communication Systems")

MEDLINE: (MH "Multimedia") OR (MH "Electronic Supplementary Materials") OR (MH "Motion Pictures") OR (MH "Books, Illustrated") OR (MH "Medical Illustration") OR (MH "Graphics")

EMBASE: Multimedia/exp

EBSCO & other Databases Keywords: (media* OR multimedia OR pictorial* OR picture* OR pictogram* OR drawing* OR diagram OR illustrat* OR diagram* OR art OR cartoon OR comic* OR depiction OR visual OR icon* OR impression* OR photo OR photograph* OR sketch* OR doodle* OR symbol* OR hieroglyphs OR glyph OR artwork* OR graphic* OR artwork* OR animation* OR "comic strip*" OR "comic book*" OR portrait* OR emblem* OR logo* OR silhouette* OR "graphic novel*") N3 (use* OR usage* OR uptake* OR roll-out* OR implement* OR utiliz* OR utilis*)

EMBASE Keywords: (media* OR multimedia* OR pictorial* OR picture* OR pictogram* OR drawing* OR diagram* OR illustrat* OR diagram* OR cartoon OR comic* OR depiction OR visual OR icon* OR impression* OR photo OR photograph* OR sketch* OR doodle* OR symbol* OR hieroglyphs OR glyph OR artwork* OR graphic* OR artwork* OR animation* OR 'comic strip*' OR 'comic book*' OR portrait* OR emblem* OR logo* OR silhouette* OR 'graphic novel*') NEAR/3 (use* OR usage* OR uptake* OR roll-out* OR implement* OR utiliz* OR utilis*)

*Concept 2: Emergency Department*

CINAHL: (MH "Emergency Service") OR (MH "Emergency Medical Service Communication Systems")

MEDLINE: (MH "Emergency Service, Hospital") OR (MH "Emergency Medical Service Communication Systems") OR (MH "Emergency Nursing") OR (MH "Emergency Medical Services")

EMBASE: 'emergency ward'/exp OR 'hospital emergency service'/exp

Keywords for all Databases: "Emergency Room*" OR "emergency service" OR "emergency department" OR "emergency room" OR "casualty*" OR "accident and emergency" OR "accident & emergency" OR "Emergency Care" OR "emergency nursing"

*Concept 3: Randomized controlled trial*

CINAHL: (MH "Controlled Clinical Trial+") OR (MH "randomized controlled trial")

MEDLINE: (MH "Controlled Clinical Trial+") OR (MH "randomized controlled trial")

EMBASE: 'controlled clinical trial'/exp OR 'randomized controlled trial'/exp

Keywords used in all Databases: randomized OR randomized OR randomly OR placebo OR "clinical trials" OR "Controlled Clinical Trial" OR "randomized controlled trial"

# The Effect of a Cartoon and an Information Video About Intravenous Insertion on Pain and Fear in Children Aged 6 to 12 Years in the Pediatric Emergency Unit: A Randomized Controlled Trial

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**Contribution to Emergency Nursing Practice**

- The current literature on intravenous insertion indicates that peripheral venous catheterization may cause pain and fear.
- This article contributes that watching an information video or cartoon was effective in the pain and fear control in children during intravenous insertion interventions.
- Key implications for emergency nursing practice found in this article are that procedural preparation and distraction work equally well to reduce fear and pain among children during catheter insertion in the emergency room.

## Abstract

**Introduction:** Intravenous insertion is the most common invasive procedure made for administering intravascular fluid and medicine. Peripheral venous catheterization may cause pain, fear, and stress in children. This study aimed to compare the effects of watching a cartoon and an information video about intravenous insertion on the pain and fear levels of children aged 6-12 years.

**Methods:** The study was an experimental, randomized controlled clinical trial. It was conducted with 477 children aged 6-12 years randomized into 3 groups: the informative animated video group, the cartoon group, and the control group. Fear and pain perception were evaluated on the basis of the feedback from the child, observer nurse, and parents. The Children's Fear Scale was used to evaluate the fear level and the Wong-Baker FACES Scale was used to assess pain levels. Data were analyzed using one-way analysis of variance, the chi-square test, and the intraclass correlation coefficient test.

**Results:** The children who watched the information video before the intravenous insertion procedure and those who watched a cartoon during the procedure had lower mean pain and fear scores as evaluated by the child (pain: $F = 278.67$, $P = 0.001$; fear: $F = 294.88$, $P = 0.001$), parent (pain:

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J Emerg Nurs 2021;47:76-87.
Available online 18 July 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.04.011

F = 279.53, $P = 0.001$; fear: F = 294.47, $P = 0.001$), and nurse (pain: F = 286.88, $P = 0.001$; fear: F = 300.81, $P = 0.001$) than children in the control group.

**Discussion:** This study showed that watching an animation video or a cartoon was effective in lowering children's perceived level of pain and fear during an intravenous insertion intervention.

**Key words:** Child; Pain; Fear; Intravenous; Peripheral

## Introduction

Intravenous (IV) insertion performed for the administration of intravascular fluid and medicine is the most common invasive procedure in the emergency department.[1-3] Peripheral venous catheterization may cause pain, fear, and stress in children.[3-5] Evidence shows that the pain experienced during invasive procedures such as an IV insertion can have a permanent effect on a child's life.[1,3] It is recommended to control/reduce pain during painful interventions because pain experienced in childhood can affect the physiologic and behavioral responses to pain in later stages of life.[2,5,6]

Children have a complex pain perception owing to behavioral, physiologic, psychological, and developmental factors.[1] Children display behavioral (eg, grimacing, crying, groaning, tooth clenching, staying immobile), physiologic (eg, sweating, tears, and an increase in heart rate, blood pressure, and breathing rate), and psychological (eg, fear, anger, anxiety, irritation, and uneasiness) responses to pain.[2,5] The response of a child to pain varies depending on their age, sex, development level, temperament, cause of pain, response of the family to pain, sociocultural factors, and past pain experiences.[7,8]

There is a known relationship between pain and anxiety.[5] Regardless of the source of pain, the most important emotional response accompanying pain is fear. Fear is an irrational feeling of anxiety in which indefinite concern and distress, without any known reason, create the sense that something bad is about to happen.[5-7] Tolerance toward pain increases when fear decreases. Unpredictable pain intensity increases fear as well as the subsequent pain expectations.[6,9]

Distraction methods are recommended to minimize pain and fear during invasive interventions such as an IV insertion. Nonpharmacologic methods used to cope with pain and fear are affordable and can be implemented by most nurses.[1,5] The method used in pain management should be selected with consideration for the child's development level, the preference of the child and family, the type of pain, and the type of procedure to be performed.[2,10] Distraction techniques are among the most efficacious methods of nonpharmacologic pain relief. They can be applied quickly and easily.[5] In this technique, the pain tolerance is increased by deflecting the child's attention from the procedure through a stimulus that captures their attention.[4] Methods such as inflating a balloon, coughing,[1,8] using a kaleidoscope, showing attractive cards,[11] listening to music,[7] counting, playing video games,[12,13] and watching a cartoon[14,15] reduce the pain and fear of children.

Pain induced by invasive procedures produces more fear, and not knowing what to expect increases the pain related to the intervention. Giving information appropriate to the child's age and development level in all medical procedures is recommended. Information regarding the medical procedure is important because it will help children to adjust their expectations.[5,14,16]

School-age children have an idea of body functions; therefore, they can understand the reason for the procedures.[16,17] Giving an explanation about the procedures that are to be performed decreases pain and fear in children.[2,7] Giving information about IV insertion before the procedure reduces fear in children,[2] and showing procedure videos while providing care to children with burns reduces procedure-related pain.[18]

No study investigating the effect of watching informative videos about IV insertion procedures on the pain and fear experienced by children during such procedures was found in the literature. The purpose of this study was to compare the effects of watching a cartoon and an information video about IV insertion on the pain and fear levels of children aged 6-12 years.

The hypotheses of the study were as follows:

- Hypothesis 1: Children who watch a cartoon or an information video about IV insertion procedures have lower pain scores during the procedure than children in a control group.
- Hypothesis 2: Children who watch a cartoon or an information video about IV insertion procedures have lower fear scores during the procedure than children in a control group.
- Hypothesis 3: Children who watch an information video about IV insertion procedures have lower

pain and fear scores during the procedure than children who watch a cartoon.

## Methods

### STUDY DESIGN

The study was an experimental, randomized controlled clinical trial comparing the effect of watching a cartoon or an animated video prepared for informative purposes about IV insertion procedures in children aged 6-12 years on procedural pain and fear levels (Figure 1). The study took place between December 2017 and July 2018.

### SETTING

A pediatric emergency unit in Istanbul (Turkey) was chosen because of the volume of patients. An average of 20,000 children come to the unit annually. The most common patient presentations are acute gastroenteritis, high fever, and respiratory diseases.

### SAMPLE

The study sample comprised children aged 6-12 years who presented to the pediatric emergency unit of a medical faculty hospital and underwent IV insertion procedures. The inclusion criteria of the study were as follows: age 6-12 years, being conscious (responsive to pain stimuli), not being under the influence of any sedative/anticonvulsant/analgesic, no previous hospitalization, no chronic or life-threatening disease (eg, sepsis, shock, or respiratory/cardiogenic arrest), and a triage designation of green on a 3-level (red-yellow-green) triage system. The exclusion criteria were unconsciousness, being under the influence of any sedative/anticonvulsant/analgesic drug, previous hospitalization, presence of a chronic or life-threatening disease (eg, sepsis, shock, or respiratory/cardiogenic arrest), and triage designation of red or yellow on a 3-level triage system.

The sample size was determined using power analysis to find a 0.20 effect size with 0.80 power. The minimum sample size was calculated as 477 children (n = 159 for each group).

### ALLOCATION

The patients who met the sample selection criteria were randomly and equally assigned into 3 groups—the informational animated video group (group 1), the cartoon group (group 2), and the control group—using a computer-based program (http://www1.assumption.edu/users/avadum/applets/RandAssign/GroupGen.html).

### DATA COLLECTION TOOLS

Data were collected by using an author-developed, literature-based questionnaire that included the child's age, reason for presentation, and pain and fear scores before and after the intervention.[2,7] In addition, we used the Wong-Baker FACES Scale and Children's Fear Scale (CFS).

#### *Wong-Baker FACES Scale*

This instrument was developed in 1981 to assess children's pain levels. The scale is used to diagnose pain in children aged 3-18 years. In the scale, pain is scored according to the numeric values given to various cartoon faces. The lowest score is 1 and the highest is 5. As the score obtained from the scale increases, the pain tolerance decreases.[18]

#### *Children's Fear Scale*

The CFS was used to evaluate anxiety levels in the children. The CFS is a 0-4 scale showing 5 cartoon faces that range from a face with a neutral expression (0 = no anxiety) to a frightened face (4 = severe anxiety).[19]

### DATA COLLECTION

The children and parents were informed about the study before the procedure, and their verbal and written consent were obtained. Vascular access was established by the same nurse in all children in the sample group in accordance with the procedure steps. The IV nurse was a member of the research team. The study only took place when this 1 nurse was on duty.

#### *IV Insertion Procedure*

In the IV insertion, a 24-gauge peripheral catheter appropriate to the child's age was used. The IV insertion lasted for 3 minutes on average (minimum: 1 minute; maximum: 5 minutes). The pain and fear scale scores of the children before and 5 minutes after the IV insertion were evaluated by the nurse, child, and the parent. The pain level caused by the procedure was evaluated using the Wong-Baker FACES Scale and CFS. In addition, the $SpO_2$, pulse, and blood pressure values of the child were measured 5 minutes

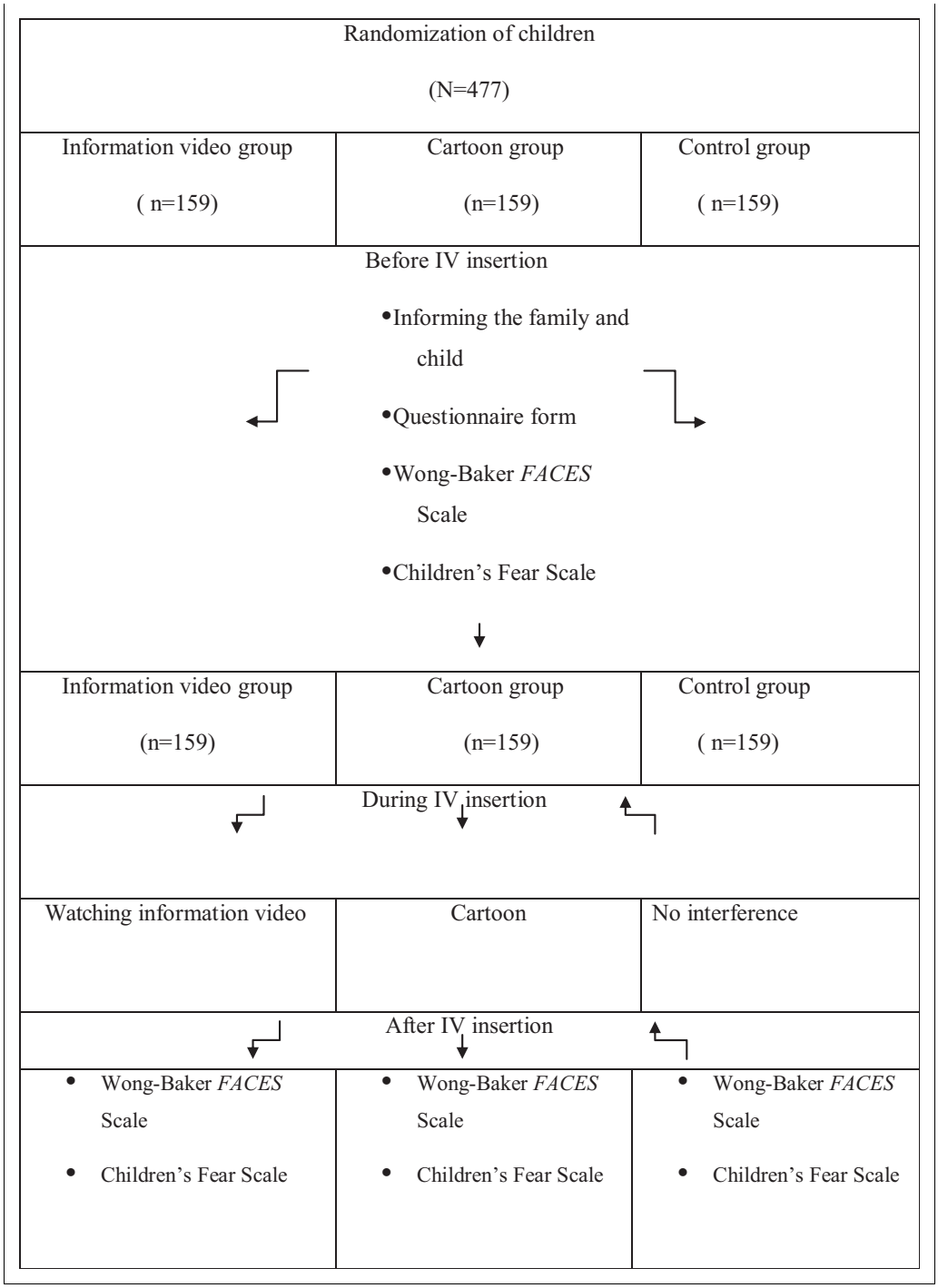


FIGURE 1
Flow diagram. IV, intravenous.

TABLE 1
**Comparison of physiologic parameters among the study groups (N = 477)**

| Physiologic parameters | Information video group (n = 159) | Cartoon group (n = 159) | Control group (n = 159) | Test* | *P* value |
|---|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD) | | |
| Before IV insertion: pulse/min | 130.62 (25.83) | 129.42 (27.64) | 129.55 (27.24) | $\chi^2 = 0.18$ | 0.92 |
| After IV insertion: pulse/min | 110.90 (20.32) | 109.79 (17.41) | 132.54 (23.07)‡ | $\chi^2 = 267.82$ | 0.001 |
| Test/*P* value† | Z = −10.34 *P* = 0.001 | Z = −8.50 *P* = 0.001 | Z = −0.05 *P* = 0.96 | | |
| Before IV insertion: blood pressure/systole | 111.69 (16.49) | 113.88 (20.67) | 113.84 (20.65) | $\chi^2 = 0.13$ | 0.94 |
| After IV insertion: blood pressure/systole | 101.47 (11.54) | 101.48 (14.11) | 112.10 (13.66)‡ | $\chi^2 = 196.07$ | 0.001 |
| Test/*P* value† | Z = −9.19 *P* = 0.001 | Z = −7.39 *P* = 0.001 | Z = −0.49 *P* = 0.63 | | |
| Before IV insertion: blood pressure/diastole | 72.01 (11.47) | 72.57 (13.73) | 72.64 (13.75) | $\chi^2 = 0.14$ | 0.93 |
| After IV insertion: blood pressure/diastole | 62.71 (10.23) | 62.14 (13.90) | 70.34 (12.98)‡ | $\chi^2 = 132.14$ | 0.001 |
| Test/*P* value† | Z = −9.24 *P* = 0.001 | Z = −7.49 *P* = 0.001 | Z = −5.27 *P* = 0.001 | | |
| Before IV insertion: $SpO_2$ | 98.75 (1.67) | 98.76 (1.81) | 98.57 (1.90) | $\chi^2 = 3.22$ | 0.08 |
| After IV insertion: $SpO_2$ | 99.01 (1.27) | 98.98 (1.40) | 98.92 (1.68) | $\chi^2 = 0.56$ | 0.17 |
| Test/*P* value† | Z = −1.86 *P* = 0.06 | Z = −1.65 *P* = 0.10 | Z = −3.78 *P* = 0.001 | | |

IV, intravenous.
* Kruskal-Wallis test.
† Z = Wilcoxon signed-rank test.
‡ Bonferroni test, $P < 0.01$.

before and after the procedure. The physiologic parameters and pain scores of the children were evaluated by the nurse who performed the procedure (Table 1).

## INTERVENTION

### *Information Video Group (Group 1)*

The children in this group watched the information video about IV insertion before the procedure. The content of the animated video, which was prepared according to the development level of children aged 6-12 years, was determined by the researchers. The video was prepared by a computer programmer in accordance with the specified content. The animated video, which was prepared in 3D, was reviewed by 5 experts in the field of pediatric nursing and was finalized in line with their recommendations. The video, which lasts 2 minutes and 44 seconds, explains the features of the equipment used for an IV insertion and how the procedure is performed (Figures 2 and 3).

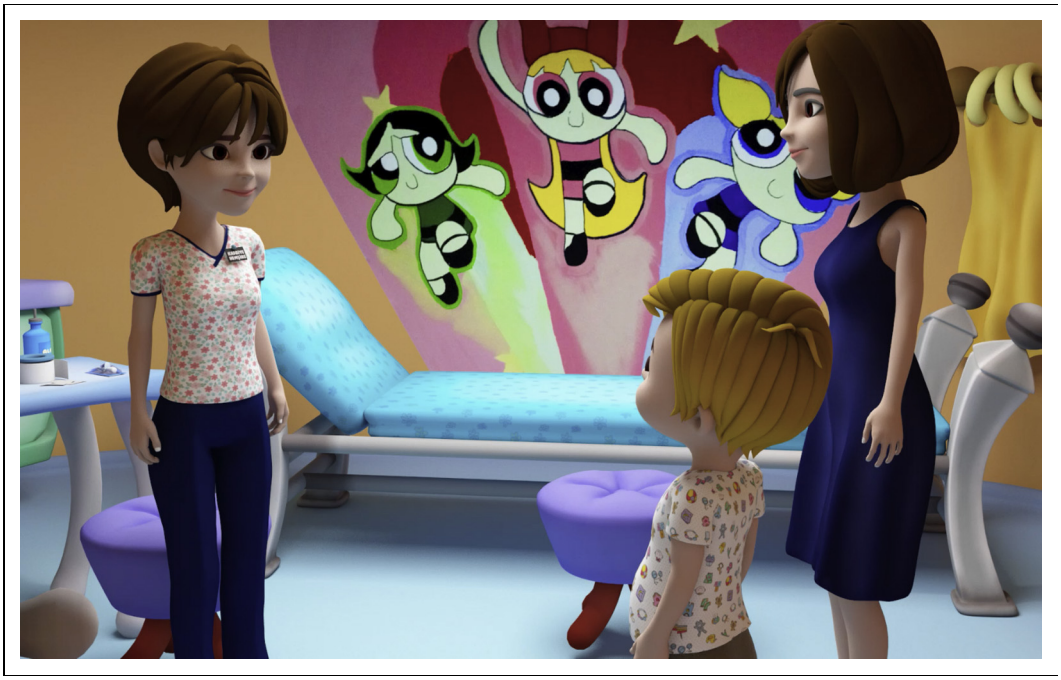

FIGURE 2
Information video intervention: child comes to unit with mother.

*Cartoon Group (Group 2)*

The children in this group watched a cartoon during the IV insertion procedure. Two popular cartoons that children aged 6-12 years like to watch were selected. When deciding the selection of the cartoons, the opinions and requests of 10 children in the age group of 6-12 years were taken into consideration. The children were asked to select one of the cartoons before the procedure, and they watched their chosen cartoon during the procedure.

*Control Group (Group 3)*

Vascular access was established using standard care procedures for the emergency department. No pharmacologic or nonpharmacologic methods are used routinely in hospitals in Turkey for pain and anxiety reduction during IV insertion procedures. Parents are allowed to stay with the child during the procedure. In this study, all parents stayed with their children during the IV insertion procedures.

## ETHICAL CONSIDERATION

The study was approved by the ethics committee of the Istanbul Faculty of Medicine, Istanbul University (25/03/2016:06). The children and their parents were informed about the aim and method of the study. Written permission from the parents and verbal permission from the children were obtained. In accordance with the regulation on clinical research in Turkey, written consent of the parent/legal representative is to be obtained before a child is allowed to participate in a clinical research study. Written permission is obtained from children aged 13 years or older.

## STATISTICAL ANALYSIS

All statistical analyses were performed using SPSS version 21.0 (IBM Corp, Armonk, NY). The data are reported as mean, SD, minimum, maximum, frequency, and percentage. The assessment of normality was performed using the Kolmogorov-Smirnov test. Groups were compared using the Kruskal-Wallis, Wilcoxon

FIGURE 3
Information video intervention: nurse explains the procedure.

signed-rank, chi-square and one-way analysis of variance tests. A Bonferroni test was performed as a post hoc test. The intraclass correlation coefficient test was used to check the harmony of the measurements made by the child, mother, and nurse. Statistical significance was set at $P < 0.05$.

TABLE 2
**Baseline characteristics of the study groups (N = 477)**

| Characteristics | Information video group (n = 159) Mean (SD) | Cartoon group (n = 159) Mean (SD) | Control group (n = 159) Mean (SD) | Test | *P* value |
|---|---|---|---|---|---|
| Parent's age | 33.85 (5.47) | 34.18 (5.12) | 33.75 (4.56) | $F = 0.67$ | 0.71* |
| Children's age | 8.70 (1.99) | 8.76 (1.96) | 8.94 (2.19) | $F = 1.08$ | 0.58* |
| Children's sex | | | | | |
| Girls (n = 231) | 79 | 67 | 85 | $\chi^2 = 4.23$ | 0.12† |
| Boys (n = 246) | 80 | 92 | 74 | | |
| IV intervention history | | | | | |
| Yes | 134 | 138 | 127 | $\chi^2 = 2.85$ | 0.24† |
| No | 25 | 21 | 32 | | |

NOTE. All participating parents were mothers.
IV, intravenous.
* One-way analysis of variance.
† $\chi^2$ test.

TABLE 3
**Comparison of pain scores among the study groups (N = 477)**

| Pain score | Information video group (n = 159), mean (SD) | Cartoon group (n = 159), mean (SD) | Control group (n = 159), mean (SD) | Test* | *P* value |
|---|---|---|---|---|---|
| **Child** | | | | | |
| Before IV insertion | 1.36 (0.91) | 1.36 (0.89) | 1.35 (0.90) | $\chi^2 = 0.03$ | 0.98 |
| After IV insertion | 0.09 (0.48) | 0.30 (0.88) | 4.14 (1.11)‡ | $\chi^2 = 278.67$ | 0.001<br>1 < 3; 2 < 3 |
| Test/*P* value† | Z = −10.39<br>*P* = 0.001 | Z = −8.41<br>*P* = 0.001 | Z = −10.57<br>*P* = 0.001 | | |
| Parent | | | | | |
| Before IV insertion | 1.97 (1.04) | 1.95 (1.04) | 1.95 (1.05) | $\chi^2 = 0.04$ | 0.98 |
| After IV insertion | 0.25 (0.51) | 0.48 (0.89) | 4.10 (1.05)‡ | $\chi^2 = 279.53$ | 0.001<br>1 < 3; 2 < 3 |
| Test/*P* value† | Z = −10.45<br>*P* = 0.001 | Z = −7.46<br>*P* = 0.001 | Z = −9.54<br>*P* = 0.001 | | |
| Nurse | | | | | |
| Before IV insertion | 2.19 (1.11) | 2.20 (1.16) | 2.40 (1.19) | $\chi^2 = 2.94$ | 0.23 |
| After IV insertion | 0.34 (0.56) | 0.61 (0.93) | 4.15 (1.04)‡ | $\chi^2 = 286.88$ | 0.001<br>1 < 3; 2 < 3 |
| Test/*P* value† | Z = −10.48<br>*P* = 0.001 | Z = −9.36<br>*P* = 0.001 | Z = −9.88<br>*P* = 0.001 | | |

IV, intravenous.
* Kruskal-Wallis test.
† Z = Wilcoxon signed-rank test, $P < 0.01$.
‡ Bonferroni test.

## Results

A total of 477 children were enrolled in the study. Eighteen parents who were approached declined to participate in the study.

### COMPARISON OF THE GROUPS

Table 2 shows the descriptive characteristics of the mothers and children in the information video group (n = 159), cartoon group (n = 159), and control group (n = 159). Of the children in the study groups, 48.4% were girls (n = 231) and 51.6% (n = 246) were boys. The mean age of the children in the study sample (N = 477) was 8.8 years (SD = 1.5).

There was no statistical difference between the age, sex, and IV intervention history of the children in the sample groups and the mean age of their mothers, and the groups were homogeneous ($P > 0.05$) (Table 2).

### COMPARISON OF THE GROUPS IN TERMS OF PAIN LEVELS

No significant difference was found among the information video group, cartoon group, and control group before the intervention in terms of mean pain scores as evaluated by the child, parent, and nurse (Table 3).

The children who watched the information video before the IV insertion procedure and those who watched a cartoon during the procedure had lower pain mean scores as evaluated by the child, parent, and nurse than the children in the control group (Table 3).

TABLE 4
**Comparison of fear scores among the study groups (N = 477)**

| Fear score | Information video group (n = 159), mean (SD) | Cartoon group (n = 159), mean (SD) | Control group (n = 159), mean (SD) | Test* | *P* value |
|---|---|---|---|---|---|
| Child | | | | | |
| Before IV insertion | 1.82 (0.86) | 1.83 (0.85) | 1.77 (0.87) | $\chi^2 = 0.547$ | 0.76 |
| After IV insertion | 0.05 (0.36) | 0.32 (0.85) | 3.41 (1.00)‡ | $\chi^2 = 294.88$ | 0.001<br>1 < 3; 2 < 3 |
| Test/*P* value† | Z = −10.80<br>*P* = 0.001 | Z = −9.48<br>*P* = 0.001 | Z = −9.51<br>*P* = 0.001 | | |
| Parent | | | | | |
| Before IV insertion | 2.53 (0.96) | 2.52 (0.97) | 2.52 (0.99) | $\chi^2 = 0.048$ | 0.98 |
| After IV insertion | 0.02 (0.50) | 0.48 (0.91) | 3.45 (0.93)‡ | $\chi^2 = 294.47$ | 0.001<br>1 < 3; 2 < 3 |
| Test/*P* value† | Z = −10.94<br>*P* = 0.001 | Z = −9.93<br>*P* = 0.001 | Z = −8.55<br>*P* = 0.001 | | |
| Nurse | | | | | |
| Before IV insertion | 2.78 (0.90) | 2.60 (1.02) | 2.53 (1.00) | $\chi^2 = 4.47$ | 0.11 |
| After IV insertion | 0.26 (0.54) | 0.59 (0.92) | 3.44 (0.98)‡ | $\chi^2 = 300.81$ | 0.001<br>1 < 3; 2 < 3 |
| Test/*P* value† | Z = −10.99<br>*P* = 0.001 | Z = −10.17<br>*P* = 0.001 | Z = −8.37<br>*P* = 0.001 | | |

IV, intravenous.
* Kruskal-Wallis test.
† Z = Wilcoxon signed-rank test.
‡ Bonferroni test, $P < 0.01$.

COMPARISON OF THE GROUPS IN TERMS OF ANXIETY LEVELS

The children who watched the information video before the IV insertion procedure and those who watched a cartoon during the procedure had lower mean fear scores as evaluated by the child, parent, and nurse than the children in the control group (Table 4).

The harmony between the mean scores of pain and fear before and after the intervention determined according to the evaluations of the children, parents, and nurses is examined in Table 5. The harmony among the evaluators for the pain score is statistically significant, in terms of the video group, cartoon group, and control group for before the intervention (video group: F = 4.89, $P < 0.01$; cartoon group: F = 3.95, $P < 0.01$; and control group: F = 18.27, $P < 0.01$) and after (video group: F = 3.95, $P < 0.01$; cartoon group: F = 8.73, $P < 0.01$; and control group: F = 27.32, $P < 0.01$). The harmony among the evaluators for the fear score is statistically significant, in terms of the video group, cartoon group, and control group for before the intervention (video group: F = 4.173, $P < 0.01$; cartoon group: F = 3.39, $P < 0.01$; and control group: F = 13.76, $P < 0.01$) and after (video group: F = 5.91, $P < 0.01$; cartoon group: F = 8.39, $P < 0.01$; and control group: F = 26.45, $P < 0.01$).

## Discussion

Our study compared procedural preparation using an educational video with procedural distraction using a nonmedical cartoon. The cost of the educational animation used in the research was approximately $2,850. The study revealed that watching an animated information video before the procedure or watching a cartoon were equally effective in reducing pain in children undergoing an IV insertion (hypothesis 1 supported). There are also studies, albeit a few, reporting that watching cartoons is not effective in reducing pain and anxiety in children during painful procedures. Cassidy et al[20] determined that showing a cartoon

TABLE 5
**Intraclass correlation coefficient among children, parents, and nurses for mean scores of pain and fear before and after the intervention**

| Scores | Before IV insertion | | | After IV insertion | | |
|---|---|---|---|---|---|---|
| | *F* | ICC | *P* value | *F* | ICC | *P* value |
| Pain score | | | | | | |
| Information video group | 4.89 | 0.80 | <.01 | 3.95 | 0.75 | <.01 |
| Cartoon group | 3.95 | 0.75 | <.01 | 8.73 | 0.89 | <.01 |
| Control group | 18.27 | 0.95 | <.01 | 27.32 | 0.96 | <.01 |
| Fear score | | | | | | |
| Information video group | 4.17 | 0.76 | <.01 | 5.91 | 0.83 | <.01 |
| Cartoon group | 3.39 | 0.71 | <.01 | 8.39 | 0.88 | <.01 |
| Control group | 13.76 | 0.93 | <.01 | 26.45 | 0.93 | <.01 |

F, ANOVA test; ICC, intraclass correlation coefficient; IV, intravenous.

to children receiving intramuscular vaccines was not effective in reducing pain. Landolt et al[21] also reported that watching a cartoon was not effective in reducing pain in children receiving dressings for burns. The results of the present study are in line with studies indicating that cartoon-watching is effective in eliminating pain and anxiety during IV insertion procedures.[1,5,12,14,15,21,22]

Painful interventions cause fear and concern in children and parents.[19,23] Previous research has demonstrated that pain caused by invasive procedures in children decreases and their tolerance increases when distraction techniques are used.[4,8,24] Other researchers have revealed that watching cartoons as a distraction technique during interventional procedures was effective in reducing pain in children.[5,13,25] Our study is original in terms of revealing the effects of distraction and giving information on pain and fear in children. We prepared a novel animation video intervention for children regarding vascular access. In addition to reducing pain and fear during an IV insertion, the video may also be used as instructional material for informative purposes in children's clinics.

Informing children about IV insertion decreases pain.[2,26] Tuna and Açıkgöz[6] investigated the effect of reading a training booklet before peripheral cannula insertion and performing the procedure on a teddy bear for children aged 9-12 years on pain and anxiety. Pain and anxiety scores during the procedure were lower in both groups than in the control group. Hsieh et al[27] evaluated the effects of a cognitive-behavioral program on pain and fear of medical procedures in children into whom IV cannulae were inserted. Accordingly, it was found that the pain and fear scores of the children for whom a cognitive-behavioral program was used (a picture book was read before the procedure, and they watched a music video) were lower than in the control group. Watching an animated information video before an IV insertion procedure can be used as an effective method for reducing pain in children.

Our study showed that watching an animated information video before the procedure or watching a cartoon during the procedure was effective in reducing fear/anxiety in children who underwent an IV insertion (hypothesis 2 supported). It has been reported that informing children about the procedures relieved the child and reduced their anxiety.[2,9,26] In a study of 140 children, in which the level of stress was analyzed before and during venipuncture, 98% of children aged 3-11 years, without distraction, showed anxiety during the procedure, with 49% showing a moderate/severe level of anxiety.[23] İnan and İnal[4] found that playing a video game and watching a cartoon were more effective in reducing procedural pain and anxiety in children aged 6-10 years during bloodletting than distraction by talking with parents.[4] Kolk et al[26] determined that prepared children who were to undergo an IV insertion had less distress (mean = 1.85, SD = 0.69) than nonprepared children (mean = 2.80, SD = 1.21). They showed that preparing children for the procedure decreased the stress during the procedure.[26]

According to the Emergency Nurses Association, anxiety increases a person's awareness of pain owing to increased sympathetic responses to pain stimuli. Pain thresholds are reduced by the increased awareness and can result in increased pain for a particular procedure.[5] No statistically significant difference was found between the pain and fear scores of the children who watched the animated information video and those who watched the cartoon during the IV insertion among the children in our study (hypothesis 3 not supported). Studies have shown that watching cartoons during vascular access is effective in reducing children's pain and fear.[14,23,28] No study investigating the effect of watching an information video in children who underwent an IV insertion on fear and pain was found. Any distraction is better than no distraction, so even if emergency departments cannot afford to use an instructional video, they should find a way to use a cartoon as a distraction.

## Limitations

This study was not double-blind. The physiologic parameters and pain scores of the children were evaluated by the nurse who performed the procedure. The nurse knew which child was in which study group. The study only took place when this 1 nurse was on duty (the nurse worked day/night shifts on different days of the week). The parents may have anticipated specific results because they were informed about our hypotheses. The intraclass correlation among children, parents, and the research nurse was highest in the control group (Table 5), confirming the potential for this bias. This situation could have biased our results by affecting the reports of the parents and the observers. The clinical trial protocol was not registered.

## Implications for Emergency Nurses

Our study is original because it is the first experimental study of information videos. Video interventions like ours may be useful for clinical practice for both patient education and as an intervention to reduce pain and fear. We demonstrated that the study intervention would contribute to reducing pain and fear related to invasive interventions, increasing the comfort of the child and family in pediatric emergency units, and improving the quality of nursing care. Nurses must be aware of the fear and pain associated with the IV insertion procedure. Reduction of fear and pain should be a hallmark of pediatric care. Nurses can promote the watching of informational videos and cartoons to reduce pain and fear in children during an IV insertion. There is evidence to support the effectiveness of patient information/preparation in combination with distraction to decrease pain and distress in the Emergency Nurses Association's clinical practice guideline.[5]

## Conclusions

This study showed that watching a cartoon and an animated information video was effective in pain and fear control in children during IV insertion procedures. No distinctive result was obtained regarding the superiority of the 2 methods in terms of the pain and fear scores of the children who watched the cartoon and those who watched the information video before the IV insertion procedures. It is relatively simple and quick to provide a distraction and prepare children for the procedure, but it makes a huge difference in outcomes in terms of pain, fear, and their experience of the emergency department visit. According to the results of the study, during IV interventions, it may be recommended to show children an information video or a cartoon for pain management.

## Acknowledgments

The authors acknowledge the children and their parents who participated in this study. This study was supported by TUBITAK (Scientific and Technological Research Council of Turkey) (project number: 216S764). We would like to thank TUBITAK, the administrators at the Istanbul University Faculty of Medicine, and the staff in the Pediatric Emergency Department for their support.

## Author Disclosures

Conflicts of interest: none to report.

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# Initial Testing of a Web-Based Intervention to Reduce Adolescent Driver Inattention: A Randomized Controlled Trial

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### Contribution to Emergency Nursing Practice

- The current literature on motor vehicle crash prevention indicates that adolescent driver inattention contributes to crashes, yet there is a lack of theoretically grounded interventions to reduce this type of risky driving behavior.
- This article contributes the findings that although a theoretically grounded web-based intervention did not reduce adolescent driver inattention in newly licensed drivers, self-reported cell phone use while driving was present at enrollment in these newly licensed drivers and increased over the 6 months of study enrollment.
- Key implications for emergency nursing practice found in this article are that motor vehicle crash prevention efforts will take a multipronged approach, as even the newest drivers are engaging in cell phone use while driving. Injury prevention efforts related to adolescent driver inattention can start early with adolescents, well before they are independent drivers.

## Abstract

**Introduction:** Motor vehicle crashes are the leading cause of adolescent death. Inattention to the roadway contributes to crash risk. The objective of this study was to deploy an initial study of a web-based intervention (*Let's Choose Ourselves*) designed to improve adolescent driver attention to the roadway.

**Methods:** We used a randomized controlled trial design in a sample of adolescent drivers to test if a web-based intervention decreased cell phone engagement in driving simulation at 3 months as compared with controls. As secondary hypotheses, we tested if the intervention increased the use of peer passengers to manage distractions and decreased eyes off the forward roadway in driving simulation and decreased self-reported risky driving behaviors. Adolescents, aged 16-17 years, licensed for ≤90 days were randomized to *Let's Choose Ourselves* with distractions in the simulator protocol at baseline, *Let's Choose Ourselves* with no distractions, an attention control intervention on healthy eating with distractions, or attention control with no distractions. We used Poisson regression modeling to test the primary and secondary hypotheses.

**Results:** The trial included 60 adolescents (66.7% female, 78.3% non-Hispanic white subjects, mean age 16.8 years, licensed 50.8 days). In Poisson regression, controlling for sex, we found no significant effects of *Let's Choose Ourselves* on primary or secondary outcomes. However, there was a significant effect of visit on self-report outcomes, with self-reported distracted driving behaviors increasing over time.

**Discussion:** Although there were no significant effects of *Let's Choose Ourselves*, self-reported risky driving behaviors

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J Emerg Nurs 2021;47:88-100.
Available online 3 October 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.07.012

increased over time. Further investigation of the relationship between driving experience and increasing inattention to the road in adolescents is warranted.

**Key words:** Adolescent; Distracted driving; Intervention; Inattention; Motor vehicle crash

## Introduction

Motor vehicle crashes (MVCs) are the leading cause of adolescent death and disability.[1] Adolescent drivers are at highest MVC risk in the first 6 months of licensure, making it a vitally important period for interventions.[2,3] Inattention to the roadway is a major contributor to adolescent driver MVCs[4,5] and includes not looking at the roadway, hands not on the wheel, and mind off the task of driving.[6] Adolescents are particularly susceptible to driver inattention, notably owing to cell phone use and presence of peer passengers in the vehicle. Adolescent drivers disproportionately account for distraction-related crashes, with cell phones involved in 23% of distracted-related fatal crashes with adolescent drivers.[7] A higher number of peer passengers also increases fatal MVC risk among adolescent drivers.[8,9] Both cell phones and peer passengers can take attention away from the roadway, including eyes off the roadway. Eye glances >2 seconds off the roadway by teenagers is associated with an odds ratio of 5.5 increased risk of a crash.[10]

Few theoretically grounded, behavioral interventions exist to reduce teenage driver inattention. We carried out an initial study of an individually targeted, theoretically grounded web-based intervention designed to reduce adolescent driver inattention to the roadway (*Let's Choose Ourselves* [LCO]). LCO addressed cell phone use and peer passengers as contributors to adolescent driver inattention, rooted in the theoretical constructs of attitudes, perceived behavioral control, and norms related to adolescent driver inattention.[11] We used a 4-group, randomized controlled trial design (n = 60) with a simulated driving assessment and self-reported risky driving behaviors to test if LCO could improve attention to the roadway.

## Methods

### DESIGN

We enrolled adolescent drivers aged 16-17 years and licensed for ≤90 days in the Commonwealth of Pennsylvania. The protocol was approved by the institutional review board at Children's Hospital of Philadelphia (CHOP) under the protocol #14-011336 "Web-based Intervention to Prevent Risky Driving Study." We obtained written consent from parents/guardians and written adolescent assent (paper or electronic through Research Electronic Data Capture software). We also obtained a Certificate of Confidentiality, had an independent safety monitor, and registered the trial with Clinicaltrials.gov (NCT02319317). Data collection occurred between June 30, 2015, and August 8, 2016.

We used a 4-group, randomized controlled trial design. We tested LCO against an attention control intervention on healthy eating. Outcomes were assessed using a simulator protocol that included simulated driving assessment at baseline and a 3-month follow-up. In addition, self-reported risky driving behaviors at baseline, 1-, 3-, and 6-month follow-ups were assessed.

### PARTICIPANTS

Adolescents were recruited through letters and e-mails to families affiliated with CHOP. We also used word of mouth, information sessions at local high schools, and e-mails to groups expressing interest. In addition to age (16-17 years) and licensure requirements (≤90 days in Pennsylvania), inclusion criteria were access to a computer, internet and personal e-mail; willing to travel to CHOP for study procedures; and the ability to read and write English. Exclusion criteria were self-reported history of claustrophobia, migraine headaches, or motion sickness; self-reported current pregnancy (all related to the ability to complete the assessment in the driving simulator); or participation in a teenage driving study at CHOP within the past 6 months.

### INTERVENTION DESCRIPTION

The web-based intervention LCO was developed through a multistep process on the basis of the Theory of Planned Behavior and previously reported[11] and delivered through a commercially available e-learning software by means of a secure learning management system. LCO consisted of 6 sections (welcome, general content on adolescent driving, ideas behind LCO, cell phone use, passengers, and wrap-up). The content for LCO was fact-based; grounded in focus group data collected by the study team;[12,13] interactive; and addressed attitudes, perceived behavioral control, and norms about adolescent driver inattention. LCO provided realistic scenarios of how to deal with cell phone and passenger distractions with content and interactive activities that included free-answer questions, drag-and-drop

activities, multiple choice questions, and videos from a driving simulator displaying what can happen when an adolescent takes attention away from the roadway. The goal was for participants to complete their assigned intervention in 1 online session lasting 30-45 minutes without interaction with a study team member.

An attention control was used with the goal to expose control participants to an interactive web-based experience on health content with activities that were similar in format and delivery but did not overlap on driving-related content. The attention control contained fact-based information on healthy food choices and exercise, interactive questions and activities, and realistic scenarios for making food choices. The attention control modules were intended to parallel the LCO activities but with content on nutritious meals and snacks, exercise, how to make healthy choices for yourself, and school food options.

Here we describe the 4 groups to which they were randomized. In group 1 (LCO with distractions [LCO-D]), participants received cell phone distractions and the presence of a sex-matched research assistant (RA) peer passenger in the baseline simulator protocol before the online intervention LCO. Group 2 (LCO with no distractions [LCO-ND]) participants received no distractions or the presence of a sex-matched RA peer passenger in the baseline simulator protocol before the online intervention LCO. Group 3 (healthy eating with distractions [HE-D]) participants received cell phone distractions and the presence of a sex-matched RA peer passenger in the baseline simulator protocol before the online intervention HE. Group 4 (healthy eating with no distractions [HE-ND]) participants received no cell phone distractions and the presence of a sex-matched RA peer passenger in the baseline simulator protocol before the online intervention HE. In this initial study, we chose to include groups with and without exposure to cell phone distractions and a sex-matched RA peer passenger in the baseline simulator protocol to examine potential assessment reactivity of distractions at baseline.[14,15] The details of distractions and sex-matched RA passengers are described in the simulated driving protocol details and Supplementary Appendix.

## PROCEDURES

After consent, assent, and eligibility were confirmed, participants completed the baseline self-report questionnaires and experimental drives in the simulator protocol. Participants then completed their assigned online intervention (LCO or HE) at a study computer at CHOP. At 3-months post-enrollment, participants returned for a follow-up assessment in the driving simulator. At 1, 3, and 6 months, participants also completed self-report questionnaires online or in person. We chose to include 1-month self-report measures to increase retention, as well as collect data during a time period in which driving behaviors change rapidly; a 1-month in-person study visit with the driving simulator was deemed undue participant burden given the time intensity of the simulator protocol study visit. Retention strategies also included e-mails and study phone calls for reminders to complete the questionnaires or attend the in-person study visit.

## RANDOMIZATION PROCEDURES

A list of participant numbers was randomized by computer software by a statistician into 4 groups and placed in envelopes, sealed, and locked in a drawer in consecutive order by participant number.[15]

## SIMULATED DRIVING PROTOCOL

The simulated driving assessment protocol was used at baseline and 3-month follow-up to assess the effects of the intervention on the outcome measures described later in the text. A previously validated driving assessment in a simulator (simulated driving assessment)[16] was delivered to participants using a Realtime Technology, Inc. fixed-based driving simulator and an Applied Science Laboratories mobile eye tracking system located at CHOP. The simulated driving assessment exposed participants to variations of the most common adolescent driver crash configurations.[17] The 21 potential crash scenarios were distributed across 3 experimental drives, separated by intervening straight roads, curves, and turns not intended to trigger collisions.[16] Supplementary Appendix outlines the details of the simulated driving protocol.

## VARIABLES

Our primary outcome was cell phone engagement during the simulated driving assessment measured at baseline and 3 months. The secondary outcomes, also measured at baseline and 3 months during the simulated driving assessment, included the use of a peer passenger to manage distractions and eyes off the forward roadway (EOFR) ≥2 seconds. The secondary outcomes included self-report driving behaviors, included baseline, 1-, 3- and 6-months cell phone use while driving on the road and highest number of peer passengers. See Supplementary Appendix for details of interrater reliability of coded simulator protocol variables.

*Cell Phone Engagement*

Driving simulator videos of participant behaviors at baseline and 3 months were used to determine cell phone engagement on 6 cell phone–related events (Supplementary Appendix, Supplementary Table 1 for distraction event description by experimental drive). Cell phone engagement was defined as visual or manual interaction with the phone. This included looking at the phone, picking up the phone, taking a picture, sending the picture, hand manipulation of phone (mimicking writing a text), answering a call, and looking at a picture on the phone (Supplementary Appendix, Supplementary Table 2 for definitions of variables for cell phone distractions coded as yes/no [eg, looked at phone]). Across the 6 distraction events, counts of yes = 1 and no = 0 were summed for scores of cell phone engagement (possible range, 0-17).

*Use of a Peer Passenger to Manage Distractions*

Driving simulator videos of participant behaviors at baseline and 3 months were used to determine the use of a peer passenger to manage distractions on 3 cell phone–related events (Supplementary Appendix, Supplementary Table 1). The use of a peer passenger was defined as interactions with the RA peer passenger to handle the cell phone interactions during the simulated driving assessment, such as asking the passenger to read or send a text (Supplementary Appendix, Supplementary Table 2). This outcome metric was based on the focus group research indicating that adolescent drivers perceived using a peer passenger to handle a cell phone (eg, looking at messages, sending messages) was a safety-conscious behavior.[13] Across the 3 distraction events in drive C, counts of yes = 1 and no = 0 on the interaction metrics were summed for scores of the use of a peer passenger (possible range, 0-3).

For those randomized to receive distractions during their baseline simulated driving assessment, videos were coded at baseline and the 3-month follow-up visit; for those randomized not to receive baseline distractions, only their 3-month follow-up visit videos were coded (ie, the baseline did not contain distraction events).

*EOFR ≥2 Second*

Eye tracking videos of participant glances were used to determine the number of glances with EOFR ≥2 seconds during the simulated driving assessment. EOFR ≥2 seconds was calculated as a count of glances with duration ≥2 seconds. These were calculated across the 6 events described in Supplementary Appendix, Supplementary Table 1. EOFR ≥2 seconds in a 6-second interval is associated with increased crash risk in adolescents.[10] See details in Supplementary Appendix for coding of EOFR ≥2 seconds. Across the 6 events, the number of EOFR ≥2 seconds events while moving were summed for a sum score as a count.

*Self-Report Driving Behaviors*

We collected self-report behavioral data at baseline, 1 month, 3 months and 6 months on cell phone and peer passenger–related behaviors. Items included the average number of days per month that they (while driving): (1) talked on a handheld cell phone, (2) talked on a hands-free cell phone, (3) read a text, or (4) sent a text. The response options were counts of 0-31 days. The participants were also asked to report the highest number of teenage passengers they had in the car while driving. The response options were counts of 0-6 or more. The response of 6 or more was transformed to a discrete value of 6 for the purposes of analysis. At baseline, the participants were asked to report on behavior in the previous month; at 1 month, 3 months, and 6 months, participants were asked to report on behavior since the previous assessment.

*Demographic Characteristics*

At baseline, self-reported characteristics on sex, date of birth to calculate age, race/ethnicity, and date of licensure to calculate licensure length were collected in person or online. Age, state of licensure, and licensure date were verified at the baseline study visit with a copy of the participant's driver's license.

## DATA ANALYSIS

We used descriptive statistics to describe the sample characteristics, as well as the simulator protocol and self-report outcome measures at baseline, 1 month, 3 months, and 6 months. The distributions of participant demographic characteristics and baseline measures were compared across groups at baseline using Wilcoxon rank sum tests for continuous variables and chi-square statistics for categorical variables.

To estimate effects on the primary and secondary outcomes across the 4 groups, separate models were used for cell phone engagement; use of a peer passenger; and EOFR ≥2 seconds at 3 months using Poisson regression. Using these models, we calculated rate ratios (RRs) and 95% confidence intervals (CIs) by comparing counts of each outcome

variable per participant among intervention groups controlling for sex. Given that only participants in the LOC-D and HE-D groups received exposure to distractions and the use of an RA peer passenger at baseline, we also used Poisson regression models to estimate the RR and 95% CI with only those 2 groups for each of the simulator outcomes at 3 months, controlling for baseline simulator outcomes and sex. Separate models for each of the self-report measures at 1 month, 3 months, and 6 months were examined using repeated measures Poisson regression, controlling for sex and baseline measures and accounting for correlation among visits within participant, plus the interaction of group and visit. For final models, we removed interaction terms that were not statistically significant. We accounted for overdispersion in all Poisson models by including the ratio of the deviance to degrees of freedom as dispersion parameter.

At the inception of the overall study (including before the steps of intervention development[11]), an a priori power analysis indicated a sample of 60 participants would yield at least 80% power to detect an effect size ≥0.30 (Cohen's d) for the interaction between group and time in a $2 \times 2$ mixed design analysis of variance, given up to 50% attrition, a correlation of at least 0.50 between baseline and follow-up measurements, and $\alpha \leq 0.05$. Because this was a phase II trial in preparation for a later phase III trial, the design evolved through the process of intervention development, and the need to examine potential assessment reactivity of baseline exposures to distractions in the simulator emerged. This resulted in a 4-group design. The study team could not increase the sample in this initial study, and thus the target of 60 remained. In the resultant design, we sought to estimate key study parameters with RRs with 2-sided 95% CIs and test the hypotheses at the traditional 2-sided level αof 0.05. The limitations of the sample size and a post hoc power analysis of the effect size of the primary outcome will be discussed. The analyses were conducted using SAS 9.4 (SAS Institute Inc., Cary, NC).

## Results

We tracked our participants using guidelines from the Consolidated Standards of Reporting Trials (Figure). Table 1 outlines the demographic characteristics of the sample overall and by intervention group; 61 participants were enrolled and randomized. We found no differences in the demographic characteristics by intervention group. All adolescents completed their assigned intervention, and the mean time to complete LCO was 27 minutes, 59 seconds (range: 15 minutes, 2 seconds to 39 minutes, 51 seconds). For the attention control on healthy eating, it was 24 minutes, 52 seconds (range: 13 minutes, 0 seconds to 60 minutes, 53 seconds).

Table 2 describes the simulator outcomes of cell phone engagement, the use of a peer passenger, and EOFR ≥2 second at baseline and 3-month follow-up. Table 3 shows the RR and 95% CI from the Poisson regression analyses. In the Poisson regression across all 4 groups, controlling for sex, we did not find significant effects of LCO at 3 months. We observed that the direction of the effect of LCO-D trended toward safer behaviors: those who received LCO-D had less cell phone engagement, more use of a peer passenger, and fewer EOFR ≥2 seconds. In the Poisson regression for simulator outcomes across only the 2 groups that received distractions in the baseline assessment, controlling for sex and baseline distraction metrics, we also did not find significant effects of LCO at 3 months (Table 3). Similarly, we found that again trends compared with the control group; LCO-D had less cell phone engagement, more use of a peer passenger, and fewer EOFR ≥2 seconds, though CIs did not indicate significance.

Table 4 describes the means and standard deviations of self-reported risky driving behaviors at baseline, 1-, 3- and 6-month follow-up. Using a repeated measures Poisson regression, controlling for sex and baseline measure, we found that there was no significant effect of the interaction between visit and intervention group on any of the self-reported outcomes measures. Using a repeated measures Poisson regression, controlling for sex and baseline behaviors, with no interaction term of visit and group, there was a significant effect of time, in which there was an increasing engagement in self-reported risky behaviors over time. Table 5 outlines the results of these Poisson regression analyses. These behaviors included the highest numbers of peer passengers (3 month [rate ratio RR 1.32; 95% CI, 1.15–1.52] and 6 month [1.58; 1.38–1.81] compared with 1 month), sending a text message (3 month [ 1.58; 1.03–2.42] compared with 1 month), and reading text messages (3 month [1.45; 1.08–1.94] and 6 month [1.55; 1.11–2.17] compared with 1 month).

## Discussion

We did not find significant effects of LCO on primary or secondary outcomes in reducing inattention as measured in our simulator protocol. We also did not find effects of exposure to baseline risks in the simulator. However, the results indicated a preliminary effect size of LCO, with directionality indicating the potential for reducing unsafe driving behavior for adolescents through an individually targeted

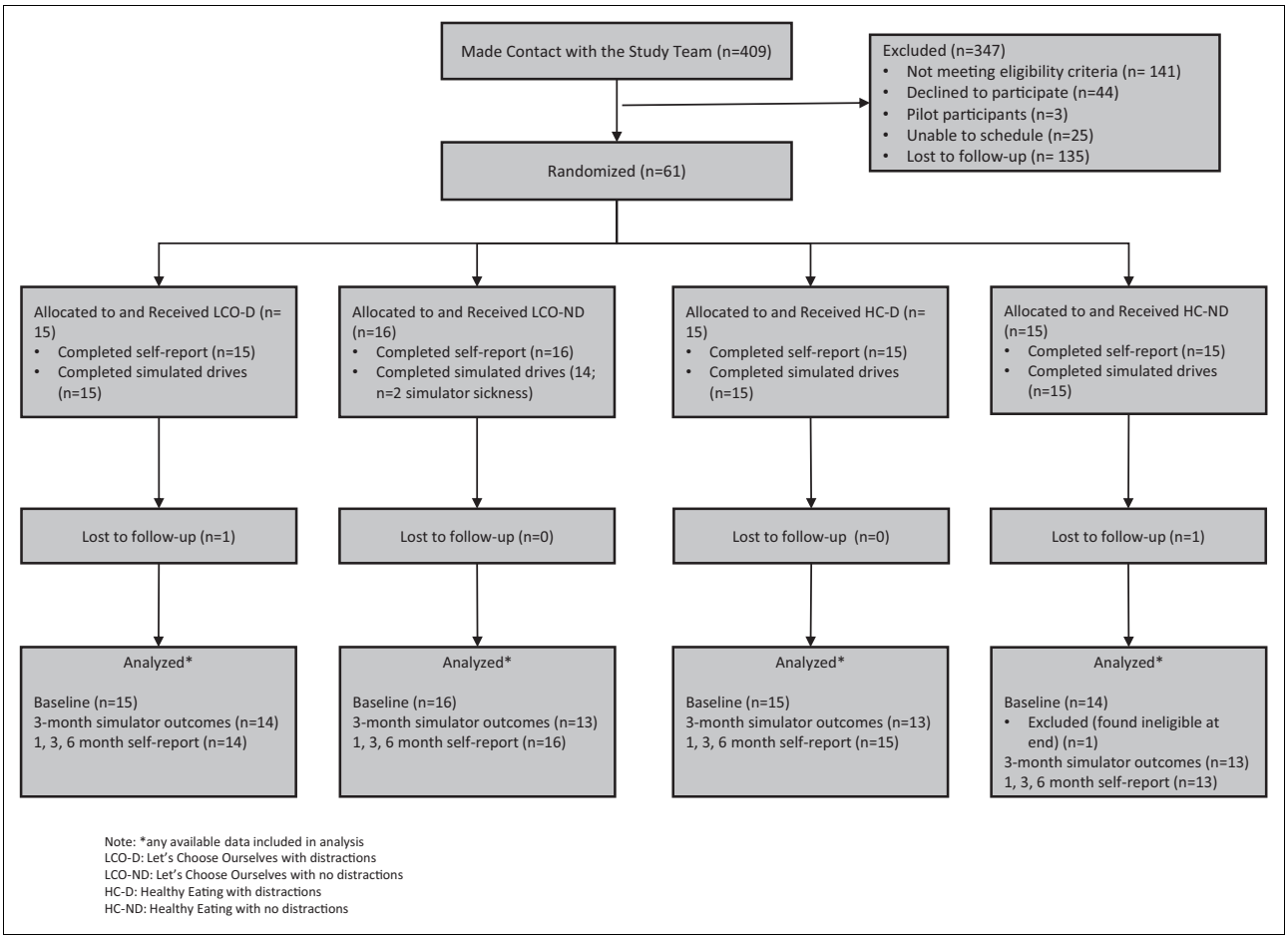


FIGURE
Study flow diagram.

intervention. In addition, in this small sample, there was an increase in the report of cell phone use and carrying number of peer passengers over the 6 months of study enrollment as they gained driving experience. The results with this one-time, brief online intervention delivered during the initial months of licensure add knowledge of when and how interventions are delivered to reduce adolescent driver MVC risk.

Although not significant, the results are encouraging in that they were in the direction of safer behaviors (ie, less cell phone engagement in the simulator). For the primary outcome, the HE groups were 23%-24% more likely to engage with their cell phone than the group LCO with distractions, although not significant. The HE groups were also 16%-74% less likely (although not significant) to use the peer passengers to manage distractions than the group LCO with distractions. This can be described as the LCO group more often handing the cell phone to the peer passenger to check or send messages. Such behaviors can be argued as potential harm reduction behaviors for cell phone use while driving in adolescents. These effects were consistent with EOFR ≥2 seconds, with the HE groups having 15%-58% more events than the group LCO with distractions. This may contribute to the understanding of components that may be useful for future interventions in driver inattention for adolescents.

More research is needed on the quickly changing behaviors related to social norms among adolescents in their use of technology relative to driving. The introduction of cell phones into the vehicle has also created a virtual peer passenger for the driver to engage with during trips. Although increasing numbers of peer passengers in the vehicle are a known risk factor for fatal risk,[8,9] we know little about the scenarios for adolescent drivers in which there is a driver, peer passenger, and cell phone.[13,18] Overall, a nimble

TABLE 1
**Demographic characteristics by intervention group**

| Variable | Total sample | | LCO-D | | LCO-ND | | HE-D | | HE-ND | | *P* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | N | % | n | % | n | % | |
| Total | 60 | 100.0 | 15 | 25.0 | 16 | 26.7 | 15 | 25.0 | 14 | 23.3 | |
| Sex | | | | | | | | | | | 0.31 |
| Female | 40 | 66.7 | 8 | 53.3 | 13 | 81.3 | 11 | 73.3 | 8 | 57.1 | |
| Male | 20 | 33.3 | 7 | 46.7 | 3 | 18.8 | 4 | 26.7 | 6 | 42.9 | |
| Race/ethnicity | | | | | | | | | | | 0.53 |
| NH black | 9 | 15.0 | 4 | 26.7 | 3 | 18.8 | 1 | 6.7 | 1 | 7.1 | |
| NH other / Mixed | 4 | 6.7 | – | – | 2 | 12.5 | 1 | 6.7 | 1 | 7.1 | |
| NH white | 47 | 78.3 | 11 | 73.3 | 11 | 68.8 | 13 | 86.7 | 12 | 85.7 | |
| | **Mean (SD)** | **Median (IQR)** | **Mean (SD)** | **Median (IQR)** | **Mean (SD)** | **Median (IQR)** | **Mean (SD)** | **Median (IQR)** | **Mean (SD)** | **Median (IQR)** | |
| Age, y | 17 (0.4) | 16.8 (16.7–17.2) | 17.1 (0.4) | 17.2 (16.8–17.4) | 17 (0.4) | 16.8 (16.7–17.1) | 17 (0.3) | 17 (16.8–17.3) | 16.8 (0.2) | 16.8 (16.7–16.8) | 0.06 |
| Length of licensure, mo | 50.8 (23.7) | 49 (32.5–71.0) | 54.3 (28.2) | 47 (32.0–86.0) | 56.6 (22.5) | 60 (42.0–75.0) | 49.3 (26.3) | 41 (27.0–78.0) | 41.9 (14.7) | 44 (36.0–49.0) | 0.36 |

LCO, Let's Choose Ourselves; LCO-D, LCO with baseline distractions; LCO-ND, LCO with no baseline distractions; HE-D, healthy eating (control) with baseline distractions; HE-ND, healthy eating with no baseline distractions; NH, non-Hispanic; IQR, interquartile range.

TABLE 2
**Distribution of simulator outcomes by intervention group**

| | Total sample | | | LCO-D | | | LCO-ND | | | HE-D | | | HE-ND | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean (SD) | Median (IQR) | n | Mean (SD) | Median (IQR) | n | Mean (SD) | Median (IQR) | n | Mean (SD) | Median (IQR) | n | Mean (SD) | Median (IQR) |
| Cell phone engagement | | | | | | | | | | | | | | | |
| Baseline | 30 | 8.13 (5.22) | 8 (4–13) | 15 | 7.67 (5.21) | 6 (4–14) | 16 | NA | NA | 15 | 8.60 (5.37) | 8 (5–13) | 14 | NA | NA |
| 3 mo | 53 | 9.43 (5.40) | 10 (6–14) | 14 | 8.36 (6.31) | 7 (2–14) | 13 | 9.85 (5.79) | 10 (9–12) | 13 | 9.46 (5.43) | 10 (6–14) | 13 | 10.15 (4.30) | 10 (6–13) |
| Use of a peer passenger to manage distractions | | | | | | | | | | | | | | | |
| Baseline | 30 | 0.90 (0.96) | 1 (0–2) | 15 | 0.80 (0.68) | 1 (0–1) | 16 | NA | NA | 15 | 1 (1.2) | 0 (0–2) | 14 | NA | NA |
| 3 mo | 53 | 0.64 (0.9) | 0 (0–1) | 14 | 0.86 (0.86) | 1 (0–2) | 13 | 0.62 (0.96) | 0 (0–2) | 13 | 0.85 (1.07) | 0 (0–2) | 13 | 0.23 (0.60) | 0 (0–0) |
| EOFR ≥2 s | | | | | | | | | | | | | | | |
| Baseline | 30 | 1.50 (2.19) | 0.50 (0–3) | 15 | 1.07 (1.53) | 0 (0–2) | 16 | NA | NA | 15 | 1.93 (2.69) | 1 (0–3) | 14 | NA | NA |
| 3 mo | 53 | 1.26 (1.56) | 1 (0–2) | 14 | 1.14 (1.35) | 0.50 (0–2) | 13 | 0.92 (1.32) | 0 (0–2) | 13 | 1.69 (1.75) | 1 (0–2) | 13 | 1.31 (1.84) | 1 (0–2) |

LCO, Let's Choose Ourselves; LCO-D, LCO with baseline distractions; LCO-ND, LCO with no baseline distractions; HE-D, healthy eating (control) with baseline distractions; HE-ND, healthy eating with no baseline distractions; IQR, interquartile range; EOFR, eyes off the forward roadway; NA, not applicable.

approach to address these inattentive behaviors that responds to rapidly changing technology, even in the newly licensed adolescents, is needed.

A unique contribution was the periodic assessment of self-report cell phone use and peer passenger carrying for 6 months during the early phase of licensure (enrolled at ≤90 days of licensure). Adolescents were engaging in behaviors that take their eyes off the road and their mind off the task of driving. Although the intervention did not have a significant effect on self-report distracted driving behaviors, there was an increase in self-reported cell phone use and highest number of peer passengers over the 6 months. For reading a text message, at 3 and 6 months compared with 1 month, they reported 45% and 55% increases in behaviors, respectively. The highest number of peer passengers reported at baseline was above the graduated driver license passenger restrictions in Pennsylvania (total sample 1.97 compared with no more than 1 passenger younger than 18 years for the first 6 months of licensure).[19] Our results highlight the importance of addressing risky driving behaviors either during the prelicensure phase or at the time of licensure.

To reduce driver inattention, repeated interactions with adolescents may be needed. Event monitoring and feedback with parent-adolescent dyads have shown to reduce adolescent kinematic risky driving events.[20,21] With the increasing pervasiveness of cell phones,[22,23] further research is needed on when and how to address these types of distractions in a way that is effective and sustained. Given that today's adolescents are exposed to parental cell phone use while driving from childhood through their adolescent years,[24–26] multipronged efforts will be needed.

## Limitations

Our study was limited by a small sample size. We chose to use a 4-group design to understand the role of in-vehicle distractions and wanted to understand multiple secondary outcomes to determine our next steps. However, the sample size, particularly when comparing the 2 groups who received distractions at baseline, limited our abilities to detect differences between groups. It is acknowledged that the original power analysis was for a 2-group design, and during the intervention development, the need for the evaluation of assessment reactivity in the simulation was needed. We carried out a post hoc analysis of the Poisson models that controlled for sex and baseline assessment of distractions for our primary outcome of cell phone engagement in the simulator. We found that a sample size of n = 307 would be needed to detect significant differences between the

TABLE 3
**Simulator outcomes at 3-month follow-up**

| | Rate ratio | 95% CI | *P* value |
|---|---|---|---|
| Controlling for sex | | | |
| Cell phone engagement | | | |
| Sex (M vs F) | 1.38 | 0.95–2.01 | 0.10 |
| HE-D vs LCO-D | 1.24 | 0.74–2.08 | 0.42 |
| HE-ND vs LCO-D | 1.23 | 0.75–2.02 | 0.41 |
| LCO-ND vs LCO-D | 1.32 | 0.79–2.23 | 0.29 |
| Use of peer passenger to manage distractions | | | |
| Sex (M vs F) | 0.50 | 0.19–1.32 | 0.16 |
| HE-D vs LCO-D | 0.84 | 0.33–2.15 | 0.71 |
| HE-ND vs LCO-D | 0.26 | 0.06–1.09 | 0.07 |
| LCO-ND vs LCO-D | 0.58 | 0.21–1.65 | 0.31 |
| EOFR ≥2 s | | | |
| Sex (M vs F) | 1.26 | 0.59–2.66 | 0.55 |
| HE-D vs LCO-D | 1.58 | 0.60–4.12 | 0.35 |
| HE-ND vs LCO-D | 1.15 | 0.43–3.11 | 0.78 |
| LCO-ND vs LCO-D | 0.88 | 0.29–2.69 | 0.82 |
| Controlling for sex and baseline assessment of distractions* | | | |
| Cell phone engagement | | | |
| Sex (M vs F) | 1.49 | 1.05–2.13 | 0.03 |
| HE-D vs LCO-D | 1.14 | 0.81–1.60 | 0.45 |
| Use of peer passenger to manage distractions | | | |
| Sex (M vs F) | 0.40 | 0.15–1.04 | 0.06 |
| HE-D vs LCO-D | 0.50 | 0.20–1.24 | 0.14 |
| EOFR ≥2 s | | | |
| Sex (M vs F) | 0.80 | 0.30–2.17 | 0.66 |
| HE-D vs LCO-D | 1.11 | 0.43–2.84 | 0.83 |

LCO, Let's Choose Ourselves; LCO-D, LCO with baseline distractions; LCO-ND, LCO with no baseline distractions; HE-D, healthy eating (control) with baseline distractions; HE-ND, healthy eating with no baseline distractions; EOFR, Eyes Off Forward Roadway; CI, confidence interval; M, male; F, female.

* These models only included 2 groups: LCO-D and HE-D.

LCO and HE groups. This should inform future research relative to this intervention approach. The rigorous experimental control in the simulator is useful when trying to test interventions in potentially unsafe driving situations. However, the simulator is an artificial environment where there is no risk for an actual crash, and participants are fully aware that they are being monitored. Therefore, behaviors in the simulator may not be generalizable to on-road behaviors. Response bias may limit the validity of the self-report data related to cell phone use while driving and carrying peer passengers. The sample was biased in that they were all from 1 state, recruited primarily through the resources through the CHOP primary care system. In addition, the sample was predominately female and white non-Hispanic subjects.

## Implications for Emergency Nurses

Key implications for emergency nursing practice rest on the foundation that adolescent MVCs are largely preventable. Knowledge about state policies on cell phone use while driving, peer passenger restrictions, and other parameters of graduated driver license provisions can help provide evidence-based anticipatory guidance to adolescents and families. Even the newest drivers engaged in distracted driving behaviors, and thus further education and reinforcement of safety-conscious behaviors are needed. In addition, consideration of efforts aimed at not just those adolescents who are in their learner permit phase or newly licensed but rather at a broader target of those who are not yet drivers. Programs can capitalize on state policies that address distracted driving. For example, survey data indicate that adolescents support policy restrictions on handheld cell phone use as well as reading/sending messages.[27] An intervention prevention program could leverage positive community norms around these policies.

Injury prevention programs by emergency nurses could address the intersection of adolescent driving, parent involvement, and technology. There is a strong emphasis on the role of parents in the learning to drive or early licensure time period.[3,28] Technological interventions such as text message–blocking technology show promise,[29] but there are few studies to examine effects. There may be advantages to combining facets of technology-based interventions with behavioral interventions to increase uptake. There are a few commercially available products that can inhibit cell phone use while driving. However, families must find these technological-based interventions acceptable and feasible for use for their adolescents.[30]

## Conclusions

Newly licensed adolescent drivers are at particularly high risk for MVCs. LCO is an individually targeted intervention for newly licensed teenage drivers that addresses inattention

TABLE 4
**Distribution of self-reported driving behaviors by intervention group and time**

| | Total population | | | Intervention group | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LCO-D | | | LCO-ND | | | HE-D | | | HE-ND | | |
| | N | Mean (SD) | Median (IQR) | n | Mean (SD) | Median (IQR) | N | Mean (SD) | Median (IQR) | n | Mean (SD) | Median (IQR) | n | Mean (SD) | Median (IQR) |
| Handheld cell phone use (average d/mo) | | | | | | | | | | | | | | | |
| Baseline | 60 | 0.78 (1.70) | 0 (0–1) | 15 | 0.67 (1.40) | 0 (0–1) | 16 | 0.5 (0.73) | 0 (0–1) | 15 | 1.27 (2.81) | 0 (0–1) | 14 | 0.68 (1.23) | 0 (0–1.5) |
| 1 mo | 58 | 2.22 (4.3) | 0 (0–2) | 14 | 2.79 (5.59) | 0 (0–2) | 16 | 2.56 (4.40) | 0 (0–3.5) | 15 | 1.6 (3.07) | 0 (0–3) | 13 | 1.92 (4.23) | 0 (0–2) |
| 3 mo | 55 | 2.44 (5.13) | 0 (0–2) | 14 | 1.86 (4.05) | 0 (0–2) | 15 | 3.6 (6.62) | 0 (0–5) | 13 | 3.08 (6.51) | 0 (0–1) | 13 | 1.08 (1.61) | 0 (0–1) |
| 6 mo | 56 | 3.07 (5.48) | 1 (0–4.50) | 13 | 3.31 (7.10) | 0 (0–3) | 15 | 3.87 (6.58) | 1 (0–5) | 15 | 3.4 (4.52) | 1 (0–5) | 13 | 1.54 (3.04) | 0 (0–1) |
| Hands-free cell phone use (average d/mo) | | | | | | | | | | | | | | | |
| Baseline | 60 | 1.08 (2.17) | 0 (0–1.5) | 15 | 0.87 (2.59) | 0 (0–0) | 16 | 0.88 (1.36) | 0 (0–1.5) | 15 | 0.97 (1.88) | 0 (0–2) | 14 | 1.68 (2.77) | 0.5 (0–2) |
| 1 mo | 58 | 2.16 (4.51) | 0 (0–2) | 14 | 1.71 (2.89) | 0 (0–5) | 16 | 1.69 (3.16) | 0 (0–2) | 15 | 2.40 (4.91) | 0 (0–2) | 13 | 2.92 (6.76) | 0 (0–0) |
| 3 mo | 55 | 2.65 (4.84) | 0 (0–3) | 14 | 2.79 (5.49) | 0 (0–1) | 15 | 4.47 (5.72) | 3 (0–10) | 13 | 1.15 (2.19) | 0 (0–0) | 13 | 1.92 (4.73) | 0 (0–0) |
| 6 mo | 55 | 3.16 (5.03) | 1 (0–4) | 13 | 3.00 (4.40) | 0 (0–6) | 15 | 5.07 (6.94) | 2 (0–9) | 14 | 2.21 (3.53) | 0.5 (0–3) | 13 | 2.15 (4.24) | 0 (0–3) |
| Read text (average d/mo) | | | | | | | | | | | | | | | |
| Baseline | 60 | 1.86 (4.61) | 0 (0–2) | 15 | 2.53 (7.10) | 0 (0–2) | 16 | 1.06 (1.69) | 0 (0–1.5) | 15 | 2.2 (4.49) | 0 (0–2) | 14 | 1.68 (3.94) | 0 (0–1) |
| 1 mo | 58 | 2.88 (5.53) | 0 (0–2) | 14 | 4.21 (7.62) | 0.5 (0–2) | 16 | 2.63 (5.19) | 1 (0–2.5) | 15 | 2.53 (4.47) | 0 (0–3) | 13 | 2.15 (4.72) | 0 (0–1) |
| 3 mo | 55 | 4.22 (7.00) | 1 (0–4) | 14 | 3 (6.85) | 0.5 (0–2) | 15 | 4.6 (6.67) | 2 (0–6) | 13 | 5.54 (8.53) | 2 (1–4) | 13 | 3.77 (6.41) | 1 (0–3) |
| 6 mo | 56 | 4.48 (6.26) | 2 (0–5.50) | 13 | 4.38 (7.53) | 1 (0–4) | 15 | 5.93 (7.27) | 3 (1–10) | 15 | 4.93 (6.12) | 3 (0–10) | 13 | 2.38 (3.12) | 1 (0–4) |
| Send text (average d/mo) | | | | | | | | | | | | | | | |
| Baseline | 60 | 1.61 (4.43) | 0 (0–1) | 15 | 2.27 (7.16) | 0 (0–1) | 16 | 0.63 (1.63) | 0 (0–0) | 15 | 2.07 (3.58) | 0 (0–4) | 14 | 1.54 (3.9) | 0 (0–1) |
| 1 mo | 58 | 1.76 (4.49) | 0 (0–1) | 14 | 3.14 (7.28) | 0 (0–1) | 16 | 1.38 (2.70) | 0 (0–1.5) | 15 | 1.27 (3.86) | 0 (0–0) | 13 | 1.31 (2.95) | 0 (0–1) |
| 3 mo | 55 | 2.82 (6.25) | 0 (0–2) | 14 | 1.86 (5.39) | 0 (0–0) | 15 | 3.8 (6.86) | 0 (0–5) | 13 | 3 (8.18) | 0 (0–2) | 13 | 2.54 (4.5) | 0 (0–2) |
| 6 mo | 56 | 2.82 (5.22) | 0 (0–3.50) | 13 | 1.62 (4.25) | 0 (0–0) | 15 | 4.87 (7.41) | 1 (0–10) | 15 | 2.47 (4.6) | 0 (0–3) | 13 | 2.08 (3.23) | 0 (0–4) |
| Highest number of teenage passengers | | | | | | | | | | | | | | | |
| Baseline | 60 | 1.97 (1.44) | 2 (1–2.5) | 15 | 1.4 (0.99) | 1 (1–2) | 16 | 2.25 (1.34) | 2 (1–2.5) | 15 | 2.2 (1.82) | 1 (1–3) | 14 | 2.00 (1.47) | 1.50 (1–3) |
| 1 mo | 58 | 1.97 (1.14) | 2 (1–2) | 14 | 1.5 (0.94) | 1.5 (1–2) | 16 | 2.13 (1.15) | 2 (1–2.5) | 15 | 2.2 (1.26) | 2 (1–2) | 13 | 2.00 (1.15) | 2 (1–3) |
| 3 mo | 55 | 2.56 (1.41) | 2 (1–3) | 14 | 2.71 (1.64) | 2.5 (1–3) | 15 | 2.40 (0.91) | 2 (2–3) | 13 | 2.62 (1.71) | 2 (1–3) | 13 | 2.54 (1.45) | 2 (1–4) |
| 6 mo | 56 | 3.09 (1.35) | 3 (2–4) | 13 | 2.54 (1.13) | 3 (2–3) | 15 | 3.20 (1.01) | 3 (2–4) | 15 | 3.6 (1.35) | 4 (2–4) | 13 | 2.92 (1.75) | 3 (2–4) |

LCO, Let's Choose Ourselves; LCO-D, LCO with baseline distractions; LCO-ND, LCO with no baseline distractions; HE-D, healthy eating (control) with baseline distractions; HE-ND, healthy eating with no baseline distractions; IQR, interquartile range.

TABLE 5
**Self-reported driving behaviors at 3- and 6-month follow-up**

| | Rate ratio | 95% CI | *P* value |
|---|---|---|---|
| Handheld cell phone use | | | |
| Sex (M vs F) | 1.23 | 0.59–2.56 | 0.58 |
| HE-D vs LCO-D | 0.58 | 0.17–2.05 | 0.40 |
| HE-ND vs LCO-D | 0.59 | 0.18–1.92 | 0.38 |
| LCO-ND vs LCO-D | 1.74 | 0.49–6.11 | 0.39 |
| 3m vs 1m | 1.16 | 0.76–1.78 | 0.49 |
| 6m vs 1m | 1.44 | 0.98–2.11 | 0.06 |
| Hands-free cell phone use | | | |
| Sex (M vs F) | 0.64 | 0.26–1.56 | 0.32 |
| HE-D vs LCO-D | 0.76 | 0.23–2.52 | 0.65 |
| HE-ND vs LCO-D | 0.73 | 0.21–2.59 | 0.63 |
| LCO-ND vs LCO-D | 1.53 | 0.47–4.99 | 0.48 |
| 3 mo vs 1mo | 1.25 | 0.81–1.94 | 0.32 |
| 6 mo vs 1 mo | 1.42 | 0.85–2.37 | 0.18 |
| Read text | | | |
| Sex (M vs F) | 1.42 | 0.79–2.55 | 0.25 |
| HE-D vs LCO-D | 2.06 | 0.76–5.57 | 0.15 |
| HE-ND vs LCO-D | 1.28 | 0.51–3.21 | 0.60 |
| LCO-ND vs LCO-D | 3.11 | 1.20–8.09 | 0.02 |
| 3 mo vs 1 mo | 1.45 | 1.08–1.94 | 0.01 |
| 6 mo vs 1 mo | 1.55 | 1.11–2.17 | 0.01 |
| Send text | | | |
| Sex (M vs F) | 1.61 | 0.73–3.58 | 0.24 |
| HE-D vs LCO-D | 4.03 | 0.57–28.61 | 0.16 |
| HE-ND vs LCO-D | 2.89 | 0.58–14.29 | 0.19 |
| LCO-ND vs LCO-D | 10.19 | 1.80–57.76 | 0.01 |
| 3 mo vs 1 mo | 1.58 | 1.03–2.42 | 0.04 |
| 6 mo vs 1 mo | 1.60 | 0.91–2.81 | 0.10 |
| Highest number of teenage passengers | | | |
| Sex (M vs F) | 1.03 | 0.87–1.21 | 0.75 |
| HE-D vs LCO-D | 1.04 | 0.83–1.31 | 0.74 |
| HE-ND vs LCO-D | 0.95 | 0.71–1.26 | 0.72 |
| LCO-ND vs LCO-D | 1.00 | 0.78–1.28 | 0.98 |
| 3 mo vs 1 mo | 1.32 | 1.15–1.52 | < 0.001 |
| 6 mo vs 1 mo | 1.58 | 1.38–1.81 | < 0.001 |

LCO, Let's Choose Ourselves; LCO-D, LCO with distractions; LCO-ND, LCO with no distractions; HE-D, healthy eating (control) with distractions; HE-ND, healthy eating with no distractions; CI, confidence interval; M, male; F, female.

to the roadway. This initial study of testing LCO did not indicate significant effects of the intervention, although trends were in the expected direction. The results point toward a need to address inattention early in the learning to drive and licensure process as we saw increasing frequency of self-reported risky driving over the 6 months of enrollment. Further work is needed to better understand effective measures that can address cell phone use while driving.

## Acknowledgments

We thank Flaura K. Winston, MD, PHD and Nancy Kassam-Adams, PhD, for their contributions. We also thank Chelsea Ward, MS and the Center for Research Injury and Prevention Driving Simulator Core at the Children's Hospital of Philadelphia. For assistance in recruitment, we thank the Pediatric Research Consortium and the Recruitment Enhancement Core at the Children's Hospital of Philadelphia. Finally, we thank the participants in this study.

## Author Disclosures

This research was supported by the National Institute of Nursing Research of the National Institutes of Health under award number R00NR013548 (Principal Investigator: C.C. McDonald). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. This research was also supported by the Dorothy Mereness Endowed Research Fund at the University of Pennsylvania School of Nursing.

Conflicts of interest: none to report.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.07.012.

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## Supplementary Appendix

SIMULATED DRIVING PROTOCOL

The RTI driving simulator system included a driver seat, 3 channel 4,600 LCD (liquid-crystal display) panels (160° field of view), rear view, left, and right mirror inlayed images, pedals, and a steering system. Graphics were delivered at 1,280 × 1,024 resolution at 60 Hz and raw simulator data were collected at 60 Hz. Videos of the participant's driving behavior in the simulator were also recorded by 3 cameras (positioned over the right shoulder, pointing at the participant's face and over the foot for view of brake and accelerator). The ASL Mobile Eye captured eye movements on the forward scene at 30 Hz. Participants wore the ASL Mobile Eye glasses (or alternative goggles worn over eyeglasses) with 2 video cameras (forward image and right eye of participant) to capture gaze location during experimental drives. Video data from the 2 cameras were integrated into a single video with superimposed crosshairs for eye gaze location.

The simulated driving assessment protocol exposed participants to variations of the most common adolescent driver crash configurations.[17] The 21 potential crash scenarios were distributed across 3 experimental drives, separated by intervening straight roads, curves, and turns not intended to trigger collisions.[16] There were 2 experimental drives with cellphone events (Drive A and B) and 1 experimental drive with presence of a gender-matched RA posing as a peer passenger (RA peer passenger) and distraction-related events (Drive C). The exposure to cellphone engagement in the simulator and use of a gender-matched RA peer passenger to manage distractions were designed to occur in intervening segments outside the 21 potential crash scenarios. The protocol that included cellphone distraction events and presence of a gender-matched RA peer passenger had incoming text messages, an incoming call, a prompt to take a picture, a prompt to look at a picture and a prompt to send a text message distributed during the experimental drives (Drives A, B, and C). See Supplementary Table. 1 Distraction events descriptions outlining details of distraction events by drive. Half the participants were randomized to the simulator protocol that included exposure to cellphone distraction events (Drive A, B, and C) and presence of a gender-matched RA peer passenger during the 3 experimental drives. The other half completed the same experimental drives, but they did not contain exposure to cellphone distraction events or the presence of a gender-matched RA peer passenger.

Before initiating experimental drives, adolescent participants received a hands-on orientation to the study cellphone (Verizon LG Optimus Zone 2 Prepaid Smartphone). Participants received standard instructions to treat it as their own phone and use it how they normally would use a cellphone when driving.

CODING OF *EOFR ≥2 SECONDS*

First, glances during the distraction events were calculated in a 6-second interval from the initial engagement in each event (i.e. 6-seconds from when a participant first looked at phone in taking a picture prompt, etc.). To capture *EOFR ≥2* seconds while the "car" was moving, we also evaluated velocity during glance duration. Although on-road studies use an average velocity of 5 mph in a 6-second epoch, we chose a conservative threshold of 2.5 mph for this simulator study so to capture glances when the vehicle was in motion, rather than at a stop sign or light.[31] To determine if the *EOFR ≥2* seconds occurred ≥2.5 mph, simulator video and supplemental simulator-recorded velocity were used to determine velocity at *EOFR ≥2* seconds events. RAs recorded velocities at time of initial glance for *EOFR* ≥2 seconds and checked against supplemental simulator-recorded velocity.

INTERRATER RELIABILITY OF CODED SIMULATOR PROTOCOL VARIABLES

A Master Coder trained 2 RAs to code items for "cell phone engagement and use of a peer passenger" using the definitions in Supplementary Table 2 below. After the initial training, results were compared, discussed, definitions clarified, and discrepancies reconciled. Coding was completed independently by the RAs with 2 more participants and 100% agreement on items was reached. The 2 RA coders used the standard rubric and definitions and reviewed the simulator videos for analysis. When the simulator video did not clearly indicate a Yes/No on an item, eye tracking videos were used to confirm coding outcome. The coders noted "Yes" or "No" for each item in the events and the simulator time was also recorded if Yes was coded. A Master Coder performed interrater reliability random checks on 25%-30% of the participants from each visit to determine discrepancies with "Yes" or "No." Any discrepancies were reviewed by the PI to determine final item coding. The average interrater reliability for the 2 RA coders with the Master Coder was 0.93 for the items used in the calculation of cell phone engagement and Peer Passenger Use. Coders were blinded to whether participants were assigned to the intervention or control groups.

Eye tracking videos were used to code *EOFR ≥2* seconds. For *EOFR ≥2* seconds, the start time in the eye tracking video for coding each 6-second interval was double verified by 2 research team members. The start time of a glance was when the participant's eye gaze began to leave

the road; end time was when the participant's eye gaze was focused back on the forward roadway. Start and end time of glances were recorded, and duration of glances were calculated. A Master Coder trained 3 RAs to standardize coding procedures for 100% agreement on presence of glance ≥1 second and <10% difference in duration of glances. A Master Coder performed random checks on 25%-30% of the participants from each visit to determine agreement on glance duration ≥1 second (average 5.2%) and number of glances ≥1 second (96.8%). Discrepancies >10% were reconciled by the PI. We chose 1-second glance duration for the random checks for a conservative approach to the coding. Coders were blinded to whether participants were assigned to the intervention or control groups.

**Supplementary Table 1. Distraction events descriptions**

| Distraction | Description | Drive | Items coded |
|---|---|---|---|
| Prompt by study staff to take a picture | Prompt from study staff: *"At any point during the drive, feel free to take a picture and send it to your best friend (in your contacts as "best friend"). Remember you cannot take a selfie with this phone."* | A | • Look at phone<br>• Pick up phone<br>• Take picture<br>• Send picture to friend |
| Incoming text message | In coming text message states: *"I was at Starbucks and I got an extra coffee. Do you want it? Yes or No?"* | A | • Look at phone<br>• Pick up phone<br>• Hand manipulation of phone |
| Incoming phone call | Script from study staff if participant answers the phone call: "*Hi it's Mom/Dad… Don't forget to buy bread at the store!... Thank you, bye."* | B | • Look at phone<br>• Pick up phone<br>• Answer call |
| Text prompted by study staff | Prompt from study staff: *"You realize that you will be late for the concert. Your best friend is waiting for you two there. You may text them that you are running late."* | C | • Look at phone<br>• Pick up phone<br>• Hand manipulation of phone<br>• Asks passenger to send text |
| Showing a picture prompted by research assistant passenger | Script from research assistant study staff acting as a passenger holding up the study phone: *"Wow did you see how close our seats are to the stage?"* | C | • Look at picture |
| Incoming text message | In coming text message states: *"Hey I'm already here. I'll save you a seat."* | C | • Look at phone<br>• Pick up phone<br>• Hand manipulation of phone<br>• Asks passenger to read text<br>• Asks passenger to send text |

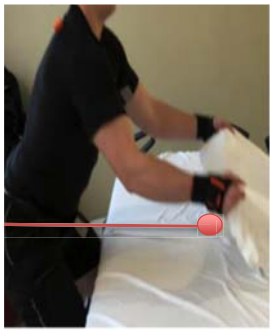
**Supplementary Table 2. Definitions of variables for cell phone distractions**

| Item | Definition |
|---|---|
| Cell phone engagement | |
| Looks at phone | Eyes glance and/or head movement toward phone. |
| Picks up phone | When phone is in hand of participant (e.g. participant reaches for phone and puts in hand when a notification comes in). |
| Takes a picture | Opening of camera, camera is visible, holds phone up to the screen in response to prompt **or** a camera click is audible (picture makes a clicking sound). |
| Sends picture to friend | Hand manipulation of the phone screen after the picture is taken (likely texting friend after taking the picture). |
| Hand manipulation of phone | Hand interaction with phone screen. |
| Answers call | Accepts incoming call and ringer stops. |
| Looks at picture | Eye glance and/or head motion toward picture that passenger is holding up. |
| Use of peer passenger to manage distractions | |
| Asks passenger to text | Verbal request of research assistant passenger to send text to friend. |
| Asks passenger to read | Verbal request of research assistant passenger to read text that was received. |

Journal of
EMERGENCY NURSING

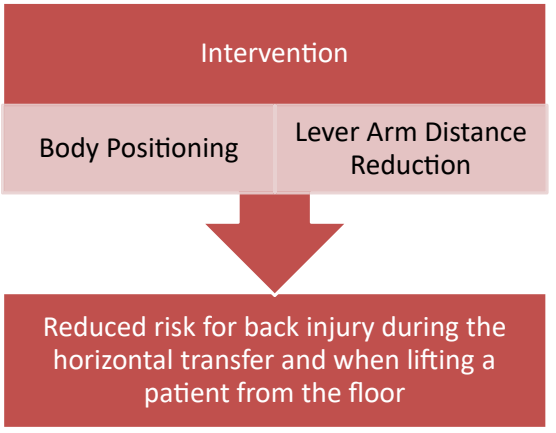
# Development and Feasibility Testing of a Contextual Patient Movement Intervention

**Authors:** Michael L. Callihan, PhD, RN, Joshua C. Eyer, PhD, Cameron J. McCoy, BSN, Anna M. Dailey, BSN, Kathleen M. Diket, BSN, Adam T. Robinson, MA, and Sara Kaylor, EdD, RN, Tuscaloosa, AL



The distance from L5S1 to the center of the load, (lever arm), is a contributing factor to back injury risk.

Through teaching proper body positioning, specifically to address the lever arm distance, back injury risk is reduced.





J Emerg Nurs 2021;47:101-12.0099-1767
http://dx.doi.org/10.1016/j.jen.2020.05.018

# Development and Feasibility Testing of a Contextual Patient Movement Intervention

**Authors:** Michael L. Callihan, PhD, RN, Joshua C. Eyer, PhD, Cameron J. McCoy, BSN, Anna M. Dailey, BSN, Kathleen M. Diket, BSN, Adam T. Robinson, MA, and Sara Kaylor, EdD, RN, Tuscaloosa, AL

### Contribution to Emergency Nursing Practice

- The current literature on low back injury prevention among nurses indicates that the elimination of manual handling of patients is the best practice; yet, this approach is not always practical in the emergency setting. Little evidence guides the emergency nurse in the safe handling and moving of critical, emergency patients.
- This article contributes the finding that a contextually based training module was acceptable to students and reduced 1 key risk factor related to lifting a patient from the floor and during the horizontal transfer.
- Key implications for emergency nursing practice found in this article focus on the feasibility of a safer method for moving a patient during emergency patient care.

### Abstract

**Introduction:** Nurses and emergency medical services workers frequently suffer musculoskeletal injuries at a disproportionate rate in relation to the rest of the population. The most common form of this musculoskeletal injury is lumbar spine injury. The purpose of this study was to develop and conduct phase 1 feasibility testing of a contextual lifting intervention that reduces the risks of low back injury.

**Methods:** This study was an intervention development and phase 1 feasibility test. The intervention was created on the basis of weightlifting techniques to specifically reduce the incidence injury related to valgus knee, asymmetrical lifting technique, and rotation of the trunk and pelvis. Motion capture technology (Xsens; Xsens Technologies) was used while 17 nursing students completed the direct patient lift from the floor, the lift from the floor with a manikin attached to a rigid spine board, the push portion of the horizontal transfer, and the pull portion of the horizontal transfer. Pre- and postintervention data were collected. Linear mixed model regression, with pairwise comparisons, was conducted for each lift at the time points of preintervention, immediately after the intervention, and 1-month postintervention.

**Results:** Significant changes were noted between the initial lifting techniques used and those used after the intervention. The maximum lever arm distance, defined as the distance from L5-S1 to the center of the force applied to the load, showed a significant reduction after the intervention in 3 of the 4 movements.

**Discussion:** Our results support the idea that injury risk can be reduced through appropriate contextual training methods.

**Key words:** Back injury; Patient lifting and moving; Human engineering; Nursing research

## Introduction

When caring for critically sick or injured patients, the physical well-being of the health care worker is often a lower priority, placing workers at a high risk of musculoskeletal injury,

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J Emerg Nurs 2021;47:101-12.
Available online 25 September 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.05.018

specifically the low back.[1] Emergency nurses must often lift sick or injured patients from the floor and place them onto a bed manually, or lift patients while they are secured to a rigid backboard, or transfer them from an emergency medical services stretcher to the gurney. The use of mechanical transfer equipment has given indication of a decrease in injury rates when used,[2-5] but using this equipment is not always practical or available in the emergency setting, creating the need for manual handling of the patient that may physically overload the nurse. The repetitive overloading of the body while using improper techniques to lift and move patients and equipment[6] creates microtrauma to lower back tissues and leads to pain and long-term injury.[6]

When evaluating the risk of low back injury, one must account for the fatigue failure process[7] associated with the angle of the spine relative to the load while lifting. Gallagher et al[8] created a tool to assess the risk associated with cumulative loading of the lower back, the Lifting Fatigue Failure Tool (LiFFT). The LiFFT measures the amount of strain on the muscles of the back using elements of the biological physics of rotational torque: the frequency of a lifting activity in a shift, the weight of the load, and the horizontal distance from the hip to the center of the working load (lever arm distance).[8] Although the frequency and weight of patients vary unpredictably for emergency nurses, the reduction in the lever arm distance can be controlled with proper training and reduce the risk of low back injury. Although the industry teaches to hold the load close to the body when lifting,[9,10] this practice is not always an option in nursing.

Improper body positioning was found to account for 80% of the force exerted on the lower back when using devices to assist with patient movement.[11] The use of contextual training allows the nurse to have the knowledge required to position themselves during the lifting process while receiving hands-on application of the skill. The reduction in loading of the knees and hips has been shown to be affected by the stance of the lifter[12] and, through inverse dynamics, can be assumed to translate to a reduction in the force exerted on the lower back.

Current preventative methods are loosely based on the findings of Engkvist et al[13] and their conceptual model that addresses the accident process, showing the links among the organization, the workplace, the patient, and the nurse. These methods have driven workplace interventions such as ergonomic adaptations,[14,15] mechanical lifting devices,[16-18] institutional zero-lift policies,[5,19] and educational models teaching improved lifting techniques to health care workers.[20,21] However, injury rates remain high. Although engineering controls can reduce lever arm distance in many occupational settings, the pace of emergency nursing does not always allow for such accommodations, and current educational models do not address this need. The purpose of this study, therefore, was to develop and conduct phase 1 feasibility testing of a contextual lifting intervention designed to teach nursing students proper lifting techniques that can reduce their risk of low back injury.

## Methods

This study was an intervention development and phase 1 feasibility trial. The study used a single test group in a pre-post repeated measures design with a 1-month follow-up. No control group was used in this study; instead, a test-retest experimental approach investigated the effectiveness of the contextual intervention. The institutional review board at the University of Alabama reviewed and approved all study procedures (approval number: 18-OR-456-A).

### PARTICIPANTS

The participants were 17 students (65% women) recruited from approximately 300 upper division Bachelor of Science in Nursing program students who had completed their initial education in lifting and moving patients (Table 1). A convenience sampling method used face-to-face recruitment among all cohorts within the college of nursing. No recruited participant met the exclusion criteria of pregnancy, preexisting medical conditions that prohibited exercise, or a current injury that restricted exercise. Although pregnancy alone is not an indication to reduce lifting requirements, to limit the risk during the testing, pregnant women were excluded from the study. All enrolled participants completed the study (100%).

### MOTION CAPTURE

Three-dimensional motion capture is the gold standard for kinematic analysis.[22] The technology used for this research study, the Xsens motion capture system (Xsens Technologies), uses the orientation of 17 inertial measurement units placed on the body to identify body segment and joint angles (Figure 1). The researchers employed the Xsens system according to the manufacturer's recommendations. First, body measurements for the 17 inertial measurement units were collected. Then, after practicing the study's lifting motions, the participants received sensors on the foot, shank, thigh, pelvis, sternum, shoulder, upper arm, forearm, hand, and head bilaterally (Figure 1). Finally, the motion capture system was calibrated in the standing N-pose and through a walking trial. Data were processed using Xsens motion capture software and Visual 3D (C-Motion Inc)

TABLE 1
**Mean sample characteristics of nursing student participants**

| Participants | n | Age, y (SD) | Height, ft' in" (SD) | Weight, lb (SD) | Weightlifting, h/wk (SD) |
|---|---|---|---|---|---|
| Total | 17 | 20.6 (0.8) | 5' 6.9" (3.1") | 150.8 (28.2) | 2.5 (2.3) |
| Women | 11 | 20.5 (0.5) | 5' 5.6" (2.9") | 137.8 (25.6) | 1.7 (1.9) |
| Men | 6 | 20.8 (1.2) | 5' 9.3" (1.4") | 174.5 (13.7) | 4.0 (2.5) |

to calculate the primary outcome, the maximum lever arm distance (LAD).

For each lifting movement, the LAD—also called the moment arm—was calculated by creating a virtual marker at the level of the lumbosacral joint (spinal location L5-S1) that tracked with the tips of the right hand (Figure 2). The right hand was chosen for all participants to represent the location where the force was being applied to the load for the movement. The risk of back injury increases as torque increases, computed by multiplying the length of the LAD from the rotational axis by the force applied perpendicular to the rotation. The research team processed raw data to determine the maximum LAD throughout the lift, and then they determined the mean value of both for the 3 repetitions of each lift for statistical analysis. The mean of 3 trials for each movement was used to create the average score. The LAD scores were obtained by taking the maximum distance from the 3 trials.

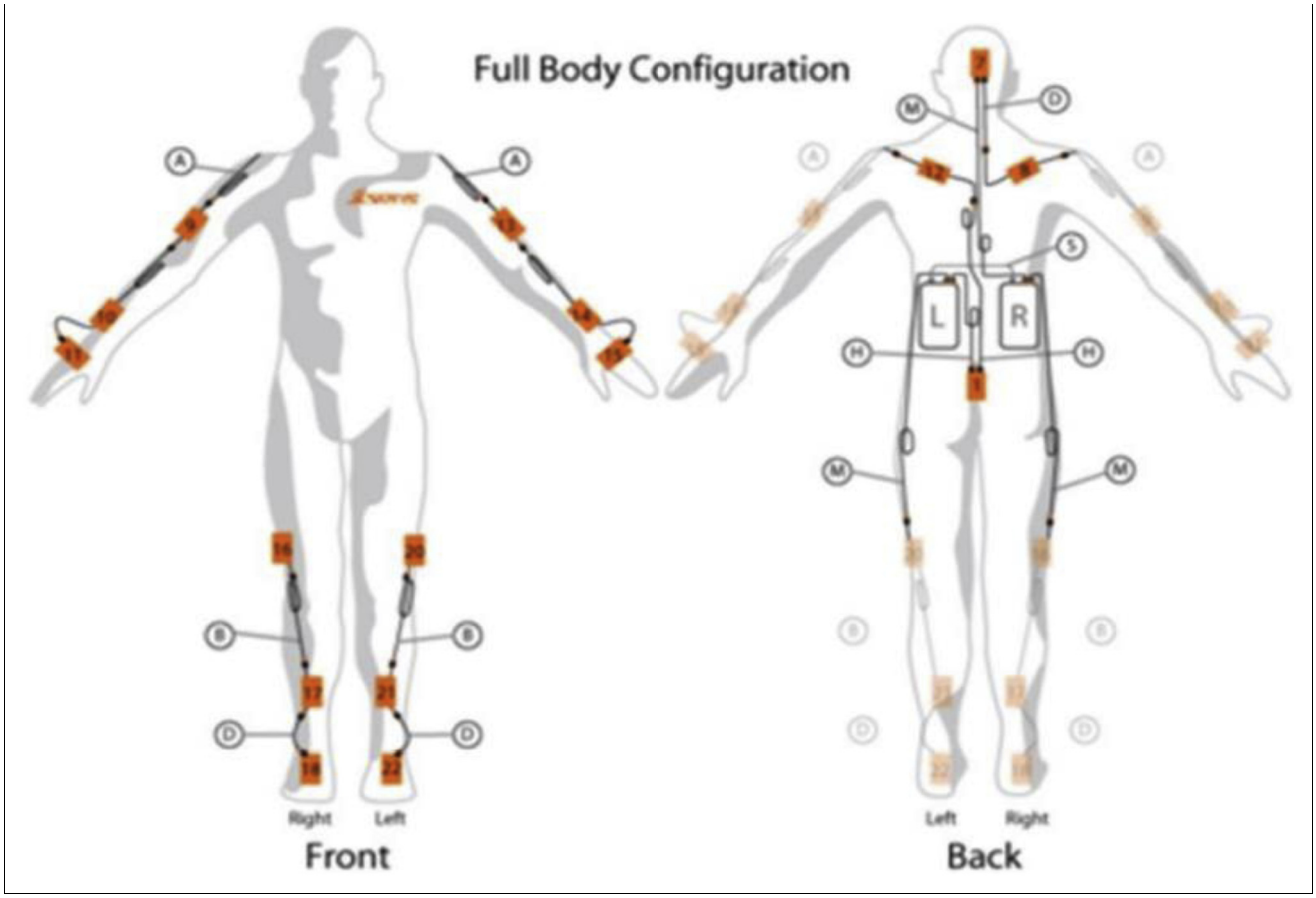


FIGURE 1
Positioning of the Xsens inertial measurement unit sensors, shown in orange (Xsens motion capture; Xsens Technologies).

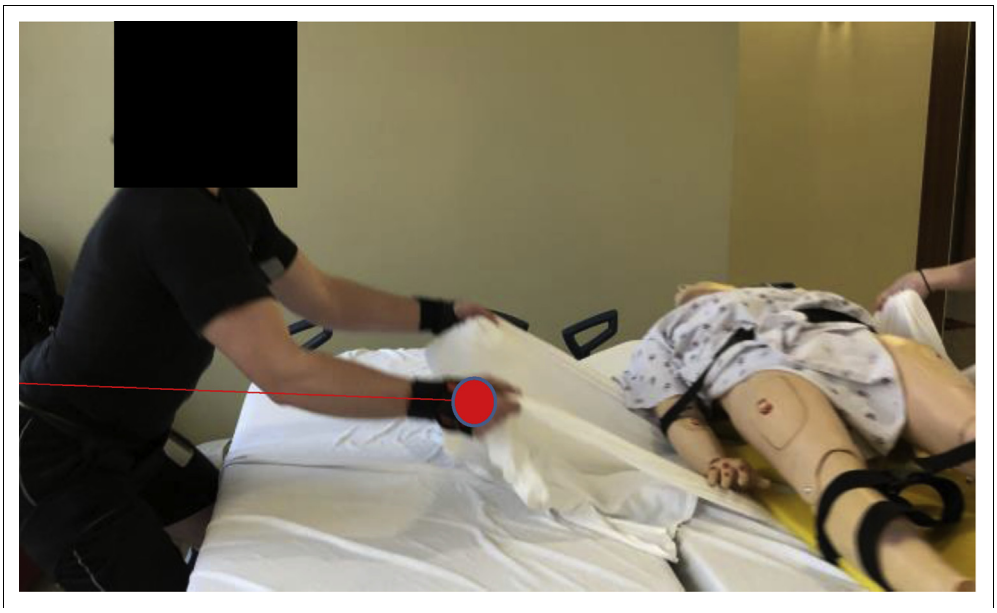

FIGURE 2
Virtual marker at level of L5-S1 and distance of right hand.

## INTERVENTION

In the light of the existing knowledge relating injury risk to core stability, body positioning, and LAD, the Safe Handling and Applied Efficiency contextual training intervention was developed (Table 2). The movements used in this intervention are considered high risk:[23,24] a direct patient lift (DL), a lift from the floor with the patient secured to a rigid backboard (BB), and the push (PUSH) and pull (PULL) portions of the horizontal transfer. The intervention followed a contextual learning format of didactic lessons, practice, and coaching, and lasted approximately 30 minutes. All members of the research team received training in the intervention from a senior member of the research team who was a certified personal trainer. In the first step, the intervention demonstrated the proper lifting technique to all participants, which they then practiced by themselves. Then, the team delivered one-on-one coaching with demonstration until the participants achieved the proper lifting techniques. This face-to-face coaching on the proper lifting methods while the participants practiced provided the key contextual learning aspect of the intervention.

## PROCEDURE

The eligible participants were asked to report to the environmentally controlled Clinical Practice Laboratory at the college of nursing during business hours and to wear comfortable clothing for the data collection. All participants were well rested. The initial data collection and intervention lasted approximately 60 minutes with the 1-month follow-up lasting 30 minutes per participant. The data collection and intervention used a 34-kg manikin.

All participants received detailed information about the study and provided informed consent. After an orientation, they practiced the 4 study movements using their existing knowledge until they were ready to proceed. After the Xsens calibration, the participants established their baseline performance by completing 3 repetitions of the 4 study movements. Then, the participants received the contextual training intervention (Table 2). Afterward, the participants completed 3 repetitions of the same movements to obtain postintervention data. The participants returned 1 month later for follow-up data collection, completing the 3 repetitions of the same series of lifts without additional training.

## STATISTICAL ANALYSIS

The analyses described the sample and investigated the impact of the intervention. Time was set as a fixed variable because it was tightly controlled and represented 3 specific levels—before the intervention, immediately after the intervention, and 1 month after the intervention—whereas participant was set as a random variable because it varied without limits and did not represent all the potential levels

TABLE 2
**Components of the Safe Handling and Applied Efficiency contextual training intervention**

| Movement | Instruction |
|---|---|
| Core activation (used for each movement) | Stand straight with feet shoulder-width apart, shoulders back, and chest pushed forward. Contract gluteal muscles fully and take a deep breath. On exhale of the breath, contract the abdominal muscles. While maintaining tension on the abdominal muscles, relax the gluteal muscles. Core activation must be used throughout each of the movement patterns. |
| Direct lift of patient from floor | With patient positioned between feet, fold at hips, shifting weight to heels, squatting down behind the patient. Reach hands around the patient's chest and take each wrist in hands, grasping the left wrist with the right hand and the right wrist with the left hand. Inhale through nose, tighten abdominal muscles and gluteal muscles, and drive through heels, extending the hips and knees until in upright position. Reverse the motion to lower patient back to the floor. |
| Lift of patient from the floor secured to a rigid spine board | With backboard positioned between feet, fold at hips, shifting weight to heels. Reach hands down to object, grasping the handles. Inhale through nose, tighten abdominal muscles and gluteal muscles, and drive through heels, extending the hips and knees until in upright position. Reverse the motion to lower patient back to the floor. |
| Horizontal transfer of patient, push and pull positions | One member of the team will be on either side of the patient, who is on a hard slide board. The bed will be positioned such that all participants can grasp the draw sheet under the patient with knees slightly bent and spine in a neutral position. In a coordinated effort, the participant on the push side of the patient will push through their heel, extending their arms as they push the patient across the slide board. The participant receiving the patient will push through their heels, standing upright and pulling their elbows back, squeezing their scapulae together. |

of variation. IBM SPSS version 27 (IBM Corp) and Microsoft Excel for Mac version 16.37 (Microsoft Corporation) were used to employ linear mixed effects modeling for each lift movement on the repeated measure maximum LAD at preintervention, postintervention, and follow-up 1 month after the intervention. Pairwise comparisons detailed the pattern and significance of identified change across time. The hypotheses were that the intervention would produce a significant linear trend showing a reduction in the LAD at post and follow-up. Inferential analyses were used to investigate the effectiveness of the intervention.

## Results

Descriptive data for the analyses are presented in Tables 3 and 4. The participants were 11 female and 6 male college students (n = 17), with an average age of 20.6 years, average height of 170 cm, average weight of 68.5 kg, and average duration of 2.5 hours spent lifting weights each week (Table 1). A low attrition rate (0%) was achieved throughout the study.

### INTERVENTION ANALYSIS: MAXIMUM LAD SCORES

To assess the intervention's effects on the BB lift, a linear mixed model analyzed the maximum LAD scores with time entered as a fixed effect and participant as a random effect (Table 3). The parameter estimates for time indicated a significant change in scores across time points, $\beta = -0.035$, SE = 0.007, $P < 0.001$, 95% confidence interval (CI) [–0.05, –0.02]. Variability among the participants also achieved significance, $\beta = 0.350$, SE = 0.016, $P < 0.001$, 95% CI [0.32, 0.38]. An examination of Figure 3 A shows a diminishing trend in the LAD scores among preintervention, postintervention, and follow-up 1 month after the intervention for the BB group. Pairwise comparisons detailing this pattern (Table 4) showed that, compared with the preintervention scores, the LAD scores were significantly lower at post, $t\ (16) = -5.93$, $P < 0.001$, and 1 month follow-up, $t\ (16) = -5.13$, $P < 0.001$. The scores were not significantly different between post and follow-up, $t\ (16) = -0.47$, $P > 0.05$.

To assess the intervention's effects on the DL movement, an identical linear mixed model analyzed the effects of the intervention on the LAD (Table 3). As depicted in

TABLE 3
**Linear mixed effects statistics for the impact of the Safe Handling and Applied Efficiency contextual training intervention on maximum lever arm distance scores in nursing students**

| Movements/effects | β | SE | 95% CI | *t* | *P* | BIC |
|---|---|---|---|---|---|---|
| Backboard lift | | | | | | –130.5 |
| Participant (random) | 0.350 | 0.016 | [0.318, 0.384] | 21.83 | <0.001 | |
| Time (fixed) | –0.035 | 0.007 | [–0.051, –0.020] | 34.19 | <0.001 | |
| Direct lift | | | | | | –113.6 |
| Participant (random) | 0.494 | 0.018 | [0.457, 0.531] | 26.98 | <0.001 | |
| Time (fixed) | –0.003 | 0.009 | [–0.021, 0.014] | –0.37 | 0.72 | |
| Horizontal transfer, push | | | | | | –100.9 |
| Participant (random) | 0.808 | 0.026 | [0.754, 0.862] | 30.70 | <0.001 | |
| Time (fixed) | –0.086 | 0.012 | [–0.111, –0.061] | –7.08 | <0.001 | |
| Horizontal transfer, pull | | | | | | –93.0 |
| Participant (random) | 0.756 | 0.028 | [0.680, 0.831] | 26.68 | <0.001 | |
| Time (fixed) | –0.061 | 0.013 | [–0.096, –0.026] | –4.65 | 0.01 | |

The total sample comprised 17 participants (11 women and 6 men). Maximum likelihood estimation was used.
BIC, Schwarz Bayesian Information Criterion.

Figure 3B, the maximum LAD scores showed no significant effect for time, $\beta = -0.003$, SE = 0.009, $P = 0.72$, 95% CI [–0.02, 0.01], but they did for participant variability, $\beta = 0.494$, SE = 0.018, $P < 0.001$, 95% CI [0.46, 0.53]. The pattern, detailed by pairwise comparisons (Table 4), showed that the LAD scores worsened after the intervention but returned to the baseline at follow-up.

To assess the intervention's effects on the PUSH, a horizontal transfer movement, an identical linear mixed model analyzed the maximum LAD scores for time (fixed) and participant (random) effects. Again, the parameter estimates were significant for both time, $\beta = -0.086$, SE = 0.012, $P < 0.001$, 95% CI [–0.11, –0.06], and participant, $\beta = 0.808$, SE = 0.026, $P < 0.001$, 95% CI [0.75, 0.86]. There was a significant downward trend in the scores for the PUSH movement across time points (Figure 3C). To detail this pattern, pairwise comparisons compared the mean scores for each time point (Table 4). Compared with the baseline, the scores were significantly lower at post, $t\,(16) = -6.31$, $P < 0.001$, and at 1-month follow-up, $t\,(16) = 9.38$, $P < 0.001$. There were no differences between the scores at post and follow-up, $t\,(16) = -0.84$, $P = 0.41$.

To assess the intervention's effects on the PULL, a horizontal transfer movement, an identical linear mixed model analyzed the maximum LAD scores for time (fixed) and participant (random) effects. Time was again significant, $\beta = -0.061$, SE = 0.013, $P = 0.007$, 95% CI [–0.10, –0.03], as was participant, $\beta = 0.756$, SE = 0.028, $P < 0.001$, 95% CI [0.68, 0.83]. The maximum LAD scores for the PULL movement showed a decreasing trend across time points (Figure 3D). To better understand this trend, pairwise comparisons compared the mean scores for each time point (Table 4). As for the BB lift and PUSH movement, the scores at preintervention were higher than at post, $t\,(16) = -5.59$, $P < 0.001$, and 1-month follow-up, $t\,(16) = -8.81$, $P < 0.001$. There were no differences between the scores at post and follow-up, $t\,(16) = 1.55$, $P > 0.05$.

An identical analytic strategy investigated the related measure of the average LAD scores for each movement but is not reported in this paper. The results followed the same pattern as the maximum LAD and are included as supplementary online material.

## Discussion

The purpose of this study was to develop a contextual lifting intervention to reduce the risks of low back injury in nurses and conduct phase 1 feasibility and initial effectiveness piloting of the intervention with nursing students. The primary outcome was the LAD as measured using the Xsens motion capture system. The study found that the intervention showed a reduction in the LAD during the BB lift and both the PUSH and PULL movements in a horizontal patient transfer, but not during the DL. As explained by the

TABLE 4
**Descriptive statistics and pairwise comparisons among pre-, post-, and 1-month–postintervention time points for maximum lever arm distance in nursing students (n = 17)**

| Movement | Time | M | SD | Comparison | $M_{Diff}$ | SEM | % CI | *t* | *P* | $d_{rm}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Backboard lift | T1, Pre | .267 | .033 | T2−T1 | −.044 | .011 | [−0.066, −0.021] | −4.09 | <0.001 | −1.12 |
| | T2, Post | .223 | .043 | T3−T1 | −.052 | .012 | [−0.101, −0.002] | −4.32 | <0.001 | −1.21 |
| | T3, FU | .215 | .049 | T3−T2 | −.008 | .015 | [−0.055, 0.039] | −0.53 | 0.60 | −0.17 |
| Direct lift | T1, Pre | .390 | .044 | T2−T1 | .015 | .015 | [−0.060, 0.089] | 1.02 | 0.32 | 0.20 |
| | T2, Post | .405 | .081 | T3−T1 | −.001 | .014 | [−0.100, 0.099] | −0.06 | 0.95 | −0.02 |
| | T3, FU | .389 | .053 | T3−T2 | −.016 | .018 | [−0.127, 0.096] | −0.86 | 0.40 | −0.22 |
| Horizontal transfer, push | T1, Pre | .598 | .063 | T2−T1 | −.167 | .024 | [−0.366, 0.031] | −6.84 | <0.001 | −2.54 |
| | T2, Post | .430 | .069 | T3−T1 | −.170 | .020 | [−0.372, 0.031] | −8.54 | <0.001 | −2.84 |
| | T3, FU | .427 | .057 | T3−T2 | −.003 | .018 | [−0.170, 0.164] | −0.17 | 0.87 | −0.05 |
| Horizontal transfer, pull | T1, Pre | .530 | .058 | T2−T1 | −.151 | .023 | [−0.403, 0.101] | −6.67 | <0.001 | −2.18 |
| | T2, Post | .379 | .078 | T3−T1 | −.134 | .016 | [−0.349, 0.080] | −8.20 | <0.001 | −2.59 |
| | T3, FU | .396 | .044 | T3−T2 | .017 | .020 | [−0.229, 0.263] | 0.82 | 0.42 | 0.26 |

$df = 16$ for all analyses.
$d_{rm}$, Cohen *d* effect size for repeated measures; FU, 1-month follow-up assessment; M, mean; $M_{diff}$, mean of the difference scores; Pre, preintervention assessment; Post, postintervention assessment; SEM, standard error of the mean.

LiFFT model,[8] this decrease in the LAD instills a reduction in injury risk to nurses on the job.[8] This novel pilot study addresses the need to improve teaching strategies for health care workers because these strategies relate to the health worker's body positioning while performing patient movements, both with and without the ability to use mechanical lifting devices.

Significant decreases in the LAD during the lifting movements emerged after the intervention, and these improvements persisted to the 1-month follow-up for most participants. This finding gives hope that the contextual training produced lasting change in the way the lifters moved after 1 brief practice session. This is possible with procedural memory if participants are able to use a new skill regularly. The retention of a skill and development of muscle memory through practice of that skill are important factors to look at when moving forward with this intervention.

The data for the DL showed it worsening immediately after the intervention and then improving at the 1-month follow-up. This finding may be explained by the variation in hand placement during the initial data collection. The center of mass was changed in the DL by the participant changing their hand placement from under the axillary region before the intervention to the participant's body with arms wrapped around the chest pulling the patient into the lifter's chest (Figure 4). Although the hand position did not change significantly, the pulling of the simulated patient close to the lifter to perform the movement was deemed an improvement over the initial lifting motion. The inclusion of kinetic data would give a more definitive result to the force exerted on the lower back during this lift.

Although manual lift or movement of patients should be avoided, in instances where immediate, life-saving measures must be instituted at a moment's notice, for example, in an emergency department, it is not always possible or practical. Mechanical lifting devices require a lifting strap being placed under the patient and then attached to the hoisting device above the patient to lift the load. The positioning of the harness requires that it be put in place before the patient lies down on the bed, or if already in bed, the patient must be logrolled to allow for placement. The task of placing the strap is strenuous on the body with the patient on the floor and potentially unsafe with the patient on an emergency medical services stretcher. The positioning of the lifting device itself can also be problematic, given the space and time constraints surrounding emergency care.

The contextual Safe Handling and Applied Efficiency training intervention teaches nurses the proper body position to avoid injury when manual lifts are to be performed. It teaches them how to position themselves during the lifting process while receiving coaching and hands-on application of the skill. Through practice, muscle memory[25] is developed, such that in the emergent situation the nurse automatically assumes the appropriate position safe for the lift. Acceptability of the intervention was supported by the participants' engagement with the training and the positive

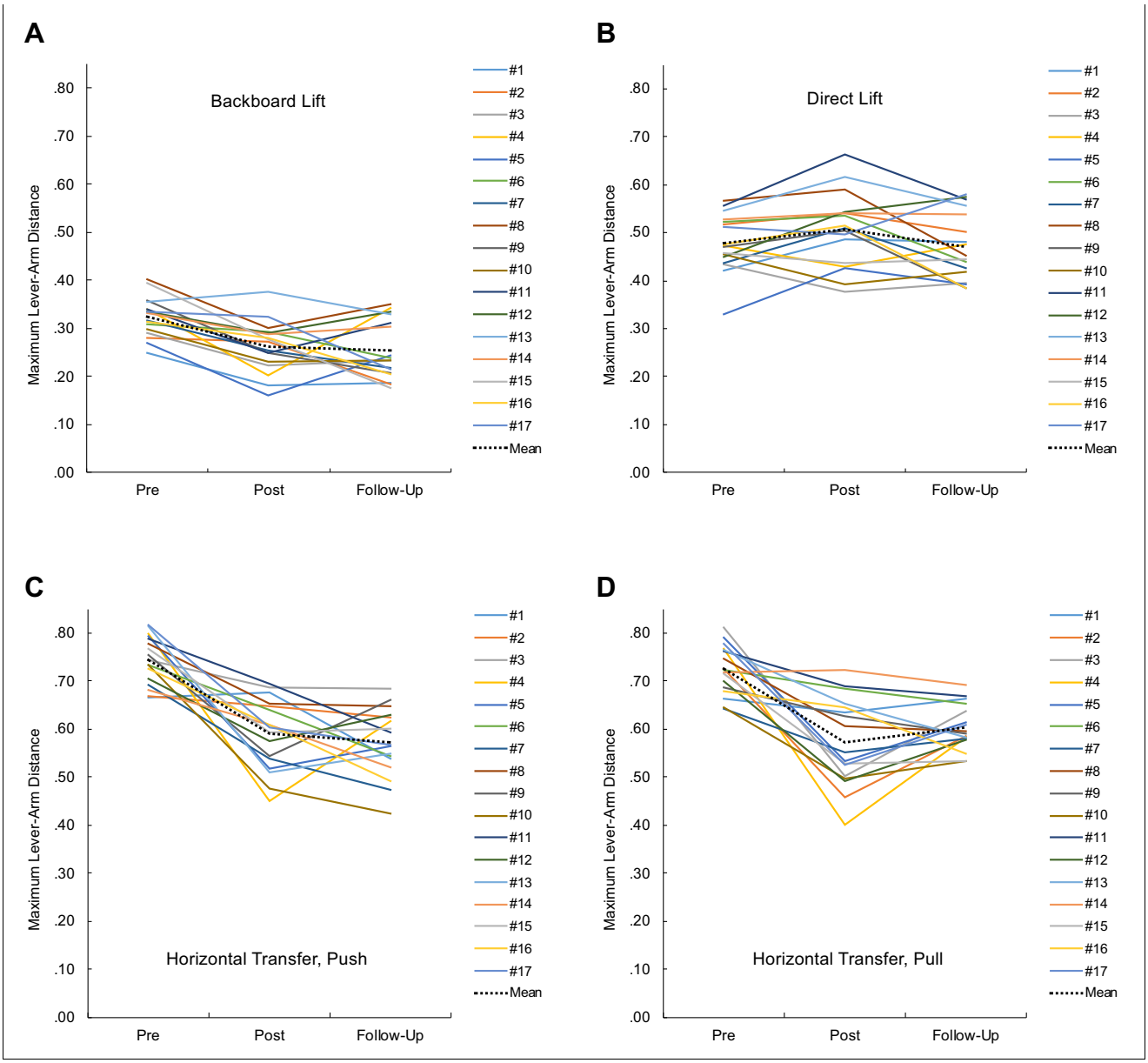


FIGURE 3

Change in maximum lever arm distance scores for (A) backboard lift, (B) direct lift, (C) horizontal transfer, push, and (D) horizontal transfer, pull, movements across preintervention, postintervention, and 1-month follow-up postintervention time points. Pre, preintervention; Post, postintervention; Follow-Up, 1-month follow-up postintervention.

verbal responses during the initial and follow-up data collection sessions.

The body positioning taught in the intervention serves to place the lifter with a solid base, feet shoulder-width apart, shoulders back in a neutral position, and the bed at a height at which the shortest member of the team is able to achieve a comfortable squat position for the transfer. The wide base allows for an equal distribution of the weight across the body, generating the force for the movement symmetrically through both legs rather than through an asymmetrical, 1-legged approach, thereby reducing the rotational forces on the lumbar spine. The neutral shoulder position is improved upon during the horizontal transfer by having the participants grip the sheet with their palms up,

FIGURE 4
Demonstration of direct patient lift from the floor.

allowing for the natural positioning of the bony structures of the arm throughout the lift. The maximum LAD for both the PUSH and PULL portions of the horizontal transfer and for the lifting from the floor with the patient secured to the rigid spine board was found to be lower after the intervention.

Future studies will require a larger sample size, including pregnant women who do not require lifting accommodations. To determine the appropriate sample size, a power analysis for a single-factor repeated measures analysis of variance was conducted using the G*Power computer software (Heinrich Heine University).[26] The analysis indicated that 28 participants would be needed to reach 0.80 power and detect a medium effect size using $\alpha$=.05. To further understand the benefits of this intervention, future studies must include the collection of kinetic data also. This kinetic data would allow for the direct calculation of forces being exerted on the ankles, knees, hips, and lower back during the movements.

## Limitations

The completion of this pilot study had several limitations including the use of a manikin rather than a live subject, use of nursing students rather than practicing nurses, a lack of blinding of the research team, no preregistration of the study protocol, and the gathering of kinematic data only. The use of a manikin allowed the research team to control for patient size, weight distribution across the manikin, and movement of the patient during the transfer process, reducing the risk during the movement. Although these controls added to the safety of the participants, the dead weight of the manikin is not representative of a human patient being moved and will need to be addressed in future studies. The use of nursing students provided a baseline for the safe patient-handling education received in 1 nursing program in Alabama. The findings of this pilot study lend support to the feasibility of using the intervention on a broader scale; however, these findings cannot be generalized to a larger population of nursing students or emergency nurses until further research has been conducted with practicing nurses. Blinding of the research team to the intervention by having a control group will add to the rigor of future studies. The use of the LiFFT[8] allowed the research team to examine a key modifiable risk factor for low back injury, but further testing of the intervention examining the kinetic variables of force and muscle activation is needed moving forward.

## Implications for Emergency Nurses

The manual lifting and moving of a patient are not recommended and should be avoided whenever possible to limit the risk of injury to the health care team. The use of

mechanical lifting equipment is a valuable asset in reducing injury risk to health care workers, but the number of injuries remains high. For important reasons, its use is limited within an emergency setting. To limit the risks associated with manual patient handling, the nurse must understand the premise of core stability, proper body positioning, and a reduction in the LADs.

The use of a friction reduction device is recommended for the horizontal transfer and can be beneficial in requiring the nurse to only generate a force equivalent to 25% of the patient's weight[11] to complete the movement on the basis of the friction reduction. This reduction in force[11] combined with the reduced risk of injury related to the reduction in LAD found in our intervention should decrease injury and microtrauma to the health care workers during the horizontal transfer of the patient that frequently occurs in the emergency department. This small study provides education to be used with friction reduction devices.

## Conclusions

Although lifting techniques alone will never be the answer to injury prevention in nursing, the combination of proper lifting techniques and the use of appropriate lifting and transfer equipment will go a long way toward reducing the number of injuries to nurses, specifically emergency nurses. The development and phase 1 piloting of the contextual lifting intervention showed promise in reducing a key risk factor for low back injury among nursing students. Further testing of the intervention, including the kinetic variables, with practicing nurses is needed. This intervention shows promise as a viable approach to teaching nurses appropriate body positioning when performing patient movement tasks.

## Acknowledgments

The research team would like to thank the Capstone College of Nursing for the use of the space to conduct the research study, the Central Appalachian Regional Education and Research Center for providing funding for this study, and Dr. Anne Franklin Lamar for editing and formatting the manuscript.

## Author Disclosures

Conflicts of interest: none to report.

Funding for this study was provided through the Central Appalachian Regional Education and Research Center, a joint project of the University of Kentucky and Eastern Kentucky University. Funded by CDC/NIOSH Cooperative Agreement 2T42OH010278-04.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.05.018.

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## Appendix

SUPPLEMENTARY TABLE

**Linear mixed effects statistics for the impact of the Safe Handling and Applied Efficiency contextual training intervention on average lever arm distance scores in nursing students**

| Movements/effects | β | SE | 95% CI | *t* | *P* | BIC |
|---|---|---|---|---|---|---|
| Backboard lift | | | | | | –153.91 |
| Participant (random) | 0.287 | 0.014 | [0.259, 0.316] | 20.51 | <0.001 | |
| Time (fixed) | –0.026 | 0.006 | [–0.039, –0.013] | –3.99 | <0.001 | |
| Direct lift | | | | | | –121.43 |
| Participant (random) | 0.396 | 0.018 | [0.360, 0.431] | 22.43 | <0.001 | |
| Time (fixed) | 0.000 | 0.008 | [–0.017, 0.016] | –0.03 | 0.98 | |
| Horizontal transfer, push | | | | | | –99.40 |
| Participant (random) | 0.655 | 0.027 | [0.599, 0.712] | 23.84 | <0.001 | |
| Time (fixed) | –0.085 | 0.013 | [–0.111, –0.059] | –6.69 | <0.001 | |
| Horizontal transfer, pull | | | | | | –99.66 |
| Participant (random) | 0.569 | 0.029 | [0.492, 0.646] | 19.81 | <0.001 | |
| Time (fixed) | –0.067 | 0.013 | [–0.103, –0.032] | –5.05 | 0.01 | |

The total sample comprised 17 participants (11 women and 6 men). Maximum likelihood estimation was used.
BIC, Schwarz Bayesian Information Criterion.

# Displaced Gastrostomy Tube in the Pediatric Emergency Department: Implementing an Evidence-based Algorithm and Quality Improvement Project

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CE Earn Up to 10.5 Hours. See page 206.

**Contribution to Emergency Nursing Practice**

- The current literature indicates that many patients are seen in the emergency department with a displaced gastrostomy tube and receive inconsistent care and support.
- The main finding of this paper is that the use of an evidence-based algorithm for displaced gastrostomy tubes in the emergency department improved the care provided to patients by decreasing the use of unnecessary contrast studies and improved documentation and referral patterns.
- Recommendations for translating the findings of this paper into emergency clinical practice include the finding that an algorithm guiding the use of contrast studies can decrease unnecessary exposure to radiation, lower costs, and ensure better care.

## Abstract

**Introduction:** ED visits for gastrostomy tube–related complications are common, and many are related to tube displacement. Evidence-based practices can provide standardized care.

**Methods:** This study was an evidence-based project to develop and implement an algorithm for the care of patients with a displaced gastrostomy tube in the emergency department. Providers were educated on the algorithm, and clinical practice change was evaluated. Provider knowledge was assessed using pretest and posttest; analyses included paired *t* test. Descriptive statistics of electronic medical record data on confirmation method, documentation, and referral were reported.

**Results:** Provider knowledge was improved after the education ($n = 22$; $t_{(21)} = -3.80$; $P = 0.001$). After the education, procedure notes were used and completed in 95% of the cases. Appropriate use of the confirmation method was present in 95% of the cases, and all cases were referred to the gastrostomy/specialty clinic.

**Discussion:** Educating providers regarding care for displaced gastrostomy tubes increased their knowledge. A standardized algorithm improved care by decreasing the use of contrast studies, improving documentation, and referring patients to the gastrostomy/specialty clinic. This evidence-based algorithm offered health care providers a protocol to ensure consistent care for children in the emergency department and support for families.

**Key words:** Gastrostomy; Emergency department; Evidence-based practice

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J Emerg Nurs 2021;47:113-22.
Available online 18 November 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.09.007

## Introduction

Gastrostomy tube (GT) displacement in children leads to ED visits in up to 61% of the patients within 30 days of initial placement.[1] Although commonly treated in the emergency department, emergency medical care for displaced GTs inconsistently addresses replacement, confirmation of placement, and documentation, and reinforces ED use rather than access to health care through specialty clinics or advanced practice providers. The aim of this project was to improve the care of children in the emergency department with a displaced GT. An algorithm was developed and implemented to educate providers and guide care in the emergency department.

### BACKGROUND

Up to one-fifth of the children with special health care needs have difficulty feeding or caring for themselves,[2] representing a high number of children who may require a GT. GT placement is a common procedure,[3,4] with a variety of complications that require clinical intervention. Minor complications include tube displacement, obstruction, malfunction, balloon rupture, granulation tissue, bleeding, infection, leakage around stoma site, and gagging/retching/vomiting.[5-7] Serious complications can include malposition or tract disruption, which may lead to peritonitis or sepsis.[6] The incidence of minor complications has been reported in up to 73% of the patients,[8] whereas major complications have been reported in up to 5%, requiring reoperation.[3]

Gastrostomies are primarily managed in the ambulatory setting; however, 15% of the patients were seen in the emergency department within 90 days of placement in a large retrospective cohort study from 38 hospitals (N = 15 642) using the Pediatric Health Information System database.[5] In a recent study of 215 patient charts with GT-related complaints in pediatric patients who visited the emergency department, GT displacement made up 86% of the encounters (ie, 261 GT dislodgments in a total of 302 encounters).[9] The reasons for the visits included recent surgical placement, difficulty replacing tube, parent insecurity, lack of education or equipment, and timing of incident outside of clinic hours.[10]

Chart reviews from the practice site and discussion with the nursing staff identified inconsistent practices related to caring for patients with a displaced GT, including variable confirmation methods, poor documentation, and lack of referral to a gastrostomy/specialty clinic. The first concern after replacement of a GT is the confirmation of placement in the stomach before discharge. The methods of confirmation include aspiration of stomach contents, instillation of 10 to 20 mL saline followed by aspiration, and contrast studies.[11] A contrast study (ie, GT study) is a procedure where contrast is injected into the tube while a radiograph of the abdomen is taken to look for extravasation of contrast and confirm its position in the gastric lumen.[12] In the emergency department, contrast studies have been commonly performed to confirm the placement of GTs, although this has not been widely reported in the literature. In 2 studies involving pediatric patients, confirmation with a contrast study ranged from 35% to 40% of the cases.[9,10] In adult patients accessing the emergency department, the use of contrast studies for confirmation was up to 58%.[13]

Evidence supports the use of the clinical confirmation of GT placement by aspiration of gastric contents in asymptomatic patients or in those with mature tracts.[1,10,13] For symptomatic patients, or for those with tract trauma, immature tracts, or when gastric contents cannot be aspirated, a contrast study is indicated.[13]

Inconsistency in confirmation methods is common in the emergency department. Some patients undergo unnecessary contrast studies, which expose them to radiation, potential increased cost, and increased length of stay (LOS) in the emergency department.[1,13] This, along with the financial burden of GT complications, prompts the development of protocols to prevent ED visits.[6]

Another concern is poor documentation in the medical record. Studies have shown incomplete documentation of physical examination, replacement procedure, and confirmatory method in more than half of the patients presenting to the emergency department.[10,13,14] Poor documentation can have professional and legal ramifications. A standardized form can assist in meeting required documentation,[10,14] capturing the steps to replace a GT and prevent complications.

Routine referral to the gastrostomy clinic provides a resource for comprehensive care. When patients have more information and a provider, they tend to schedule appointments rather than use the emergency department for care.[15] Educating families, setting realistic expectations, offering reinforcement, being available, and empowering families are key to success for caregivers to be comfortable with the care required for their child.[16] Consequently, there are also decreased return ED visits and hospitalizations.[16]

### PURPOSE

The purpose of this project was to improve the care of children who visited the pediatric emergency department with a displaced GT. On the basis of chart reviews and discussion with the nursing staff at the project site, the following interventions were identified to improve care: (1) develop an

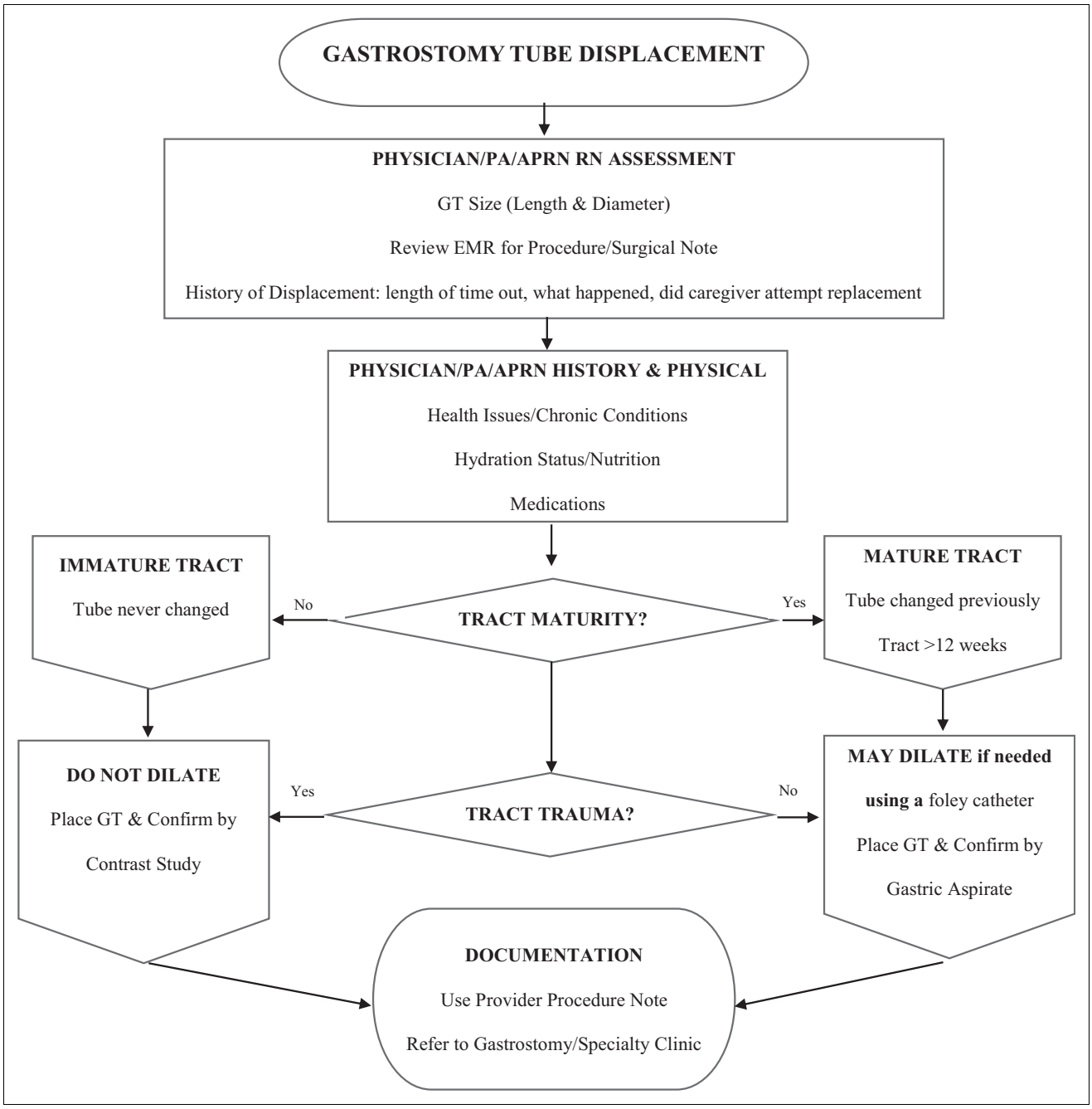


FIGURE 1

Evidence-based algorithm for management of pediatric displaced gastrostomy tube in the emergency department. PA, Physician's Assistant; APRN, Advanced Practice Registered Nurse; RN, Registered Nurse; GT, gastrostomy tube; EMR, electronic medical record. Note: Before clinical intervention, 2 decisions must be made to determine tract maturity and presence of tract trauma.

evidence-based algorithm for tube replacement, (2) educate providers, and (3) evaluate the implementation of the algorithm. The project addressed the following clinical question, which was framed using the Problem/Patient/Population, Intervention/Indicator, Comparison, Outcome model: In pediatric patients with displaced GTs in the emergency department, does education and implementation of an evidence-based algorithm, compared with past standard

**Feeding Tube**

Date/Time:

Performed by:

Authorized by:

Consent:

- Consent obtained:
- Consent given by:
- Risks discussed:
- Alternatives discussed:

Pre-procedure details:

- Old tube type:
- Old tube size:

Anesthesia (see MAR for exact dosages):

- Anesthesia method:

Procedure details:

- Patient position:
- Procedure type:
- Tube type:
- Tube size:
- Bulb inflation volume:
- Bulb inflation fluid:

Post-procedure details:

- Placement/position confirmation:
- Placement difficulty:
- Bleeding:
- Patient tolerance of procedure:

Comments:

FIGURE 2
Procedure note.

care and provider knowledge, improve the knowledge of providers and standardize the care, including confirmation methods of placement, documentation, and referrals provided to patients in the emergency department?

## Methods

This was a quality improvement project with a single group design, including pre- and posttest of clinicians and no control group. There was a comparison after the implementation of the protocol with historical controls through record review. The institution's Healthcare Professionals Research Council approved the project, and it was labeled exempt by the institutional review board at the academic institution (IRB number: 211696). No ethical considerations were identified. Both assessment of providers' knowledge and change in practice were evaluated. The data obtained through review of the electronic medical record (EMR) did not have any patient identifiers attached.

A protocol was developed, titled "Care of the Child with Displaced GT in the Emergency Department" (Figure 1). The assessment criteria included identification of the length of time that the GT was displaced, interventions attempted, and date of gastrostomy placement. The maturity of the tract was determined by the length of time that the stoma had been in place or whether the GT had been changed previously. The confirmation method was determined on the basis of tract maturity and whether there was tract trauma. A procedure note for feeding-tube placement in the EMR was identified to complete the documentation (Figure 2). Finally, the providers were prompted to refer patients to the gastrostomy/specialty clinic after the emergency visit.

### PROCEDURE

The participants were recruited as a single convenience sample cohort. An email was sent to 31 health care providers in the emergency department to introduce the project and educational offerings. The eligible participants included 20 nurses, 4 Advanced Practice Registered Nurses (APRNs), and 7 physicians. The assessment of provider knowledge was conducted using a pretest and a posttest after the education. The participants' tests were de-identified using numerical data. The education was offered immediately after the pretest to keep the participants engaged. The duration of the assessment and education component of the project was 1 month. The change in practice was then evaluated over the following 13 months.

A retrospective EMR audit was performed of children aged 0 to 18 years who presented to the pediatric emergency department using a data extraction form developed by the primary author. The preimplementation chart reviews were completed over 13 months (August 1, 2017, to August 30, 2018), and the post implementation chart reviews were completed over 13 months (December 1, 2018, to December 31, 2019). Descriptive data analyses were conducted on the confirmation method, documentation, and pattern of referrals.

TABLE 1

**Gastrostomy tube dislodgment knowledge test**

1. Who should replace the Gastrostomy tubes that the parents could not replace at home?
   a. RN
   b. APRN
   c. MD [or DO]
   d. B and C
2. When the patient comes into the emergency department with GT dislodgement, which of the following should be obtained?
   a. Length of time tube has been out
   b. Attempt to replace tube by parent/caregiver
   c. Initial gastrostomy tube placement
   d. All of the above
3. Which of the following should be gathered as part of the history and physical?
   a. Health issues, medications and hydration
   b. Hydration and nutritional status
   c. A and B
   d. None of the above, you only need to replace GT
4. How do you confirm placement of Gastrostomy tube after replacement?
   a. KUB
   b. GT study
   c. Aspiration of gastric contents
   d. B and C
   e. All of the above
5. How could you determine the maturity of the GT tract?
   a. Chart review of procedure date
   b. Parent states that the GT was placed a few weeks ago
   c. Parent informs you of the exact date of procedure and that the GT was changed once by provider
   d. All of the above
6. What should be included as part of standardized documentation of GT reinsertion?
   a. GT size
   b. Confirmation method
   c. Patient tolerance
   d. All of the above
7. What constitutes a mature tract for a gastrostomy?
   a. A tract that is twelve weeks old
   b. A tract that is two weeks old
   c. A tract that is four weeks old
   d. All of the above
8. Can all GT stomas be dilated?
   a. No, GT should never be dilated
   b. No, only if they have a mature tract
   c. Yes, only with a foley catheter the size of GT tube
   d. Yes, start with a small foley and increase the foley size until able to replace GT
9. What resources are available for GT for management?
   a. Pediatric Surgeon
   b. Pediatric Surgery APRN
   c. Pediatric Hospitalist
   d. A and B
10. What do parents need to receive from providers when they visit the emergency department?
    a. Support
    b. Emotional Guidance
    c. Expectation Management Support
    d. All of the above

Answer key 1. d 2. d 3. c 4. d 5. d 6. d 7. a 8. b 9. d 10. d

APRN, Advanced Practice Registered Nurse; DO, Doctor of Osteopathic Medicine; GT, gastrostomy tube; KUB, kidneys, ureter, bladder radiograph; MD, Doctor of Medicine; RN, Registered Nurse.

## SETTING/CONTEXT

The setting for this project was the pediatric emergency department of a large suburban community hospital in the Midwest. Approximately 17 000 children visit the emergency department annually at this institution, which has 17 pediatric ED beds. When the pediatric emergency department is closed, children are triaged in the adult/main emergency department. Health care providers (physicians, nurse practitioners, and staff nurses) who staff the pediatric emergency department participated in this project voluntarily, and the recruitment of participants was based on a list of these providers and engagement. The goal was to have 80% of the staff participate in the project. The nurse manager supported the project, allowing time for the participants to engage in education and test completion.

## EVALUATION PLAN

### *Staff Knowledge*

The participant education focused on patient status and GT care. This included the history of events, medical status, clinical exam, tract maturity, process of tube replacement, confirmatory methods, and documentation. The integration of parental needs into the plan of care and referral to the gastrostomy/specialty clinic were also included. In addition to the educational session regarding the protocol for displaced GTs, the providers were instructed to engage parents by assessing support systems, providing resources, and handling care-management expectations. These instructions were organized in a model referred to as the Support, Emotional Guidance, and Expectation Management (SEE) model. The providers supported parents by asking about available family support systems, exploring family resources and external support, and answering questions about care. The emotional needs of the families were addressed by connecting the families to resources such as respite services, social work, and chaplains. Finally, for expectation management, the providers discussed GT care, replacement, emergent concerns, follow-up, and home care needs. These concepts were important to be included in the care of families; however, this model had not been validated.

The training consisted of discussion and review of a case study. The education was offered 10 times (eg, 9 huddles and 1 quality improvement meeting), and a session lasting 15 to 20 minutes was allocated for the education. The pediatric surgery nurse practitioner provided consistent education over a 2-week period.

### *Knowledge Assessment*

A baseline assessment of knowledge was determined using a pretest before the education regarding the algorithm (Table 1). The participants' knowledge was assessed after completion of the education with a posttest. The same test questions used in the pretest were used for the posttest, which was completed by the 22 participants over a 2-week period. The pre- and posttests were 10-question paper and pencil tests in a format of structured questions allowing for statistical analysis.[17] The test was developed by the project director and 6 clinical experts who reviewed each test question for content validity. The criteria for evaluation included item clarity and relevance to the protocol. The item content validity index was 1.0 for 6 of the questions and 0.83 for the other questions. The scale content validity index was 0.93. Item content validity index and scale content validity index are considered acceptable for content validity.[17] The test had good internal consistency reliability ($\alpha = 0.94$).

### *Program Evaluation*

The participants who completed the testing and education were asked to complete a program evaluation using a 5-point Likert scale to determine if the objectives were met. The response options ranged from "strongly disagree" to "strongly agree." The objectives focused on understanding the process for replacing the GT, confirmation methods, documentation, and referral pattern. Finally, a query regarding a change in practice on the basis of the education and additional comments provided open-ended responses.

### *Adherence to Protocol*

On completion of the education and testing, the algorithm was implemented. Laminated copies of the algorithm were made available at staff workstations and break rooms to serve as a guide. The EMR audits were then completed on a monthly basis to determine adherence to the algorithm.

An audit of the EMR was completed for patients identified by a triage nurse as those with a "GI tube problem" and those who had a displaced GT. Patients with gastrojejunal or nasojejunal tubes were excluded because they required replacement in interventional radiology. Nasogastric tubes were also excluded because confirmation methods differed from those used for GTs. The data obtained included documentation using the procedure note, confirmation method, and referral to gastrostomy/specialty clinic.

The data retrieved also included tract maturity, time since displacement, difficulty with replacement, trauma, bleeding, need for dilation owing to stoma stenosis, and LOS in the emergency department. These clinical data specifically were necessary to make the decisions in the algorithm that determined the method of confirmation after replacement. The data collected before and after the implementation of the algorithm were compared to evaluate algorithm adherence and determine if there was a decrease in the use of contrast studies, increase in documentation, and increase in referrals to the gastrostomy/specialty clinic.

### *Data Analyses*

A paired samples *t* test was performed to assess for the statistical mean difference between pre- and posttests. Data analyses were completed using SPSS version 24.0 (IBM Corp).[18] A descriptive statistical approach was used to analyze the EMR data.

## Results

### STAFF KNOWLEDGE

In the pediatric emergency department, 26 participants (17 nurses, 4 APRNs, and 5 physicians) completed the pretest before the education over a 2-week period. The posttest was completed by 22 participants (14 nurses, 4 APRNs, and 4 physicians). Overall, the response rate was 84%; 85% (22 out of 26 participants) completed both the education and pre/post tests. The participants who did not complete both the pre- and posttests were excluded from the statistical analysis to determine knowledge change using the *t* test. These 4 participants were withdrawn owing to a leave of absence or because they left the institution before completion of the testing.

The paired *t* test showed a significant difference in staff knowledge ($t_{(21)} = -3.80$; $P = 0.001$; 95% CI, –16.17 to –4.73). The pretest mean score was 80.45 (SD = 10.45), and the posttest mean score was 90.91 (SD = 8.11). The mean difference was 10.45 (n = 22). Specifically, there was an overall increase in knowledge of understanding tract maturity and dilation of the tract as well as the implementation of SEE in the care of the patient/family. Before the education, 59% (13/22) identified the definition of a mature tract, and only 36% (8/22) of the participants identified stomas that could be dilated. After the education, these scores improved to 95% and 86%, respectively. Only 1 participant scored lower in the posttest than in the pretest. The other participants scored the same or had an increase in their score.

The program evaluations were completed by 68% (15/22) of the participants after the posttest. The results were reported on the basis of scores of 4 or 5 on the Likert scale, indicating that the participants agreed or strongly agreed with the statement. Most (96%) of the participants stated that they had a better understanding of GT care, including the process for replacement, confirmation methods, documentation, and algorithm use after the education. Most (86%) of the participants committed to practice change on the basis of the algorithm. In addition, most (93%) of the providers reported satisfaction with the education and algorithm to guide their practice. During the education process, it was identified that many providers were unaware that a procedure note for feeding-tube placement existed or that interventions were based on tract maturity.

### EMR AUDIT

Before the implementation of the algorithm, there were 34 patients seen in the emergency department with displaced tubes compared with 19 patients after the implementation of the algorithm (Table 2). The audit revealed that most of the patients had confirmation of GT placement through aspiration of gastric contents. However, before the algorithm implementation, 4 of the 9 contrast studies performed were clinically indicated on the basis of the criteria outlined in the algorithm, such as trauma, immature tract, or symptomatic patients compared with 3 of the 4 contrast studies after the implementation. Approximately half of the contrast studies before the implementation (56%) were inappropriate, whereas after the implementation of the algorithm 25% were not appropriate. The patients who underwent a contrast study after the implementation did spend more time in the emergency department than those without a contrast study (n = 17 cases; median = 148 minutes vs 110 minutes). However, the algorithm did not improve the LOS when compared with the cases evaluated before the implementation (median LOS with contrast study = 108 minutes). Over time, although the integration of the algorithm as part of routine care would be expected to decrease LOS, this was uncertain owing to the multiple factors that affected ED workflow: overcrowding, staffing, and other unknown conditions.

Documentation using the standardized procedure note doubled during this project. All patients were referred to the gastrostomy/specialty clinic at the study site or their specialty provider after the implementation. Before the implementation, 4 of the 34 patients returned at least twice for a

displaced GT, and 1 returned 4 times with a displaced tube. In contrast, after the implementation, only 1 patient returned to the emergency department.

## Discussion

The lack of evidence-based guidelines for tube displacement led to the development of the current algorithm. Expert consensus and evidence supporting confirmation methods,[13,19] proper documentation,[14] education of health care providers and parents,[1] referrals to clinics, and parental support can improve the care provided. This algorithm addressed GT replacement to decrease variability and promote the standardization of care across providers. In this project, a decrease in return visits to the emergency department with a displaced GT was noted after the implementation of consistent patient referral to their gastrostomy/specialty clinic.

Visiting the emergency department for care of a displaced GT results in fragmented, episodic care. The consistency of health care interactions with nurses and APRNs in a specialty clinic over time strengthens the relationship and promotes family-centered care. These health care interactions allow for parents to partner with nursing to reinforce the education and gain confidence in the skills needed to manage care. When a coordinated educational protocol was used by nurses for GT care, parents were equipped with the knowledge and supplies to change the GT at home.[20] The current algorithm reinforced the engagement with specialty clinic providers after the ED visit for follow-up care while acknowledging the opportunity to support parents at the point of care.

At the study site, a procedure note was available in the EMR for use regarding replacement of the GT but was not routinely used before the project implementation. This procedure note identified all elements of comprehensive documentation for this type of visit. It was user-friendly and met all criteria for documentation. Without this procedure note, poor documentation could have led to confusion among providers regarding the GT type and size. Parents may not always remember the tube size their child had in place; therefore, providers must rely on the medical record for this information. This project ensured consistent use of the provider note.

In a review of the EMR data and procedure note, only 1 provider ordered an unnecessary contrast study. The provider acknowledged not adhering to the protocol after the contrast study was performed. By using the algorithm and procedure note, the staff were encouraged to evaluate the status of the gastrostomy (ie, tract maturity and trauma) and replacement, which would then prompt the appropriate confirmation method. Overall, a practice change was generated after the education of the staff as noted by the use of the procedure notes in the EMR and support from the providers for referral to gastrostomy clinics. A review of the EMR documentation determined adherence to protocol practice. All patients received a referral to the gastrostomy/specialty clinic.

There was a statistically significant change in the participants' knowledge regarding general gastrostomy care, confirmation methods, and determination of tract maturity. For example, more providers were able to identify mature tracts and which stoma tracts could be dilated. This education and review of the algorithm had an impact on confirmation methods (ie, use of contrast studies), documentation, and referrals.

To sustain change of this project, education will be provided to all new staff serving ED pediatric patients during orientation, and there will be quarterly quality monitoring of the use of confirmation methods and dot phrases for documentation. Dot phrases (ie smart phrases) are documentation codes that populate a template for a note. The algorithm has been in place in the pediatric emergency department for a year, and the participants have shared their comfort with caring for patients with a displaced GT. The most noted helpful components of the protocol have been the implementation of the procedure note and guidance for the appropriate use of contrast studies. The participants also reported a decrease in patients with displaced GTs in the emergency department (K. Zebold and J. Quinn, personal e-mail communications, November 1, 2019).

The costs associated with this project were minimal. Resources were allocated for staff education time offered during huddles and a meeting. Nominal costs included lamination of the protocol and copies of the tests and evaluation forms. The LOS in the emergency department may be increased when using more staff and resources to perform a gastrostomy contrast study. In this project, the LOS was found to be longer for those who underwent a contrast study. Contrast studies can cost up to $6000 per study at this institution; reducing the use of unnecessary studies supports containment of health care delivery costs.

## Limitations

There were several limitations to this project. First, there was a small convenience sample of cases identified in the pediatric emergency department at 1 community hospital. This may not be generalizable to other settings. Second, the cases were identified by the triage nurse coding the

TABLE 2
**Summary statistics of electronic medical record data**

| Variables | Preimplementation (N = 34) | Postimplementation (N = 19) |
|---|---|---|
| Procedure note, % | 47 | 95 |
| Appropriate use of contrast study on the basis of the algorithm, n | 4 | 3 |
| Total contrast studies, n | 9 | 4 |
| Referral to gastrostomy/specialty clinic, % | 35 | 100 |
| Age of tract >12 wk, number of cases | 30 | 17 |
| Dilation of the tract with a Foley catheter, number of cases | 0 | 3 |
| LOS in emergency department, min (median) | 23-327 (82) | 51-380 (117) |
| LOS with contrast study, min (median) | 51-327 (108) | 118-380 (148) |
| LOS without contrast study, min (median) | 23-219 (66) | 51-251 (110) |

Percentages are based on the number of cases in the electronic medical record of displaced gastrostomy tube visits in the pediatric emergency department. Age of tract and dilation of the tract with Foley catheters were used to determine the appropriate confirmation method.
LOS, length of stay.

complaint as a "GI tube problem." This classification may not have yielded all patients with a displaced GT. Further limiting the sample was that after the implementation of the algorithm, the EMR data were analyzed for a short period of time. Data collection over a longer period of time may reveal different outcomes.

Other limitations included the potential for maturity or history bias by taking the same pre- and posttest within the time frame of a month. This could be improved by reordering questions or introducing a new test. Increasing the sample size in a future study can be done by including staff from the larger emergency department and other departments that may float to the emergency department or using a multisite design. A future study can evaluate provider knowledge in a comparison group with an alternative educational module to evaluate the intervention.

Finally, although this study detected a significant change from the baseline in the knowledge of the provider ($M_{diff} = -10.45$), the precision of this change score was quite wide owing to our small sample size (95% CI, –16.17 to –4.73). Therefore, we recommend replication of the study and hope that the data provided in this article can partially inform power analyses for future prospective research in this area.

## Implications for Emergency Clinical Care Nurses

This nurse-led project facilitated standardized and consistent care for children with a displaced GT in the emergency department. The algorithm established a process for confirmation studies that will decrease unnecessary exposure to radiation, lower costs, and ensure better care. The model for SEE serves as a reminder for ED staff to engage families when addressing GT concerns in the emergency department. Nurses have a vital role in triaging patients with GT displacement. They obtain critical information of GT size, the length of time the tube was out, and what interventions parents have implemented, and prepare other team members for what to expect. Nurses can also support families by sharing online educational resources to reinforce care (eg, Feeding Tube Awareness Foundation,[21] Applied Medical Technology Patient Education Guide for Mini ONE,[22] and Avanos TubeFed.com by Avanos[23]). Providers, including licensed independent providers, can intentionally work to increase referrals to the gastrostomy/specialty clinic for continuity of care in appropriate settings, use consistent confirmation methods, and complete documentation.

Nurse managers can implement processes to improve care using algorithms and promoting complete documentation practices. One such example is supporting the use of dot phrases in the EMR that prompt all of the data elements important to include in the procedure notes. Managers can work with the informatics team to implement these phrases and monitor their use. The algorithm could be part of mandatory emergency nurse training and may improve care with the goal of decreasing LOS and cost.

Another implication for practice is that children with GTs often have other medical conditions such as respiratory, cardiac, or neurologic issues,[6] which make them susceptible to illnesses. In emergency departments, there is often exposure to many illnesses, which could be detrimental to these patients. Promoting follow-up in a clinic can limit the child's exposure to potential secondary complications or illnesses and contribute to better allocation of

resources while increasing parental confidence to change the tube or replace the tube at home when possible.

## Conclusions

Education and implementation of an evidence-based algorithm improved the knowledge of providers and standardized the care of patients with displaced GTs in the emergency department. This algorithm was found to be useful and sustainable within our facility as evidenced by provider acceptance and commitment to change practice. The provider education and algorithm improved confirmation methods for placement and increased complete documentation and referrals to gastrostomy/specialty clinics for care management, education, and support of the child and parents.

## Author Disclosures

Conflicts of interest: none to report.

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# The Effect of Catheter Length Placed Into the Vein on Peripheral Ultrasound-Guided Catheter Survival Time: A Prospective Observational Study

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### Contribution to Emergency Nursing Practice

- The current state of scientific knowledge on survival time of peripheral intravenous catheters placed using ultrasound guidance indicates that variables influencing survival times of such catheters are poorly understood.
- The main finding of this research was that neither the length of catheter placed in the vein nor the catheter gauge was associated with increased catheter survival among patients whose peripheral catheter was placed using ultrasound, and it did not support our hypothesis.
- The key implication for emergency nursing practice from this research is that attempting to insert the longest length catheter or largest gauge possible into a vein specifically to increase catheter survival time may not increase catheter survival.


## Abstract

**Introduction:** Establishing and maintaining peripheral intravenous access in patients with no visible or palpable veins can be arduous. Intravenous catheters placed with ultrasound do not survive as long as traditionally placed catheters. This study was performed to determine the relationship between the catheter length placed into the lumen of the vein using ultrasound and catheter survival.

**Methods:** This was a nonrandomized prospective observational study of admitted patients with difficult intravenous placement in 2017. Subjects had ultrasound-guided peripheral intravenous placement in the emergency department or intensive care unit. The main outcome was the time of catheter survival. Data were analyzed using descriptive statistics and Cox regression.

**Results:** A total of 98 patients with an average age of 63 years were enrolled. The total number of cases examined was 97 (N = 97), of which 29 intravenous catheters were removed for catheter-related problems (events). The mean (SD) survival time for catheters placed using ultrasound was 3,445 minutes (2,414) or 2.39 days. Peripheral catheter survival was not significantly related to the in-vein length of the catheter ($X^2 = 0.03$, $P = 0.86$) nor was it significantly related to any of the covariates.

**Discussion:** The survival time of ultrasound-guided intravenous access doubled in the present study from 1674 minutes in a previous 2013 study. The results may have been due to clinician expertise and experience with the peripheral ultrasound-guided method and the use of updated equipment.


**Keywords:** Difficult intravenous access; Administration, intravenous; Ultrasound-guided; Ultrasonography; Emergency nursing

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J Emerg Nurs 2021;47:123-30.
Available online 23 September 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.05.015

## Introduction

Initiating intravenous (IV) access is a crucial, but sometimes frustrating, part of patient care in emergency departments. Establishing IV access in patients with vein paucity, that is, no visible or palpable veins, can be arduous.[1] Patient and family anxiety can increase with each failed attempt, and clinical care is delayed until IV access can be established.[2] In the context of vein paucity, once IV access is established maintaining access becomes a priority.[3]

In emergency departments nationally, 20% of patients needing IV placement have characteristics that promote vein paucity and contribute to difficult IV placement.[1,2] In this patient population, when the traditional palpation technique does not result in successful IV placement, bedside ultrasound is often employed to visualize veins deep within the peripheral tissues.[1] Ultrasound allows the nurse to see the anatomy of the veins, the relationship of veins to arteries and nerves, and where the veins change in size, pattern, and length.[1] Determination of which catheter to place is based on the visualization and assessment of the size, depth, and length of the vein.[1] The term 'survival time' in this context refers to the length of time a peripheral ultrasound-guided IV (PUSGIV) catheter remains in place functioning normally. PUSGIV catheter survival becomes paramount until access is no longer needed or a more stable type of catheter, such as a central line, can be placed.[1]

In 2007, in the same ED setting as the present study, a registered nurse (RN)–driven PUSGIV program was implemented.[4] By 2011, clinicians in this department had identified concerns regarding the survival of PUSGIV catheters. In 2013, the authors completed a nonrandomized retrospective study comparing the survival of 300 PUSGIV and 300 traditionally placed IV catheters established in the study's emergency department.[5] Catheter selection was limited, and the nurse's skill level with ultrasound was in its infancy at the study site. The gauge and length of the catheter were not considered nor the experience of the RN placing the catheter. The hospital policy at that time was to rotate sites, unless indicated by a physician, every 96 hours (4 days). Allowing an IV site to remain in place for as long as possible without causing infection and to minimize pain for the patient was typical practice. At that time, the average survival time of traditionally placed IV catheters was 4320 minutes, 3 times longer than that of PUSGIV catheters. The average PUSGIV catheter survival time was 1674 minutes.[5]

Theoretical reasons for diminished survival times of PUSGIV catheters have been discussed in the literature.[6-8] One possible explanation proposed for the relatively rapid failure of PUSGIV catheters was that shorter catheter lengths placed within the veins, especially among obese patients, would be associated with shorter survival.[7] The "angle of attack" was described as the insertion of PUSGIV catheters at sharp angles in veins at depths of 2 cm or greater.[8,9] The sharper angle of insertion possibly resulted in the catheter scraping the back wall of the vein, possibly resulting in infiltration or kinking.[8,9] In addition, PUSGIV catheters placed in the larger basilic vein on the inside of the upper arm may become dislodged during muscle contraction with bending of the elbow.[8,9] The large area of subcutaneous tissue along with loose skin encountered in the upper inner arm when placing catheters in the basilic vein in older women may cause instability when anchoring the catheter.[7,9] Finally, pressure injection for computed tomography contrast has also caused failure in our facility. Although such problems have been identified as precursors to dislodgement, studies have shown that they do not explain all the variation in survival time.[8] One possible influence not yet well explored is catheter length inside the vein. A plausible hypothesis suggested in the literature is that catheter length within the vein is positively associated with catheter survival.[7]

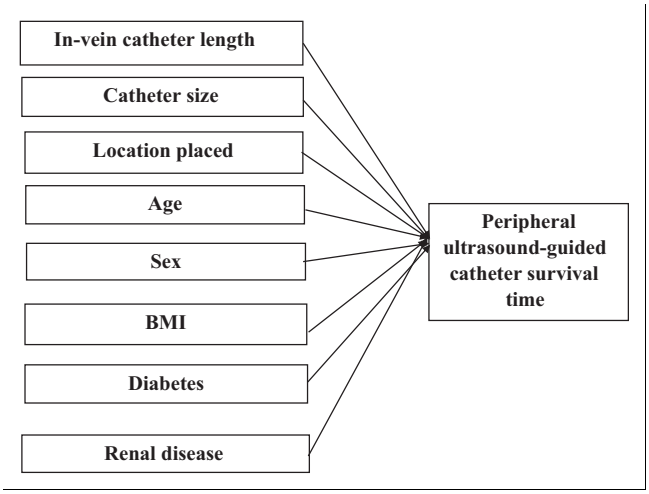


FIGURE 1

The analytic model explains the hypothesis tested using the independent variable of "In-vein catheter length" in conjunction with other covariates on the outcome: "Peripheral ultrasound-guided catheter survival time." BMI, body mass index.

### STUDY OBJECTIVES

The objective of this study was to evaluate the relationship between peripheral catheter length within veins and survival time of PUSGIV catheters. Our hypothesis was that a longer length of catheter within the vein would result in longer survival times for PUSGIV catheters. (Figure 1).

## Methods

### STUDY DESIGN

This was a nonrandomized prospective study using electronic medical records (EMR), including ultrasound images, as the source of data. The study was approved by the

Texas Health Resources Institutional Review Board located in Arlington, TX (protocol number 903294-2). Informed consent was waived.

## STUDY SETTING

The study was conducted at a 750-bed urban tertiary care center with a level II trauma center. The 100-bed emergency department has an annual patient population of 124,000. The current policy at the study hospital is to maintain functioning IVs unless symptoms develop; therefore, IVs were not routinely changed.

## SAMPLE

The sample included inpatient adults who received PUSGIV placement in the emergency department or ICU and were admitted for 60 or more hours from January 1, 2017 to January 1, 2018. Patients eligible for the study were those identified by bedside nurses as patients with difficult IV catheter placement. The bedside nurse referred the patient to nurses with special training in PUSGIV placement. Records of patients receiving PUSGIV placement but admitted for less than 60 hours were excluded because of the minimum time needed to evaluate the survival of the PUSGIV catheter. All patients were aged 18 years or older and had an 18- or 20-gauge PUSGIV catheter, 6.35, 4.5, or 3.2 cm in length, placed. Patients included in the study had the PUSGIV catheter placed either in the upper inner arm (basilic vein), the antecubital vein, or in the forearm. The sample included all eligible records during the study period with complete data, including validated in-vein catheter length measurements. Records were retrieved consecutively until the desired sample size of 98 was obtained.

## PROCEDURES

### *Clinician Training*

Nurses who participated in the study were considered PUSGIV placement experts by both physicians and their peers. Each nurse had completed a 4-hour PUSGIV training class with 10 successful supervised PUSGIV placements and had been placing PUSGIV catheters for at least a year. Nurses who met the above criteria were invited to attend formal training on measuring catheter length within veins. Nurses who agreed to participate received 1 hour of classroom instruction from an emergency medicine physician, employed onsite, who was a recognized pioneer in sonography. They learned how to successfully visualize, capture images, and measure catheter length within the lumen of the vein in real time. The instructing physician reviewed all images captured by the nurses to validate measurement accuracy.

### *Insertion of Peripheral Catheter*

Nurses were trained to pay special attention to avoid placing the intravenous catheter in the arm of a patient with a vascular dialysis graft or on patients post mastectomy. A tourniquet was applied to the upper extremity. The skin was cleansed using a chlorhexidine antiseptic swab, and the ultrasound probe was covered with a sterile Tegaderm dressing (3M, St. Paul, MN). Sterile lubricating jelly (MediChoice; Owens & Minor, Mechanicsville, VA) was then applied to the arm. The probe was moved across the skin surface using a small amount of intermittent pressure until the veins were differentiated from the arteries or the nerves by identifying the collapsibility of the vein. The vein selected was the nurse's preference. The nurse could use either the transverse or longitudinal plane to insert the catheter. Once a proper vein was located, the RN inserted the catheter through the tissue until the vein was punctured. The catheter was then inserted into the vein until the tip of the catheter was viewed in the middle of the vessel on the ultrasound monitor. Successful insertion was defined as nonpulsatile blood dripping freely from the IV catheter and the ability to thread the catheter into the vein until the hub reached the skin. After insertion, the nurse then turned the transducer to the longitudinal plane and moved the probe over the vein until the image of the catheter in the vein and the total length of the catheter in the vein to the tip could be captured.

## VARIABLES AND MEASURES

### *Independent Variable*

The independent variable of greatest interest was the catheter length. After IV placement, a measurement was taken from the insertion site to the catheter tip by imaging in real time using a linear array probe (SonoSite, Inc, Bothell, WA). Measurements were then captured as an image on the ultrasound machine. Later, the image was reviewed for accuracy by the instructing physician.

*Covariates*

Other variables included catheter gauge, placement site, age, sex, body mass index (BMI), renal disease, and diabetes.[6] Available catheters included 4 types: (1) 20-gauge 3.2 cm and 4.5 cm; and (2) 18-gauge 4.5 cm and 6.4 cm (Bard, Inc, Murray Hill, NJ). The gauge was obtained from specifications printed on the package by the manufacturer and was logged by nurses inserting the IVs. Anatomic placement sites for the PUSGIV insertion included 3 categories: forearm, antecubital, and basilic areas. Age was measured in years, sex was determined by inspection of phenotype as listed on the medical record, BMI was calculated automatically in the EMR from weight and height, and history of renal disease or diabetes was obtained from the history section of the EMR. Although IV drug abuse, cancer, and shock[6] are mentioned in the literature as possible causes for vein paucity, IV drug abuse was not prominent in our patient population, and many patients with cancer have tunneled IV access devices that limit the use of ultrasound. Therefore, the covariates were purposefully limited to the prevalence of renal disease and diabetes seen in our patient population.

*Dependent Variable*

The dependent variable was survival time, which was measured in minutes. The insertion and removal times and dates were retrieved from the EMR. Survival time was calculated as the difference in minutes. The defined event was "catheter removed for catheter-related symptoms during the first 60 hours of admission." When the target PUSGIV catheter was removed, it was assumed that policy was followed. The reasons for removal during the first 60 hours after admission included discharge, catheter-related problems, and central line placement. The reasons for removal were documented.

## ENROLLMENT

Patients receiving PUSGIV placement in the emergency department were considered for the study only if a catheter image was obtained and recorded on placement. If the image was clear and the measurements were validated by the instructing physician, the chart was later reviewed for complete documentation. For data to be retained for the study, all of the following criteria had to be met: the measure of the catheter length was judged accurate by the physician reviewing the images, the patient was admitted from the emergency department to an ICU or other hospital unit for at least 60 hours, and there was complete documentation for each independent variable for each case in the EMR. One observation during the study was that on average, 9 ED patients per day received PUSGIV placement in the study facility. But a full year was required to obtain the desired sample because most of the admitted patients receiving PUSGIV placement in the emergency department were discharged before the 60-hour admission eligibility criterion was met.

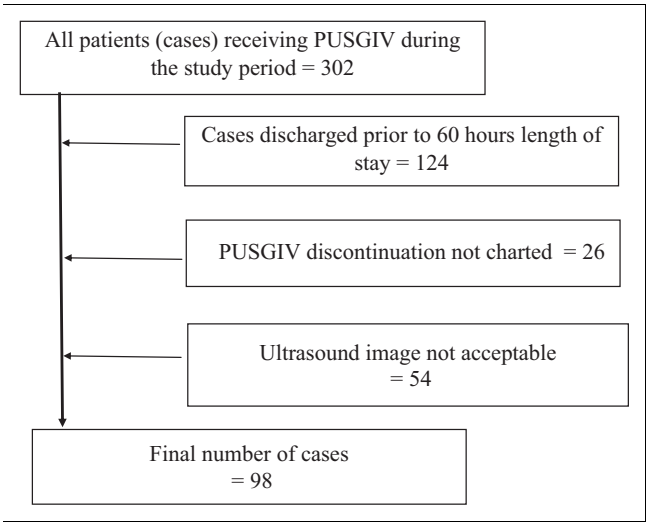


FIGURE 2

Peripheral ultrasound-guided intravenous case selection process. PUSGIV, peripheral ultrasound-guided intravenous.

## RESEARCH ACTIVITIES

Placement of a PUSGIV catheter is considered usual care at the study hospital. Research activities, in addition to usual care, were only observational and included measuring the catheter length, logging the catheter length and gauge, extracting information from the medical record, and analyzing the data.

## ANALYSIS

Descriptive statistics were used to characterize the study sample. Interaction terms were tested. Unadjusted and adjusted Cox regression models were employed to quantify the effects of the in-vein length of the catheter alone and of multiple covariates of age, BMI, sex, diabetes, renal disease, and the location of the catheter in the basilica vein on the survival time (in minutes) of the PUSGIV catheter. A priori power analysis (PASS software) indicated that at least 92

TABLE 1
**Sample characteristics of subjects receiving peripheral ultrasound-guided intravenous placement**

| Characteristics | Censored* N = 69 | Event† N = 29 |
|---|---|---|
| Continuous variables, mean (SD) | | |
| In-vein catheter length | 2.8 (0.91) | 2.8 (0.87) |
| Catheter survival time, min | 3,771 (2,541) | 2,642 (1,876) |
| Age, yr | 62.4 (15.4) | 65 (17.9) |
| BMI, kg/m$^2$ | 31.19 (11.1) | 30.6 (7.7) |
| Nominal variables, n (%) | | |
| Catheter size, 18 gauge | 43 (62) | 16 (55) |
| Location placed, basilic | 38 (55) | 14 (48) |
| Sex, male | 19 (28) | 9 (31) |
| Diabetes | 15 (22) | 6 (21) |
| Renal disease | 34 (49) | 11 (38) |

BMI, body mass index.
* Peripheral ultrasound-guided intravenous catheters remaining in place owing to having no symptoms of catheter-related problems until discharge, 60 hours, or insertion of a central line.
† Peripheral ultrasound-guided intravenous catheters removed for having catheter-related symptoms.

subjects would be needed to model the relationship between survival time and in-vein catheter length. Alpha was set at 0.05, and a moderate effect size for in-vein catheter length was anticipated. Before analysis, the data were examined for implausible outliers, and none were found. No cases with missing data were included in the analysis because inclusion criteria for records required complete data.

## Results

The study accrued a sample of 98 subjects. There were 50 patients who received PUSGIV placement in the ICU and 48 patients in the emergency department (Figure 2). One case was removed because of the unlikely length of survival time thought to be related to being physically removed but not documented as removed in the EMR (implausible value). The total cases examined were 97 (N = 97). Of the 97 cases examined, 29 IVs were removed for catheter-related problems (events). The mean (SD) survival time was 3,445 minutes (2,414). Sample characteristics are presented in Table 1, which shows that proportions of attributes were quite similar among patients who lost their IVs owing to catheter-related problems and those who did not. No differences between groups were statistically significant. Figures 3 and 4 illustrate the insignificant effects of in-vein catheter length on IV removal owing to catheter problems and catheter dwell-times for groups, respectively.

The Cox regression revealed no statistically significant association between any covariates (including in-vein catheter length) and survival of the peripheral catheter. The addition of interaction terms did not improve the model. Model fit was poor. The model with the length of the catheter in-vein as the sole predictor was insignificant ($X^2$ = 0.031, $P$ = 0.86), and the full model was as poor ($X^2$ = 2.79, $P$ = 0.95). Magnitudes of covariates are presented in Table 2. The model was run with both trimmed and untrimmed outcome outliers with negligible differences in coefficients.

## Discussion

The hypothesis that the in-vein catheter length was positively related to PUSGIV catheter survival was not supported by our data. Although not related to the catheter length in-vein, the PUSGIV placement survival time doubled from the 1674 minutes in the 2013 study[5] to 3445 minutes in this study. In both 2013 and 2017, the 2 types of catheters would have been managed similarly and would have had comparable reasons for removal,[5] but other plausible influences on survival time, such as infusion of caustic medications or inadequate securing of the IV site, could be associated with decreased peripheral catheter survival.[3]

There were 2 important factors that may have enhanced the longevity of catheter survival. In the initial 2013 study,

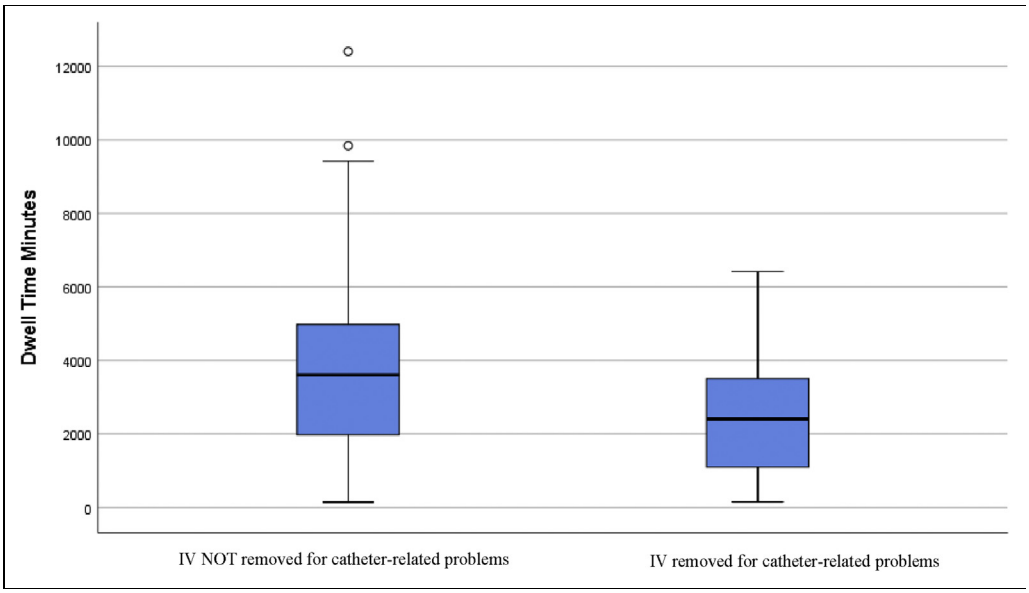


FIGURE 3

Peripheral ultrasound-guided catheter survival time with/without catheter-related problems. IV, intravenous.

there were only 3 catheters available for insertion: the 18-gauge 6.4 cm and the 18- and 20-gauge 4.5 cm.[5] By 2017, catheter sizes and lengths available for peripheral IVs doubled, allowing nurses to choose more appropriate catheters on the basis on nursing judgment of the vessel anatomy and patient needs. In addition, in 2013 our PUSGIV program was only 6 years old.[5] The program began slowly in 2007 with a small group of 4 nurses capable of inserting the catheters. Ten years later, in 2017, the program had become more robust, and the number of PUSGIV

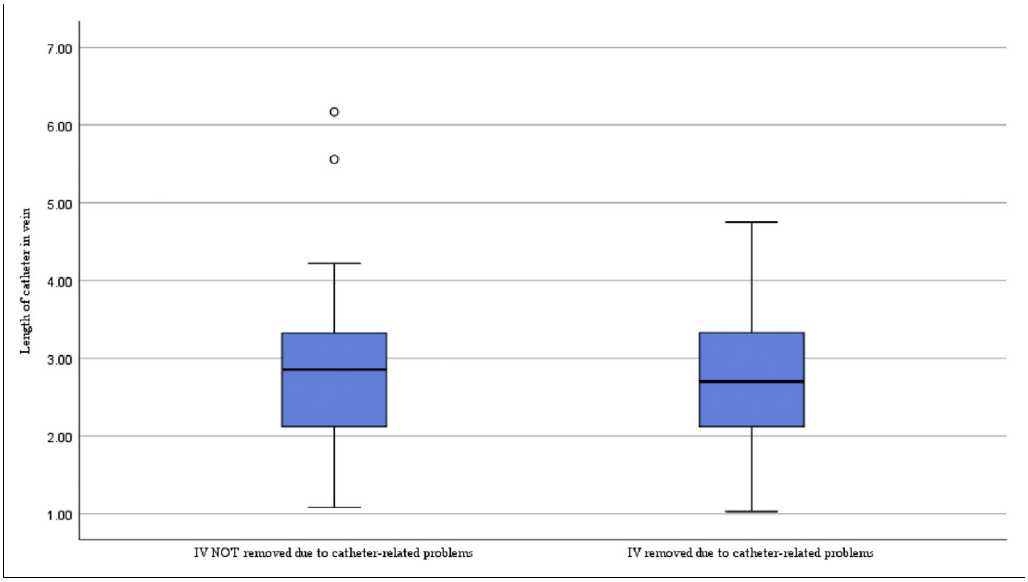


FIGURE 4

Distribution of in-vein catheter length in a peripheral ultrasound-guided intravenous (IV) catheters by removal versus not being removed because of catheter-related problems.

TABLE 2
**Cox regression analysis of in-vein catheter length and covariates on peripheral ultrasound-guided intravenous catheter survival time**

| Covariate | B coefficient | *P* value | Hazard ratio (expB) |
|---|---|---|---|
| In-vein catheter length | −0.031 | 0.90 | 0.969 |
| Catheter size (18 gauge) | −0.035 | 0.88 | 0.966 |
| Location placed (basilic) | 0.063 | 0.88 | 1.065 |
| Age | 0.012 | 0.29 | 1.013 |
| Sex (male) | −0.242 | 0.57 | 0.785 |
| BMI | 0.004 | 0.85 | 1.004 |
| Diabetes | 0.069 | 0.85 | 1.101 |
| Renal disease | −0.505 | 0.3 | 0.603 |

BMI, body mass index.

nurses had increased by a factor of 5. By 2017, some of the nurses had been inserting PUSGIV catheters for as long as 10 years. In addition, in the 2013 study, nurses used an aged ultrasound machine for PUSGIV placement, which produced a poor screen image.[5] By 2017, nurses used updated ultrasound machines with large screens allowing much better visualization of the needle entering the vein, which promoted accurate catheter placement.

Implementation of the described change in practice over time resulted in nurses becoming more confident and proficient in vessel and catheter evaluation, and more technically competent. Nurses are now able to insert shorter catheters in the veins with visibly shorter lengths and longer catheters in the larger, more straight, and sleek veins. We presume that better decision making, increased comfort in insertion, and greater variety of available catheters substantially promoted increased PUSGIV survival time in 2017. This supposition is validated by the fact that the 4.5-cm length catheter was selected most often (66.3%) showing that bedside emergency nurses are becoming increasingly confident with insertion techniques and do not require the longer catheter to reach the vein. These decision-making characteristics illustrate the concept of clinician gestalt,[2] the phenomenon in which the clinician's ability to use their expertise, along with a combination of objective measures, predict their ability to establish an IV with success.

## Limitations

Potential measurement error and sampling bias limit the validity of the study. Our results depended on accurate documentation. Inherently, because of the nurses' hectic clinical pace, random errors in IV insertion and removal times occurred. Reasons for IV removal may also not be perfectly reliable. It is also possible that some relevant records were not obtained because of random or systematic documentation errors. Given the quality of the data available, our results should be interpreted with caution. Readers should also remember that all PUSGIV catheters were placed by emergency and ICU nurses, not members of organized vascular access teams.

## Implications for Emergency Nurses

When placing an IV, the tendency in emergency nursing practice is to look for a vein that will hold as much catheter as possible. The reasoning is that the more catheter placed in the vein, the less likely dislodgement will occur, especially in the obese.[7] But this premise is not supported by this study's findings. Until our results have been replicated or refuted with additional evidence, we suggest that the clinician consider these elements when considering placement: (1) catheter length needed to get to the vein, (2) gauge requirement, (3) catheter length the vein will support, (4) how the catheter will be used, and (5) activity level of the patient. A shorter catheter placed in a shallow vessel in the forearm will most likely outlast a catheter placed in the antecubital or basilic vein where bending of the arm promotes mechanical displacement. The catheter selection should vary according to the vein anatomy and the reason for the insertion. An example of a consideration is serial blood sampling and the need for access large enough to draw blood or placement for rapid infusions.

PUSGIV placement is generally not an easily learned skill. There is a learning curve, and time is required to become comfortable with handling the probe and mastering the hand-eye coordination of inserting the catheter while watching the screen.[1,10-12] Expertise comes with allowing nurses time to become comfortable imaging veins. Currently, there is no consensus on training requirements for learning to place PUSGIV catheters.[1,10-12] The number of successful attempts required to be considered competent in PUSGIV placement varies in the literature from 5 to 25.[1,10-12] In our experience, because of the manual dexterity involved in handling the probe and the eye-to-hand coordination of advancing the needle while watching the screen, 20% of nurses taking the class will not be able to master the skill. In our opinion, the most important aspect of any PUSGIV training program is having the guidance of experienced clinicians in a clinical setting.

Furthermore, nurse administration needs to provide ways to support nurses who place PUSGIV catheters.[1] A frequent complaint is that when a nurse who is competent in inserting a PUSGIV catheter is asked to do so, they must often take time away from their own patients while inserting the catheter for other team members.[1] When helping out, the nurse needs to be assured that their patients will be taken care of or the nurse will soon avoid helping others.

## Conclusions

In conclusion, the overall survival of PUSGIV catheters placed in the emergency department in the study institution doubled from 2013 to 2017,[5] but the increased PUSGIV survival was not related to longer catheter length placed into the lumen of the vein. A comparison of the 2 studies suggests that nurses need clinician support and time to develop their insertion skills and technique. Having a variety of catheters available to choose from and having ultrasound machines with clear images may also contribute to a longer survival time by improving the nurse experience. As more nursing-driven PUSGIV programs are being implemented, the focus appears to be moving from questioning if nurse-driven PUSGIV programs can be successful to developing evidenced-based PUSGIV placement practices.[12,13]

## Author Disclosures

Conflicts of interest: none to report.

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# External Female Urinary Catheter: Implementation in the Emergency Department

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**Section Editor:** Amber Adams, DNP, RN

**Learning Objectives**
After reading this description of a clinical implementation project, the reader will be able to:

- Discuss how the use of an external female urinary catheter may decrease the use of indwelling urinary catheters in the emergency department.
- Describe the importance of staff collaboration in developing new initiatives and interventions.
- Explain how nursing autonomy can be promoted in the design and development of a new departmental initiative.

## Abstract

The emergency department is a care environment in which indwelling urinary catheters are placed frequently; however, the significance of the role of the emergency department in catheter-associated urinary tract infection prevention has been overlooked. The use of an external female urinary catheter is an alternative to placing an indwelling urinary catheter for female patients in the emergency department who are incontinent of urine or are immobile. The purpose was to describe the implementation of an initiative to decrease the number of indwelling urinary catheters and increase the use of external urinary female catheters in non–critically ill women who visited the emergency department at a 451-bed Magnet-designated community hospital in the Southeast. For this clinical implementation project, the Plan, Do, Check, Act framework was used to develop the initiative, and outcome data were collected retrospectively and included an indirect calculation of the number of indwelling urinary catheters placed in the emergency department. A total of 187 external catheters were used in place of indwelling catheters in female patients over a 3-month period. No skin irritation or breakdown was observed. This project demonstrated the initial staff acceptability and feasibility of external female urinary catheter use in the ED setting.

**Key words:** External Female Urinary Catheter; Catheter Associated Urinary Tract Infection; Hospital Acquired Infection

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J Emerg Nurs 2021;47:131-8.
Available online 10 November 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.09.008

## Patient Safety and Quality Care

Patient safety and quality care are universal aspects of today's health care environment. Many organizations have shifted their focus to become a "high-reliability organization" (HRO) in the delivery of care. The HRO approach emphasizes being accountable for building safer systems of care.[1] In the ED environment, the overall goal is to provide timely, emergent management of patients presenting for care while maintaining best practice for patient safety and quality at the forefront.

In the emergency department, the focus is often on the here and now. The long-term impact of seemingly routine procedures may be de-emphasized during emergency management. This is especially true for female patients who have urinary incontinence or poor mobility

where an indwelling urinary catheter (IUC) may be placed for convenience rather than necessity.[2,3] Women are at an increased risk for a urinary tract infection (UTI) owing to the anatomical location of the urethra, near the vagina and anus. Placement of an IUC increases infection risk because the placement of the catheter can introduce bacteria into the otherwise sterile bladder, leading to a catheter-associated UTI (CAUTI).[4] This paper describes an implementation framework to reduce the number of IUCs inserted in non–critically ill women in the emergency department while simultaneously increasing the use of external female urinary catheters (EFUCs) in women in the same emergency department.

## A Common Procedure with High-Risk Implications

CAUTI is a major concern in the inpatient environment owing to the significant impact on clinical outcomes, which include increased mortality, increased length of stay, and cost.[5] It is estimated that 65% to 75% of the CAUTIs are preventable.[5] The Centers for Medicare and Medicaid Services no longer reimburses hospitals for the cost of managing a patient with a hospital-acquired CAUTI.[5] The prevention of CAUTI has been a National Patient Safety Goal since 2012. Initial strategies for the prevention of CAUTI focused on the inpatient setting with the use of nurse-initiated discontinuation protocols, automatic stop orders, checklists, and daily reminders.[5] The more quickly the IUC is removed, the lower the likelihood of a CAUTI development.

However, the significance of the role of the emergency department in CAUTI prevention has often been overlooked. Annually, nearly 3 million IUCs are placed in emergency departments across the United States.[6] The common procedure of placing an IUC in the emergency department for patients who are immobile or have urinary incontinence has several implications for the patient and the health system.[6] IUCs placed in the emergency department have been reported to have a higher risk of CAUTI than catheters placed in other clinical settings.[7]

## Implementation Framework

The Plan, Do, Check, Act model was used to guide this initiative in the emergency department. The Plan, Do, Check, Act model is a framework for continuous process improvement and is useful in implementing new initiatives in health care.[8] The Template for Intervention Description and Replication model is a framework used as a guide to report the implementation process.[9]

## EFUC Description

The EFUC is a cylinder-shaped external catheter covered by a soft wicking-padded material that is designed to be placed externally over the female genitalia between the legs. During initial placement, the woman has her legs abducted (Figure 1). Then the legs are brought back together during EFUC use. When placed, the EFUC covers the female perineum, from the back to the symphysis pubis, and sits snugly between the labia majora. The external catheter is enclosed within a wicking cushion and is attached to wall suction. As the patient voids on the wicking-cushioned area, the urine is suctioned away from the patient to a wall canister. This keeps the patient's perineum dry and free from urine-related moisture (Figure 1). For this initiative, the selected EFUC used was already what was available through the hospital supply chain.

## Setting

The EFUC initiative took place at a 451-bed Magnet-designated community hospital in the suburban Mideastern US. The emergency department has 50 beds, cares for approximately 68 000 patients annually, and is part of the

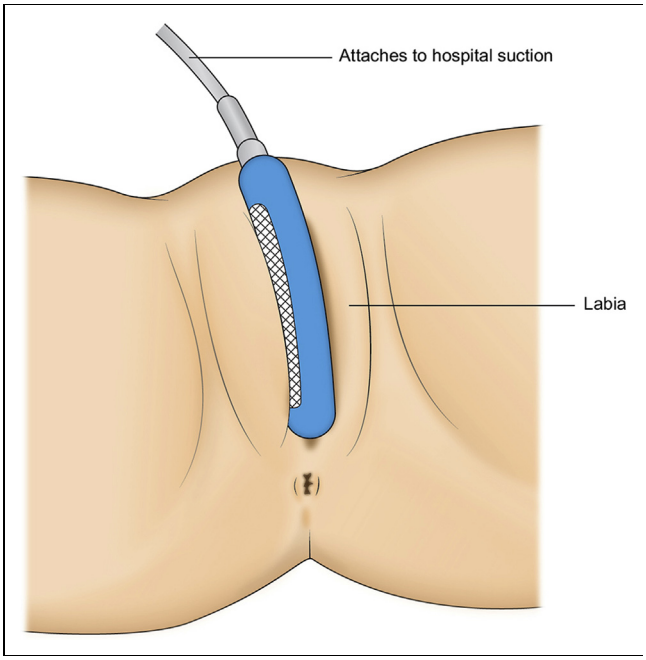


FIGURE 1

Initial placement of the external female urinary catheter, which is designed to remain outside of the anatomy to absorb and remove urine. The wicking-cushioned area lays fully facing the urethra.

TABLE
**Implementation stakeholders**

| Stakeholder | Education | Engagement | Intervention |
|---|---|---|---|
| ED leadership and infection prevention leadership | Role of emergency department in CAUTI prevention.<br>Potential financial implications of IUC and EFUC. | ED collaboration and active role in CAUTI prevention.<br>Potential decrease in hospital CAUTI. | Presented idea for project and request for EFUCs to be supplied to the emergency department. |
| Clinical quality practice council | In-person presentation of ED role in CAUTI. | Requested additional recommendations for QI project plan. | Followed through on council recommendation to collaborate with supply chain to get project started. |
| Supply chain | Discussion of who, what, when, where, and why an IUC or EFUC would be needed in the ED setting. | Decrease in IUC use may have a positive decrease in cost, both for the IUC product use and cost associated with supply use for patients with increased length of stay owing to CAUTI. | In-person meeting with supply chain manager.<br>Formal written request to supply chain to have EFUCs added to ED stock inventory.<br>Obtained data on IUC bag-only type use in the emergency department. |
| Emergency nurses | Poster board presentation regarding IUC, EFUC, and CAUTI presented by RN champions.<br>In-person in-service conducted over a month during each shift premeeting.<br>Poster remained up in break room for remainder of QI project. | Developed a collaborative CAUTI-prevention team.<br>Used a strong female superhero character holding the EFUC in hand to further emphasize the need for UTI prevention in women and empower all staff to consider use of the external catheter device.<br>Empowered RNs to use assessment skills with pre-established criteria to determine if patient could be a candidate for an EFUC.<br>Encouraged nurse education role to teach in real-time setting why an IUC prescription for a female patient may not be of benefit. | Working with support staff (EMT and EMT-P) to make recommendation to the nurse when an alternative catheter should be considered.<br>Champions' real-time mentoring on when, and when not, to use an IUC for a female patient.<br>Collaboration with ED LIP if an IUC was prescribed for a female patient who could benefit from use of an EFUC. |
| ED EMTs, EMT-Ps | Included as teachers for in-services and poster board presentations.<br>EMT and EMT-P teaching fellow medics why CAUTI is an issue and how they too can collaborate with nursing staff and LIPs regarding IUC placement. | Empowered them to mentor both fellow medics and RNs on how to apply an EFUC to a patient.<br>Emphasized that even if a male medic they too can collaborate with RN to recommend EFUC vs IUC for a female patient. | Champions helped to teach in-services.<br>Champions provided staff with real-time mentoring and support. |

*continued*

TABLE
**Continued**

| Stakeholder | Education | Engagement | Intervention |
|---|---|---|---|
| ED LIPs | Shared with ED director physician group data regarding hospital CAUTI and emergency department as 1 of top 3 areas of inserters of IUCs.<br>Provided education regarding criteria and EFUC as an alternative to IUC. | RN ability to independently assess and determine if a female patient could benefit from an EFUC.<br>No order without a need for a prescription. This decreases interruptions for a nursing-based intervention.<br>The nurse, EMT, and EMT-P will document EFUC in electronic medical record. | ED CNS created a 1-page physician education flyer that was sent out to all ED LIPs to alert them of new product and criteria for use.<br>Asked for LIP support should an RN, EMT, or EMT-P request that a prescription for an IUC be cancelled. |
| ED female patients | The clinical staff member placing the EFUC device is required to be female. A male or female clinical staff member before placement would show the patient the device and discuss how it is used. Additional discussion regarding IUC placement and CAUTI was part of the education. | Allowing the patient to see the device before use.<br>Time given for the female patient to ask questions or express concern. | Through discussion with the female patient, the patient became part of the care team decision-making. |

CAUTI, catheter-associated urinary tract infection; CNS, clinical nurse specialist; EMT, emergency medical technician; EMT-P, paramedic; EFUC, external female urinary catheter; IUC, indwelling urinary catheter; LIP, Licensed Independent Provider; QI, quality improvement; RN, Registered Nurse; UTI, urinary tract infection.

hospital's level II trauma center. In this hospital, the emergency department is 1 of the most frequent locations for IUC placement.

## IMPLEMENTATION CHAMPIONS AND STAKEHOLDERS

An ED CAUTI-prevention team was developed and led by the ED clinical nurse specialist to plan the EFUC implementation process. The ED CAUTI-prevention team members became the champions for IUC insertion–prevention and included 2 emergency nurses, 1 emergency medical technician (EMT), and 1 paramedic (EMT-P). Key stakeholders were identified by the impact their role had on urinary catheter placement, supplies, and workflow (Table) and included ED and infection control leadership, ED clinical staff, the clinical quality shared governance council, and the hospital supply chain. All the stakeholders agreed that alternatives to urinary catheters were important and that alternatives should be available in the ED environment. A review of the literature was completed to validate best practices and inclusion and exclusion criteria for this initiative.[6,7,10,11]

The following criteria for EFUC use were identified:

1. ED female patients.
2. Noncritical condition and does not require precise intake and output measurement because this would require a urinary catheter with an hourly-meter urine collection bag.
3. Aged 18 years or older, with a urinary incontinence bladder control issue or immobility.
4. Alert and oriented to person and place, with the ability to follow directions.

The clinical nurse specialist met with the team champions to discuss the rationale for use of the EFUC and to demonstrate correct placement. The risk of CAUTI from IUC placement was discussed. In addition, the importance

of patient advocacy and nurse autonomy was highly stressed because the EFUC does not require a prescription order from a medical provider.

## EFUC STAFF EDUCATION

The champion team was tasked to educate the ED clinical staff. The champions had 5 major teaching points that all the RNs, EMTs, and EMT-Ps were educated about before using the EFUC.

1. Advocating for the patient by asking to use an EFUC when an IUC was prescribed by the LIP.
2. The EFUC does not require a prescription from a licensed independent provider.
3. The location of EFUC supplies in the emergency department.
4. Safe EFUC placement through demonstration and poster presentation. Only female staff members are permitted to place an EFUC for a female patient in this organization.
5. Patient education regarding EFUC patient comfort measures.

The education rollout was completed through 10-minute preshift huddles and a poster presentation. The poster illustrated the major criteria for EFUC placement and was placed in the huddle room for the staff to view before or after their shift.

## IMPLEMENTATION MENTORING

After the initial education, the champions provided real-time mentoring and assistance by reviewing active patient prescription orders for IUC placement and worked with fellow nurses to determine if the patient met criteria for EFUC placement. The primary role of the champions was to mentor, teach, and assist with EFUC placement. In addition, the champions were tasked with being an expert resource for real-time decision-making.

The ED LIP team was provided with a 1-page document that included the criteria for EFUC use and were informed that an order was not needed for the staff to use an EFUC. Physicians were told to expect that RNs, EMTs, or EMT-Ps would be approaching them to discuss order cancellation when the patient was a candidate for an EFUC. The physician team, understanding the clinical importance of CAUTI prevention, embraced the plan and implementation. Once knowledge of the EFUC spread, more champions were welcomed, and the EFUC implementation team was expanded.

The nursing staff innovated further by using mesh underwear for women with an EFUC in place. The mesh underwear helped to stabilize the EFUC and eliminate the patient's feeling that she needed to hold the device tightly in place during the maintenance phase. Although not part of the initial implementation plan, the mesh underwear was a positive addition to the initiative.

## IMPLEMENTATION TIMELINE

The EFUC device was introduced to the champion team in August 2018 and introduced to the staff in September 2018. Over the next 3 months, 187 EFUCs were placed on women in the emergency department. Thus, the external urine collection systems replaced 187 urinary catheters in women. The EFUC is 45% less expensive than a typical IUC used for non–critically ill patients, suggesting a cost-benefit or cost-neutral impact. During the EFUC implementation initiative, we found no occurrences of skin irritation or breakdown.

## IMPLEMENTATION OUTCOME MEASUREMENT

This initiative focused only on non–critically ill female patients who needed assistance with urine elimination owing to incontinence or immobility who did not need an IUC to strictly measure urine output.

Outcome data were collected retrospectively and included the number of EFUCs placed and an indirect calculation of the number of IUCs inserted in the emergency department (Figure 2). To calculate the decrease in IUC insertion, the number of urinary catheters with simple collection bag kits ordered from the supply chain in the 3 months before the EFUC implementation (March, April, and May 2018) was compared with the 3-month post–EFUC-implementation total (September, October, and November 2018). These specific preimplementation months (March, April, and May) and postimplementation months (September, October, and November) were used for comparison because the EFUCs were being procured and stocked during June and July and were available for demonstration and staff education in August. This ensured that the reported number of EFUCs used was precise.

The champion team wanted to calculate and compare the actual number of urinary catheters that were inserted in non–critically ill patients during the pre- and post-EFUC periods. The only available data were from the hospital supply chain, which were based on the number of IUC kits with a simple collection bag supplied pre- and postimplementation. The difficulty with these data was that they were not broken down by male and female patients, and therefore only calculated estimates were available (Figure 2). Fewer IUCs were inserted after EFUC

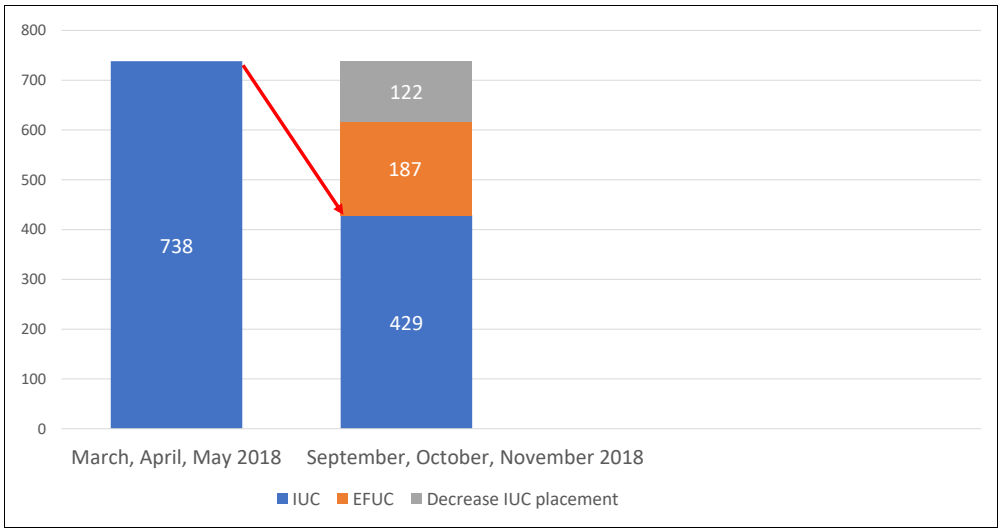


FIGURE 2

Pre- and post-EFUC implementation chart. In the 3 months post-EFUC implementation (n = 187), the decrease in use of IUCs in noncritically ill patients was greater than can be explained by implementation of EFUC alone. At baseline, 3 months before EFUC implementation, IUCs were placed in noncritically ill patients (n = 738). Three months post-EFUC implementation, IUCs were placed in noncritically ill patients (n = 429) and EFUCs were placed on noncritically ill female patients (n = 187). However, an additional decrease in IUC placement was observed (n = 122) post-EFUC implementation that cannot be explained by the EFUC implementation alone. EFUC, external female urinary catheter; IUC, indwelling urinary catheter.

implementation, as anticipated. Unexpectedly, the decrease in IUCs was greater than can be explained by use of the EFUC alone as shown by the calculations in Figure 2. There was a slight decrease in the number of ED visits during the implementation period. This decrease was not large enough to explain the decrease in IUCs. We surmise that the decrease in IUC placement was related to greater awareness of CAUTI and EFUC availability in the emergency department.

## Discussion

The emergency department is a unique setting in which nurses are frontline leaders of HROs and drive safe and high-quality care. In the emergency department, the focus of care is on the immediate needs of the patient. However, this focus can miss long-term consequences of treatment rendered in the emergency department. This implementation initiative highlights several important areas of nursing practice in the emergency department, including nursing autonomy and teamwork, staff and patient education, financial stewardship, challenges of retrospective data collection, and lessons learned.

Frequent placement of IUCs in patients who are not critically ill is an instance in which long-term consequences of care may be overlooked. This offers opportunities for staff education and improvement of patient care in the emergency department. The successful implementation of EFUC placements in the emergency department demonstrates that CAUTI prevention strategies are feasible and appropriate for settings other than inpatient units and, overall, contribute to infection prevention within the organization. We found that non–critically ill female patients tolerated the EFUC well. Furthermore, although skin irritation or breakdown is a possible risk, no patients for whom an EFUC was placed during this initiative had skin irritation or skin breakdown while in the emergency department. This associated risk may be more likely when the EFUC is in place in a long-term setting such as inpatient or admission holds in the emergency department.

In addition to decreasing the number of IUCs placed, this initiative increased nurse autonomy and caregiver collaboration. An unanticipated effect of the EFUC implementation initiative was the realization that, at times, some nursing staff were hesitant to approach the provider when an IUC was prescribed, even when the nurse believed that the EFUC was a better option. The champions played a significant role in overcoming this communication barrier. The champions coached the nursing staff to identify the specific reasons that an EFUC may be a better option than an IUC. The opportunity to discuss alternatives with the champions empowered the nursing staff to advocate for their patient with evidence-based rationale when approaching providers.

As with all practice initiatives, staff education and re-education are vital. Staff education was extensive with

written information, in-services, and hands-on application. A graphic of a strong female superhero character holding an EFUC was used to emphasize the goal of CAUTI prevention in women. This was a memorable visual to help the staff think of the EFUC as an alternative to an IUC. The EFUC champions were available on the unit to reinforce education or discuss and problem-solve with their staff colleagues.

Patient education regarding the EFUC device was paramount to the successful application and continuation of the initiative. The nurses realized that many female patients understood how to use the EFUC, but the women felt that they needed to hold it in place with their legs, which could become tiresome. The nursing staff added the use of mesh underwear for women with an EFUC to increase patient comfort. Although not part of the original performance improvement plan, this had a positive effect on the use of the EFUC for women.

Being a good financial steward is important and financial data are often used to drive changes in health care. In this case, a single EFUC is 45% less expensive than a single IUC with a simple collection bag. However, the EFUC must be changed every 8 to 12 hours, or more frequently if soiled by blood or stool. Therefore, although an EFUC is less expensive than an IUC, the need for frequent replacement will void any initial financial benefit. A more important point is to not allow the cost of a product to determine what is considered best practice. The true benefit is the positive impact on patient outcomes.

Retrospective data collection presented challenges. When the project was initiated, the goal was to change practice in the emergency department by decreasing the number of IUCs placed. The numbers in Figure 2 show that this goal was achieved. However, unexpectedly, the decrease in IUCs was even greater than the use of EFUCs alone. The hospital supply chain provided the numbers of IUCs, but because these numbers were not linked to individual patients it was impossible to determine the exact IUC decrease in women vs men. Eckert et al[11] published similar criteria to those used in this implementation project and also used supply chain data to determine EFUC and IUC use with similar limitations.

The identification of stakeholders and creation of a support team before the implementation was very helpful to create a collaborative working environment. One important lesson we learned is the necessity of planning the data collection strategy before the implementation rather than retrospectively. For example, we were not able to assess the impact of the EFUC initiative on CAUTI outcomes in the hospital. Although the hospital CAUTI rate deceased during the ED EFUC implementation, many additional factors could have contributed to the decrease in CAUTI, including inpatient-unit use of EFUCs, new inpatient prescription order sets that included IUC removal requirements, and placement of fewer IUCs in the emergency department and in the hospital.

## Conclusion

The significance of the role of the emergency department in CAUTI prevention has often been overlooked. The emergency department is an ideal environment in which to create an impact on CAUTI rates by implementing external urine collection alternatives for patients with urinary incontinence and immobility. The implementation of an initiative to place EFUCs demonstrated that they are feasible for use in the ED setting and contributed to a reduction in the insertion of IUCs.

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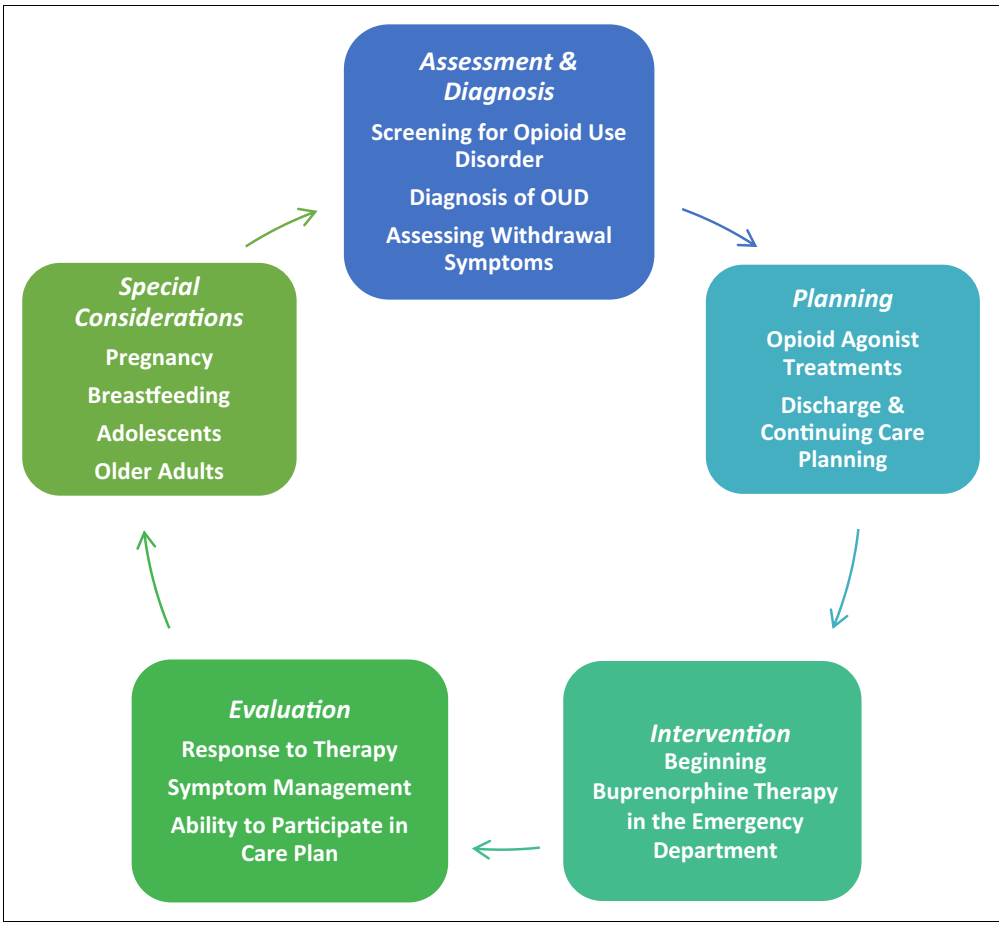
# Understanding ED Buprenorphine Initiation for Opioid Use Disorder: A Guide for Emergency Nurses

**Authors:** Tania D. Strout, PhD, RN, MS, Michael R. Baumann, MD, and Lauren T. Wendell, MD, MS, Portland, ME






J Emerg Nurs 2021;47:139-54.0099-1767
http://dx.doi.org/10.1016/j.jen.2020.10.001

# Understanding ED Buprenorphine Initiation for Opioid Use Disorder: A Guide for Emergency Nurses

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CE Earn Up to 10.5 Hours. See page 206.

**Contribution to Emergency Nursing Practice**

- Dependence on opioids is a critical public health problem in the United States and worldwide, and the emergency department is an important setting for delivering high-quality care, including medication-assisted therapy, for patients with opioid use disorder.
- This article reviews opioid use disorder and opioid withdrawal syndrome, medications used to treat opiate use disorder, considerations for beginning buprenorphine/naloxone in the emergency setting, clinical assessment of withdrawal symptoms, discharging patients with medication-assisted therapy, and specific considerations for special populations.
- Key implications for emergency nurses and their practice are summarized, including roles in education, advocacy, interventions, assessment, and referral to ongoing treatment.

## Abstract

Opioid use disorder is a critical public health problem that continues to broaden in scope, adversely affecting millions of people worldwide. Significant efforts have been made to expand access to medication therapy for opioid use disorder, in particular buprenorphine. As the emergency department is a critical point of access for many patients with opioid use disorder, the initiation of buprenorphine therapy in the emergency department is increasing, and emergency nurses should be familiar with the care of these vulnerable patients. The purpose of this article is to provide a clinical review of opioid use disorder and opioid withdrawal syndrome, medication treatments for opioid use disorder, best clinical practices for ED-initiated buprenorphine therapy, assessment of withdrawal symptoms, discharge considerations, and concerns for special populations. With expanded understanding of opioid use disorder, withdrawal, and available treatments, emergency nurses will be better prepared to deliver and support life-saving treatments for patients and families suffering from this disease. In addition, emergency nurses are well positioned to play an important role in public health advocacy around opioid use disorder, providing critical support for destigmatization and expanded access to safe and efficacious treatments.

**Key words:** Emergency department; Emergency nursing; Opioid-related disorders; Opiate substitution treatment; Buprenorphine

## Introduction

Opioid dependence and opioid use disorder (OUD) are critical public health problems that continue to increase both in the United States and beyond.[1-4] The emergency department is a critical source of care for those with OUD. Emergency department leaders have been called on by many, including the surgeon general and Centers for Disease Control and Prevention, to assist in addressing the opioid epidemic by expanding patients' access to opioid agonist treatment (OAT) with buprenorphine.[5]

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J Emerg Nurs 2021;47:139-54.
0099-1767



https://doi.org/10.1016/j.jen.2020.10.001

Patients with OUD are at an increased risk for poor health outcomes but are often marginalized or are unable to access primary health care services.[6,7] Therefore, many patients with OUD seek care in emergency departments for a variety of issues. ED visits are often a particularly critical moment for patients, bringing into focus the connection between opioid use and health consequences. Emergency clinicians are poised to leverage this moment, assisting patients to initiate effective OAT, in conjunction with a brief intervention and referral to continuing treatment. ED-based initiation of buprenorphine as treatment for OUD is rapidly expanding, and we are unaware of other peer-review, English language articles published in the *Journal of Emergency Nursing* or other emergency-oriented journals specifically focused on educating emergency nurses about this topic. Therefore, the purpose of this article is to provide emergency nurses with an overview of buprenorphine's use in treating OUD, the specifics of its use in the emergency setting, and to review the implications of ED-initiated buprenorphine for emergency nursing practice.

## Assessment and Diagnosis of Opioid Use Disorder and Opioid Withdrawal

The *Diagnostic and Statistical Manual of Mental Disorders* (5th edition, text revision) (DSM-V) defines OUD as "a problematic pattern of opioid use leading to clinically significant impairment or distress."[8] Assessment for the presence of OUD is made using a set of 11 diagnostic criteria, which also allow clinicians to determine the severity of disease (mild, moderate, or severe).[8] Whereas advanced practice emergency nurses are able to diagnose OUD using DSM-V criteria, bedside emergency nurses play an important role in screening and identifying patients who may have OUD and other substance use disorders. Assessing patients' patterns of opioid use, the degree to which they experience opioid cravings, past efforts to curtail use, and ways that opioid use may be interfering with patients' role obligations can assist in the early identification of patients who may be experiencing OUD. Patients with OUD are at a high risk for a wide range of adverse health outcomes including mortality, and recent estimates suggest that more than 16 million people worldwide and more than 2.1 million people in the US are affected.[9,10] The time required for opioid dependence to develop after exposure varies but is generally days to weeks.[11] After sustained exposure to opioids, μ-opioid receptors in the body adapt to the presence of opioid agonists by downregulating their "activation" and suppressing their neurons' excitability. When these same receptors are unbound in the absence of opioid, neuronal disinhibition and hyperexcitability result in the syndrome of opioid withdrawal.[12]

Opioid withdrawal is a constellation of predictable signs and symptoms that follows a discontinuation or reduction in opioid use.[8] Physiologic manifestations of opioid withdrawal include nausea, vomiting, diarrhea, piloerection (goose bumps/flesh), diaphoresis, yawning, mydriasis or photophobia, restlessness, lacrimation or rhinorrhea, and autonomic hyperactivity. Additional findings include pain, anxiety, irritability, stress intolerance, and drug craving.[8] These symptoms are very uncomfortable and distressing for patients. Avoiding feeling sick with withdrawal symptoms and the craving produced by the altered neurons is a primary reason for continued opioid use rather than a desire to obtain a euphoric high.[13] Opioid withdrawal is considered a high-risk period that is associated with an increased risk of return to opioid use, overdose, and death.[14-17] The use of opioid agonist medications such as methadone and buprenorphine is known to be an effective treatment for addressing opioid withdrawal.[18] An assessment for the presence and severity of opioid withdrawal should be made using a standardized, validated tool to allow for meaningful assessment and communication between providers. One widely used withdrawal assessment tool is described in the section on Evaluating Treatment Response. A clear use of terminology is also important when discussing OUD; therefore, definitions of common terms are provided in Table 1.

## Planning: Opioid Agonist Treatment for Opioid Use Disorder

Growing evidence supports the use of opioid agonists in the treatment of OUD.[11,18] Evidence from multiple systematic reviews supports the efficacy of therapy with methadone or buprenorphine across a wide range of outcomes including decreasing the use of illicit drugs, improving physical and mental health, reducing risk of HIV and hepatitis C infections, and reducing all-cause mortality.[19-27] These medications are widely used both to treat patients with active symptoms of opioid withdrawal and as a bridge to long-term treatment.

### METHADONE

Methadone is a synthetic opioid, working as a full agonist at the μ-opioid receptor and producing a long half-life with significant interindividual variability.[28,29]

TABLE 1
**Common terminology and definitions**

| Term | Definition |
|---|---|
| At-risk substance use | A pattern of substance use that deviates from the accustomed social or medical use is based on the quantity, frequency, and duration of substance use; the reasons for substance use; and the increased risk for substance-related harms to an individual's well-being.[96] |
| Diversion | The channeling of regulated pharmaceuticals from someone for whom they are legally prescribed to another person for whom they are not prescribed. |
| Induction | Refers to the initial phase of transitioning a patient from use of an opioid to a prescribed dose of opioid agonist treatment designed to provide relief from withdrawal symptoms and lessen opioid cravings. The induction process can be medically monitored or completed at home by patients. |
| Medication-assisted therapy | The use of medications, in combination with counseling and behavioral therapies, to provide a "whole-patient" approach to the treatment of substance use disorders.[97] |
| Opiate | Refers to natural opioids such as heroin, morphine, or codeine. |
| Opioid | Refers to all natural, semisynthetic, and synthetic opioids. |
| Opioid agonist treatment | Medication-based treatment for OUD using an opioid agonist treatment such as buprenorphine or methadone. |
| Opioid use disorder | A problematic pattern of opioid use leading to clinically significant impairment or distress. The DSM-V includes 12 diagnostic criteria in which the total number of criteria endorsed indicates the severity (mild, moderate, severe) of OUD.[8] |
| Opioid dependence | Occurs when the body adjusts its normal functioning around regular opioid use; people experience unpleasant symptoms (withdrawal) when opioid use is stopped. |
| Opioid withdrawal syndrome | An unpleasant set of symptoms that occur when a person with opioid dependence reduces or stops using opioid, or receives an opioid antagonist after a period of heavy opioid use. The DSM-V requires the presence of 3 or more symptoms (dysphoric mood, nausea or vomiting, muscle aches, lacrimation or rhinorrhea, pupillary dilation, piloerection or sweating, diarrhea, yawning, fever, or insomnia) to confirm a diagnosis of opioid withdrawal syndrome.[8] |
| Opioid tolerance | Occurs when a person using opioids begins to experience a diminished response to the opioid, requiring more opioid to experience the same effect. |
| Nonmedical use | Taking prescribed or diverted medications in a manner that is not consistent with the way, reasons, amount, or time-frame in which they were prescribed. |

DSM-V, Diagnostic and Statistical Manual of Mental Disorders (5th edition); OUD, opioid use disorder.

Methadone is commonly used in opioid treatment programs for maintenance treatment, with daily oral doses ranging from 10 mg to greater than 250 mg, although most patients are maintained at less than 200 mg/d.[11] Although very effective in the treatment of OUD, methadone cannot be prescribed for the OUD indication; it is only administered and dispensed in licensed, specialized clinics, requiring patients to travel to a clinic daily to receive their dose. Most clinics use the oral liquid form of methadone as most of diverted methadone associated with dangerous overdoses is in the tablet formulation prescribed for pain. Methadone can prolong the QTc interval and increase the risk for torsades de pointes, especially when combined with other medications that also cause QTc prolongation.[30] In addition, methadone interacts with many other medications, including ciprofloxacin, carBAMazepine, tricyclic antidepressants, lithium, monoamine oxidase inhibitors, and selective serotonin reuptake inhibitors.[31] As methadone is a full μ-agonist, there are elevated risks of respiratory depression and overdose, particularly if used with other sedating medications; dosing must be carefully titrated for the individual patient to avoid these risks.[29] Methadone maintenance dosing is not reported to state prescription monitoring programs

as filled prescriptions are, making it difficult for emergency clinicians to readily verify a patient's regular dosage. Verification requires direct contact with the patient's clinic. Because of these complexities and regulatory restrictions, the initiation of methadone therapy for OUD is not recommended or feasible in the ED setting. In addition, replacement of missed methadone maintenance doses in the emergency department is typically not recommended, unless dosing can be verified with the patient's regular clinic.

### BUPRENORPHINE

Buprenorphine is a semisynthetic thebaine derivative and is a partial μ-opioid receptor agonist. In the US, it is currently approved for use in the treatment of OUD as well as in the treatment of moderate-to-severe chronic pain, in which efficacy and safety are well established.[25,32] Although patients using buprenorphine for the management of opioid withdrawal symptoms will experience agonistic effects in the form of diminished cravings, miosis, mild sedation, and mild respiratory depression, a unique property of this medication is a "ceiling effect" on respiratory depression and feelings of euphoria.[11,33,34] For the patient with OUD, these qualities result in the management of opioid craving and suppression of withdrawal symptoms with less respiratory and central nervous system depression and abuse potential than is present for full opioid agonists.[35]

In the ED setting, buprenorphine is typically administered as a sublingual tablet or film strip, although it is also available in transbuccal, transdermal, subdermal implant, subcutaneous, and parenteral formulations.[11,33] Sublingual and oral buprenorphine are often administered in combination with naloxone (a full opioid antagonist) to decrease abuse potential. When administered orally, naloxone does not cross the mucosa well and has very poor bioavailability, therefore, it is essentially inactive by this route. If a patient uses oral or sublingual formulations containing naloxone by injection or inhalation, the naloxone easily gets into the bloodstream, and the antagonistic effects are fully activated.[11,33] Currently, standard ED dosing of buprenorphine for patients with withdrawal symptoms is not available, and dosing practices are variable.[36-38] Recent evidence suggests that patients in the emergency department will likely require at least 8 mg of sublingual buprenorphine to experience a significant relief of withdrawal symptoms, with most patients achieving comfort from a total of 16 mg.[11,37] At present, the maximum recommended dose of buprenorphine for ED induction is 32 mg administered sublingually.[11]

As with methadone, there is a risk of QTc interval prolongation with buprenorphine, and caution should be used especially with the coadministration of other medications known to cause QT prolongation such as antipsychotics, tricyclic antidepressants, and selective serotonin reuptake inhibitors.[33] Research evidence indicates that the risk of QTc prolongation is less with buprenorphine than it is with methadone, making it a better choice for patients with co-occurring cardiac conditions.[39-41] The coadministration of buprenorphine with sedative medications or central nervous system depressants such as alcohol or benzodiazepines can compound its depressant effects, worsening respiratory depression.[42] In addition, the administration of buprenorphine in the presence of other opioids can cause severe precipitated withdrawal symptoms owing to the higher affinity for receptors of buprenorphine compared with other opioids. There is a potential for patients who are intoxicated with other opioids, such as methadone, to experience its rapid displacement from receptors with the introduction of buprenorphine, causing the onset of severe withdrawal symptoms including vomiting, hallucinations, delirium, seizures, and hemodynamic instability.[43,44] It is important to avoid precipitating withdrawal symptoms, not only because of the extreme discomfort and dangerous symptoms it can produce, but also because patients with this profoundly unpleasant experience may be understandably hesitant to participate in OAT for OUD in the future.[30]

## Intervention: Buprenorphine/Naloxone Initiation in the Emergency Department

There is currently not a single approach to initiating buprenorphine therapy in the ED setting, and strategies may vary on the basis of local resources. A widely used strategy is presented in Figure 1. Patients presenting to the emergency department with suspected OUD or opioid withdrawal are assessed for the presence and severity of OUD using the aforementioned DSM-V criteria. In addition, their use history is evaluated, with attention to the type of opioids(s) used and the time of last use. It is important to recognize that the administration of buprenorphine in patients taking methadone may cause serious precipitated withdrawal for up to 72 hours after the patient's last use.[33,45] Patients experiencing withdrawal symptoms while on methadone are typically evaluated for methadone dosing adjustment rather than transition to buprenorphine.[11]

When OUD is confirmed, the severity of withdrawal symptoms should be assessed using a standardized tool such as the clinical opiate withdrawal scale (COWS), described in detail in later text (Table 2).[46] Patients with

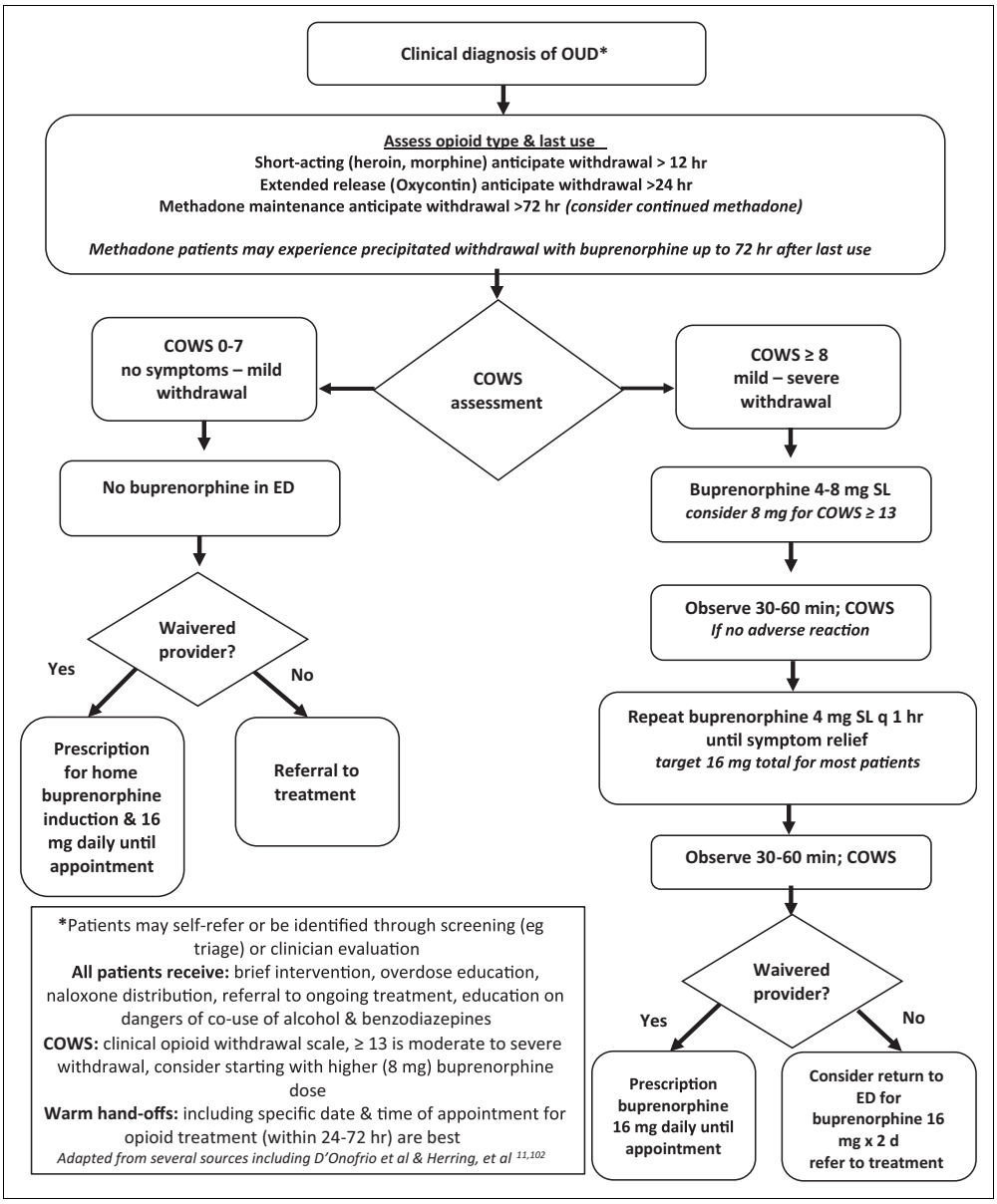


FIGURE 1

Beginning buprenorphine for uncomplicated opioid use disorder in the emergency department. OUD, opioid use disorder; COWS, clinical opiate withdrawal scale; SL, sublingual; ED, emergency department.

mild withdrawal symptoms (total COWS score 0-7) may not require buprenorphine in the emergency department; some institutions are able to provide buprenorphine, instructions on when and how to begin taking the medication, and referral to ongoing treatment for patients to be able to begin induction at home.[47] For those experiencing a greater burden of withdrawal symptoms (COWS ≥8), buprenorphine dosing typically begins with 4 to 8 mg of buprenorphine or buprenorphine/naloxone administered sublingually. The higher, 8-mg dose is widely used as a starting dose especially for patients with COWS scores of at least 13**.** In patients with higher COWS scores, the 8-mg dosing may be less likely to cause precipitated withdrawal.[48] Patients should be observed in the emergency department for 45 to 60 minutes and reassessed for withdrawal symptoms after the initial buprenorphine administration. If substantial relief of symptoms is not achieved, an additional 4 mg of sublingual buprenorphine may be

given, followed by an additional period of observation. It should be anticipated that patients may require as much as 24 to 32 mg of buprenorphine to achieve symptomatic relief.[30,32] In addition to buprenorphine, patients may require other medications to relieve symptoms. These include acetaminophen, ibuprofen, or ketorolac for myalgias; dicyclomine or loperamide for abdominal cramping or diarrhea; ondansetron, prochlorperazine, or promethazine for nausea; and cloNIDine for elevated blood pressure or tachycardia.[49]

When buprenorphine is administered to patients in moderate-to-severe opioid withdrawal, they should experience rapid relief of suffering and uncomfortable symptoms, typically within 30 to 60 minutes.[33] Relief of withdrawal symptoms and opioid cravings is important as this allows patients to focus on additional strategies that are helpful to achieving remission and improved quality of life, such as counseling or behavioral therapy.[50]

## Evaluating Treatment Response: Assessing Opioid Withdrawal Symptoms

### CLINICAL OPIATE WITHDRAWAL SCALE

Assessment of withdrawal symptoms is most commonly accomplished using the COWS.[46] The COWS grades the severity of withdrawal symptoms on a scale of 0 to 36, with higher scores indicating more severe symptoms. Both subjective reports of symptoms (eg, anxiousness, irritability, gastrointestinal upset) and clinical observations of withdrawal signs (eg, piloerection of skin, pupil size, resting heart rate) are used in computing the COWS. It is important to wait until patients are experiencing objective signs of opioid withdrawal before administering buprenorphine to avoid precipitated withdrawal; therefore, frequent assessment using a standardized assessment tool such as the COWS is critical to ensuring optimal outcomes. Generally, a COWS score of at least 8 is recommended before the administration of buprenorphine, with some guidelines suggesting waiting until the patient scores 13.[11,30,37] Regardless, emergency nurses must be well acquainted with the use and documentation of the COWS as frequent reassessment is required to guide dosing and prevention of precipitated withdrawal. Table 2 displays the COWS tool.[46]

## Discharge and Follow-up

Discharge planning for patients in the emergency department after the initiation of treatment with buprenorphine is contingent on several factors. First, whether there is a medical provider who has obtained a Drug Addiction Treatment Act of 2000 X-waiver is an important consideration. An X-waiver is required to prescribe buprenorphine for the treatment of OUD; any provider who holds a Drug Enforcement Administration registration may apply for an X-waiver after the completion of an approved training program.[51] If an X-waivered provider is available, a discharge prescription for a buprenorphine/naloxone combination product, or buprenorphine alone for pregnant patients, should be provided, with the typical buprenorphine dosage ranging between 8 mg and 16 mg daily for the sublingual formulation. The discharge prescriptions should provide enough medication for the patient to be able to attend a follow-up appointment with an OAT or recovery provider. If an X-waivered provider is not available, patients are permitted to return to the emergency department daily for up to 72 hours to receive daily doses of buprenorphine/naloxone under the "3-day rule."[52] As with patients discharged with a buprenorphine/naloxone prescription, the medication is intended to "bridge" the patient until they can reach an appointment with a follow-up provider.

Follow-up with an opioid treatment provider or program is an essential component of an ED-initiated OAT program. Establishing relationships and referral programs with community partners is helpful to ensuring that patients will be able to receive follow-up in a timely manner. Whenever possible, patients should be able to see a follow-up provider within 24 to 72 hours of their ED discharge. This may be the patient's primary care provider, if the primary care provider is an X-waivered practitioner. Otherwise, it will be necessary to refer the patient for follow-up treatment at another provider who is waivered and prescribes buprenorphine. It will likely be necessary to engage supportive resources such as social workers or care managers when arranging for outpatient follow-up, and it is ideal to use a "warm handoff" approach to smooth transitions between the emergency department and the continuing treatment.[53] It is important that clinicians provide education reinforcing the importance of engaging fully in a multimodal treatment program to maximize disease remission, and this begins with providing the patient with a date, a time, and a follow-up location whenever possible. However, a patient's preference for medication alone should not be a barrier as medication monotherapy has also been demonstrated to be effective treatment for OUD.[54,55] Recognizing that resources are often scarce and systems can be fragmented, it is important to let patients know that they can return to the emergency department if they are in need of continuing care and cannot access it in the outpatient setting.[56] With the aforementioned 3-day

rule, emergency providers can continue to prescribe buprenorphine for 72 hours to prevent relapse and ensure that the patient reaches treatment safely.

Before discharge, it is also important to ensure that patients are supported with harm-reducing strategies and knowledge, including the provision of naloxone, and to ensure that the patient and their family or support people understand the signs of an overdose, how to administer naloxone, and how to call for emergency medical assistance. Patients should be educated on the dangers associated with concomitant use of buprenorphine with benzodiazepines or alcohol, as buprenorphine can exaggerate the sedating effects of these substances.[57,58] Additional harm-reduction strategies such as overdose prevention education, hepatitis C and HIV screening, and counseling on reproductive health should also be considered and offered as appropriate.[11]

## Special Populations

Pregnancy and breastfeeding are not contraindications to receiving OAT with buprenorphine.[59] Therapy with buprenorphine for patients who are pregnant or breastfeeding with OUD is supported by the American College of Obstetricians and Gynecologists.[60] Maternal opioid use and acute withdrawal can both cause harm for the childbearing person and the baby, with increased risks of spontaneous abortion, stillbirth, prematurity, low-birth weight neonate, adverse neural effects, and birth defects.[61] Withdrawal from opioids can lead to preterm labor, fetal distress, and fetal withdrawal symptoms.[61] Buprenorphine has been demonstrated to be safe and effective in pregnancy, with a meta-analysis indicating that the rate of congenital anomalies in patients treated with buprenorphine was similar to that of the general population.[62,63]

Research demonstrates that the amount of buprenorphine detectable in human breastmilk is very small.[11,60,64] For people with OUD who are breastfeeding, buprenorphine has been associated with a lower severity of neonatal abstinence syndrome symptoms, less need for pharmacologic treatment of neonatal abstinence syndrome, and shortened hospital stay, in addition to traditional benefits such as the transfer of passive immunity, supporting parent-infant bonding, and facilitating skin-to-skin contact.[65] The American Academy of Pediatrics, American Academy of Breastfeeding Medicine, Association of Women's Health, Obstetric, and Neonatal Nurses, and American College of Obstetricians and Gynecologists all support the use of buprenorphine for OUD in people who are breastfeeding.[60,64,66-68]

Whereas clinical practice has often been to prescribe buprenorphine monotherapy, rather than the buprenorphine-naloxone combination formulation for pregnant women, some recent research found the use of the combination product to be safe in pregnant people.[69-71] Because the naloxone-free formulation is more likely to be used nonmedically or diverted, this is an important area for continued research, and potential risks of prenatal naloxone exposure should be weighed with the risk of nonmedical buprenorphine use in individual patients.

OUD is a serious health problem for adolescents, as well as for adults, with recent estimates suggesting that nonmedical use of opioids and the development of OUD is on the rise in this adolescent age group.[72] Buprenorphine is currently approved for use in treating OUD in patients aged at least 16 years.[73] Three randomized controlled trials have investigated the use of buprenorphine in the treatment of OUD in adolescent patients.[74-76] Each study found buprenorphine to be relatively safe and well tolerated, with no serious adverse effects reported. Opioid abstinence outcomes, retention in treatment, and reductions in high-risk behaviors such as injection drug use were all similar to outcomes for adult patients.[73,77,78] Because most adolescents with OUD do not receive treatment[79,80] and most who are in treatment receive therapies with high rates of dropout and relapse such as abstinence-based treatment or outpatient therapy,[77,81,82] the role of the emergency department in connecting adolescents to effective, evidence-based treatment strategies including buprenorphine may increase in the future.

As with adolescents, OUD is an important and increasing health problem for older adults.[83] Rates of OUD in older adults are expected to continue to rise as the "baby boomer" generation ages because this population has demonstrated high rates of substance use.[84] Research evidence on the use of OAT is limited in older adults; however, the properties of buprenorphine (eg, less risk of overdose and QTc prolongation) make it a good option for patients who are older and may have comorbid conditions, and it is first-line therapy for the treatment of OUD in older adults according to Canadian guidelines.[85,86] The half-life of buprenorphine is relatively stable in patients older than 65 years, and there is less polypharmacy risk than for other opioids as buprenorphine possesses less cytochrome P450 activity.[87]

## Implications for Emergency Nurses

Emergency nurses across the spectrum of professional roles all play a critical part in helping patients safely begin OAT, optimizing their chances of remission and improvement in quality of life. Although there is likely overlap between professional roles and activities, engagement from emergency

nurses in executive, managerial, scientist, advanced practice, and clinical roles is necessary to address this critical health problem. In addition to administering induction and supportive medications, assessing for effect and signs of opioid withdrawal, and providing patients and families with medication-specific education, bedside emergency nurses can be central in helping to decrease the shame and the stigma that are present around OUD. Helping patients, families, colleagues, and the public to reframe thinking about OUD is critical to reducing stigma and making it more likely that those in need will seek treatment and receive the support that is necessary to achieve OUD remission.[88] Encouraging people to think about OUD as a chronic disease that needs a consistent and multifaceted management strategy to achieve optimal results—much the way we approach other chronic diseases such as diabetes or hypertension—can be helpful. Moving from a model that conceptualizes OUD as a moral weakness or choice to one that understands OUD as a chronic medical illness provides space for OUD treatment to take its place alongside the rest of health care. Emergency nurses are well positioned to model this in discussing OUD and OAT with patients and families. People with OUD often feel a strong sense of shame, guilt, or isolation that can make engaging with treatment very difficult, and helping them to feel supported while in the emergency department, when transitioning to follow-up care, and at home can help empower them throughout the process.[89]

The use of destigmatizing language around OUD, drug use, and OAT is also of critical importance. Our language mirrors our thoughts about OUD, and the use of stigmatizing language reinforces myths and stereotypes, presents barriers to treatment seeking, sways public attitudes, and even can reduce the willingness of policymakers to allocate resources toward OUD.[88,90] The National Institute on Drug Abuse recommends the use of "person-first" or patient-centered language that supports the integrity of the person rather than equating the individual to their condition.[91] For example, rather than saying "drug abuser," an emergency nurse using a person-centered approach would say, "a person with OUD." Additional examples are provided in Table 3.

To best support patients with OUD, it is important for emergency nurses to have a strong understanding of helpful resources available within and outside of their hospital settings. Although resources will not be standard, many hospitals and emergency departments have clinical social workers, care managers, substance use disorder treatment specialists, and mental health professionals who can all play important roles in caring for patients with OUD. Understanding local resources will help the emergency nurse be prepared to coordinate the multidisciplinary team and care planning for patients. In addition, having a strong awareness of and familiarity with community resources such as treatment centers, peer support programs, needle exchanges, harm-reduction centers, virology testing centers, and shelters accepting patients receiving medication-assisted therapy OAT will ensure that the emergency nurse is able to recommend support resources appropriate for individual patients.

Emergency nurses can help ensure the delivery of high-quality care by having a strong understanding of local care standards and protocols. For example, best practice includes providing pregnancy testing for persons of childbearing age to ensure that pregnancies are identified and that patients are connected to prenatal care, in addition to guiding treatment decisions. Patients receiving medication for OUD are at high risks of relapse and overdose; therefore, ensuring access to a naloxone kit and education for patients and their supports is an important marker of high-quality care.[92] All patients receiving opioid medications must be educated on the proper storage and disposal of their medications, and buprenorphine is no exception as there has been an alarming increase in pediatric accidental exposures with the advance of OAT.[33,93] Emergency nurses are optimally positioned to ensure that each of these best practices and local standards has been provided to patients with OUD before discharge from the emergency department.

Those emergency nurses in advanced practice roles (nurse practitioner, certified nurse midwife, certified registered nurse anesthetist, certified nurse specialist) are eligible to apply for an X-waiver. To do so, they must be licensed under state law to prescribe schedule III, IV, or V medications for pain; complete at least 24 hours of education through a qualified provider; demonstrate the ability to treat and manage OUD through other training or experience; and, if required by state law, be supervised or work in collaboration with a qualifying physician. The American Association of Nurse Practitioners has created an interactive map that provides information regarding the practice environment for advanced practice nurses (APRNs) on a state-by-state basis as some states may have legislation prohibiting APRNs from prescribing these medications despite federal regulations. The map is available at https://www.aanp.org/advocacy/state/state-practice-environment. Free, 24-hour X-waiver trainings are available for APRNs through the Providers Clinical Support System, who has partnered with multiple professional organizations including the American College of Emergency Physicians, the Society for Academic Emergency Medicine, the American Psychiatric Nurses Association, and American Academy of Addiction Psychiatry to expand access to this

TABLE 2
**The Clinical Opiate Withdrawal Scale.**[46]

**Resting Pulse Rate:**
_____ beats/minute
*Measured after patient is sitting or lying for one minute*
0 pulse rate 80 or below
1 pulse rate 81-100
2 pulse rate 101-120
4 pulse rate greater than 120

**GI Upset:** *over last ½ hour*
0 no GI symptoms
1 stomach cramps
2 nausea or loose stool
3 vomiting or diarrhea
5 multiple episodes of diarrhea or vomiting

**Sweating:** *over past ½ hour not accounted for by room temperature or patient activity*
0 no report of chills or flushing
1 subjective report of chills or flushing
2 flushed or observable moistness on face
3 beads of sweat on brow or face
4 sweat streaming off face

**Tremor:** *observation of outstretched hands*
0 no tremor
1 tremor can be felt, but not observed
2 slight tremor observable
4 gross tremor or muscle twitching

**Restlessness:** *observation during assessment*
0 able to sit still
1 reports difficulty sitting still, but is able to do so
3 frequent shifting or extraneous movements of legs/arms
5 unable to sit still for more than a few seconds

**Yawning:** *observation during assessment*
0 no yawning
1 yawning once or twice during assessment
2 yawning three or more times during assessment
4 yawning several times/minute

**Pupil size**
0 pupils pinned or normal size for room light
1 pupils possibly larger than normal for room light
2 pupils moderately dilated
5 pupils so dilated that only the rim of the iris is visible

**Anxiety or Irritability**
0 none
1 patient reports increasing irritability or anxiousness
2 patient obviously irritable or anxious
4 patient so irritable or anxious that participation in the assessment is difficult

**Bone or Joint aches:** *if patient was having pain previously, only the additional component attributed to opiate withdrawal is scored*
0 not present
1 mild diffuse discomfort
2 patient reports severe diffuse aching of joints/muscles
4 patient is rubbing joints or muscles and is unable to sit still because of discomfort

**Gooseflesh skin**
0 skin is smooth
3 piloerection of skin can be felt or hairs standing upon arms
5 prominent piloerection

**Runny nose or tearing:** *Not accounted for by cold symptoms or allergies*
0 not present
1 nasal stuffiness or unusually moist eyes
2 nose running or tearing
4 nose constantly running or tears streaming down cheeks

Total Score _____
The total score is the sum of all 11 items
Initials of person completing assessment_____

Score 5-12 = mild; 13-24 = moderate; 25-36 = moderately severe; more than 36 = severe withdrawal

training (https://pcssnow.org/medications-for-addiction-treatment/). Expanding the number of emergency APRNs prepared to provide buprenorphine for OUD is critical as many patients may lack other access to health care providers, using the emergency department as a result. Because there is a cap on the number of patients that X-waivered providers can actively treat at any given time, increasing the overall number of eligible providers is essential to expanding access to this important, evidence-based treatment.[94]

In addition, emergency APRNs are often clinical leaders, participating in the development and implementation of new programs and educational efforts for other clinicians. Those with expertise in caring for patients with OUD in the ED setting can play an important role in providing continuing education in this area for colleagues within and outside of the emergency department, expanding the number of clinicians who are prepared to provide compassionate, evidence-based care for these vulnerable patients and their families. With extensive clinical knowledge

TABLE 3
**Patient-centered language**

| Stigmatizing language | Patient-centered language | Rationale |
|---|---|---|
| • Opioid substitution therapy<br>• Opioid substitution treatment<br>• Replacement therapy | • Treatment<br>• Opioid agonist therapy<br>• Medication for treatment of OUD<br>• Pharmacotherapy<br>• Medication-assisted treatment<br>• Medication-assisted therapy | • The terms "substitution" or "replacement" reinforce the misconception that medication-assisted therapy is replacing 1 addiction with another.[98]<br>• Some authors proposed that the terms "medication-assisted treatment" or "therapy" wrongly imply that medication is only an adjunct to other forms of treatment, whereas research demonstrates that medication alone is an effective treatment for OUD.[54,55] |
| • Abuse<br>• Substance misuse<br>• Misuse | When describing illicit drugs:<br>• Use<br>• At-risk substance use<br>When describing prescription medications:<br>• Used other than prescribed<br>• At-risk substance use | • Research indicates that the word "abuse" has a strong association with negative judgments and punishment.[99]<br>• Although "substance misuse" has been commonly used, recent authors describe it as technically imprecise and likely to contribute to stigma.[96] |
| • Clean | When referencing toxicology testing:<br>• Testing negative<br>Nontoxicology references:<br>• Being in remission or recovery<br>• Abstinent from drugs<br>• Not taking drugs<br>• Not currently/actively using drugs | • Use of "clean" or "dirty" can evoke or reinforce negative or punitive cognitions.[89]<br>• Use of clinically accurate, nonstigmatizing terminology is consistent with language used for other medical conditions. |
| • Dirty | When referencing toxicology testing:<br>• Testing positive<br>Nontoxicology references:<br>• Person who uses drugs | • May decrease patients' sense of hope and self-efficacy for change.[89]<br>• Use of clinically accurate, nonstigmatizing terminology is consistent with language used for other medical conditions. |
| • Habit | • Substance use disorder<br>• Drug addiction | • The word "habit" implies inaccurately that a person is choosing to use substances or can choose to stop.[98]<br>• Habit may undermine the seriousness of the disease. |
| • Addict<br>• User<br>• Substance or drug abuser<br>• Junkie<br>• Former or reformed addict | • Person with OUD<br>• Person with opioid addiction<br>• Patient<br>• Person in recovery or long-term recovery | • Use first-person language.<br>• Reinforces notion that a person has a problem rather than is the problem.[9]<br>• Avoids terms that elicit negative association, punitive attitudes, individual blame.[89] |
| • Addicted baby | • Baby with signs of withdrawal from prenatal drug exposure<br>• Baby with neonatal opioid withdrawal<br>• Baby with neonatal abstinence syndrome | • Babies can be born with manifestations of withdrawal syndrome owing to physical dependence but not OUD.[100] |

Adapted from the National Institute on Drug Abuse, 2017[89] and other sources.
OUD, opioid use disorder.

and evidence-based practice skills, emergency APRNs can also be instrumental in the implementation and evaluation of ED-based buprenorphine programs, forging the collaborative relationships necessary to develop successful treatment protocols and community referral partnerships.

Similarly, emergency nurse executives and managers are positioned to be able to advocate for and develop ED-based programs focused on identifying and providing treatment for patients with OUD. As formalized leaders, they are empowered to set priorities for special areas of focus, to bring education and training programs to their staff members, and to develop policy around the care of patients with OUD. These leaders can support the development of ED-based OUD screening programs, ED-initiated buprenorphine protocols, harm-reduction strategies such as the distribution of naloxone kits and opioid take-back sites. Our emergency nurse leaders are prepared to navigate often-complex hospital administrative systems, sponsoring and supporting ED-based programming across committees such as pharmacy and therapeutics, finance, and nursing practice. Nurse executives often set the tone and serve as examples for many other staff members. Their approach to OUD should be compassionate and nonjudgmental, drawing on current evidence, best practices, and principles of nursing theory to optimize success and positive outcomes.

Finally, scientific knowledge in this area is rapidly evolving, yet many gaps in knowledge remain. Emergency nurse scientists can and must play a central role in continuing to expand scientific evidence to support clinical practice, especially through nursing's unique lens. OUD is a complex problem with profound impacts on all facets of the human experience; therefore, research programs that embrace multiparadigmatic approaches are necessary to develop a more full and nuanced understanding of our patients' experiences with OUD. In particular, research addressing gaps in our understanding of the treatment of adolescents, older adults, patients with co-occurring psychiatric disorders, patients with chronic pain, and those living with OUD within jails and prisons is sorely needed, as is knowledge supporting the clinical care of pregnant women with OUD.[95] Emergency nursing scientists work at the intersections between nursing, medicine, public health, education, psychology, and many other disciplines and have unique opportunities to bring together traditionally "siloed" practices with the goal of ultimately improving care for patients and families affected by OUD.

OUD is a complex and widespread public health problem, and the emergency department is an important point of entry into the health care system for many patients with OUD. By expanding access to OAT through provision of buprenorphine in the emergency department, it is anticipated that our nation's emergency departments can play an important role in saving lives and improving the health and quality of life for many patients with OUD. As experts in communication, advocacy, navigating complex systems, and providing expert clinical care, emergency nurses are poised to help address this continuing health crisis.

## Author Disclosures

Conflicts of interest: none to report.

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# Emergency Nursing Review Questions: January 2021

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These review questions are based on the Emergency Nursing Core Curriculum and other pertinent resources to emergency nursing practice. They offer emergency nurses an opportunity to test their knowledge about their practice.

## QUESTIONS

**1.** A patient is given discharge instructions after being treated for a tick bite. Which of the following statements made by the patient indicates further teaching is needed?

**A.** "I will remove ticks by twisting them out with a pair of tweezers."
**B.** "I will use isopropyl alcohol to clean my skin after removing the tick."
**C.** "I can flush the tick down the toilet."
**D.** "I will apply permethrin to my clothes."

**2.** A patient presents to the emergency department with symptoms that started with double vision and drooping eyelids. The symptoms have progressed to difficulty swallowing over the past several hours. Which of the following information, provided by the patient, should be reported immediately to the health care provider?

**A.** History of recent viral infection
**B.** Eating green beans canned at home
**C.** Recently visiting a zoo
**D.** Camping in a tick-infested area

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J Emerg Nurs 2021;47:155-6.
0099-1767



https://doi.org/10.1016/j.jen.2020.08.008

**3.** A patient diagnosed with cannabinoid hyperemesis syndrome presents to the emergency department during the hyperemesis phase of the syndrome. In addition to interventions for dehydration, which of the following medications would the nurse anticipate administering?

**A.** Ondansetron
**B.** Promethazine
**C.** Metoclopramide
**D.** Capsaicin

**4.** A patient with chronic heart failure presents to the emergency department with acute dehydration and hypokalemia after an increase in their dose of furosemide. In addition to monitoring the patient's potassium level, which of the following laboratory values is most important to monitor?

**A.** Sodium
**B.** Chloride
**C.** Magnesium
**D.** Calcium

**5.** An unsheltered patient presents to the emergency department with fever, fatigue, and loss of appetite. Based on these symptoms and this population's risk factors, which of the following specific assessment questions would be most important for the nurse to ask next?

**A.** Do you have nausea and vomiting?
**B.** What colors are your urine and stool?
**C.** Do you have kidney disease?
**D.** What medications are you taking?

## ANSWERS

**1. Correct answer: A**

The tick should be removed with a steady even pressure because jerking or twisting could cause the tick's mouth parts to remain in the skin. Using isopropyl alcohol to clean the skin (B), disposing of the tick down the toilet (C), and

applying a permethrin product to clothing or shoes is correct (D). However, permethrin products should not be applied to skin.[1,2]

### 2. Correct answer: B

This patient is exhibiting signs of botulism, an acute paralytic illness caused by ingesting a neurotoxin produced by *Clostridium botulinum.* Although botulism is rare, it is most often caused by eating improperly canned foods. Botulism results in a descending flaccid paralysis that begins with the cranial nerves. It is important that treatment with *C botulinum* antitoxin begins as soon as possible because the antitoxin only neutralizes toxin that has not yet bound to nerve endings. Recent viral infection (A), visiting a zoo (C), and exposure to ticks (D) are not associated with the symmetrical descending paralysis seen in botulism.[3]

### 3. Correct answer: D

Cannabinoid hyperemesis syndrome is a condition that may occur in regular cannabis users. It has 3 phases: prodromal, vomiting, and recovery. The prodromal phase is characterized by mild symptoms of nausea and gastrointestinal discomfort that are usually worse in the morning. The hyperemic phase is characterized by intense vomiting, epigastric or abdominal pain, and sweating and flushing. The recovery phase begins when vomiting ends. The usual antiemetic medications, ondansetron (A), promethazine (B), and metoclopramide (C), are not effective in relieving nausea and vomiting. However, a hot shower or bath may relieve symptoms, as well as a capsaicin-based cream applied to the abdomen. The cause of this syndrome is not yet fully understood.[4]

### 4. Correct answer: C

Furosemide causes urinary magnesium loss. When the magnesium level is low, the kidneys increase excretion of potassium, which will exacerbate hypokalemia if the low magnesium level is not also addressed. This, in turn, can increase the patient's risk for cardiac dysrhythmias. The other laboratory values should also be monitored, but in this situation, the magnesium level is the highest priority.[5]

### 5. Correct answer: B

Hepatitis A is an acute illness with signs and symptoms that include fever, fatigue, loss of appetite, dark urine, light-colored stools and jaundice. Hepatitis A is transmitted by means of the fecal oral route. In the past, it was often associated with food, but the most recent increase in cases, which began in 2016, has been associated with those in close contact with infected individuals including: homeless individuals, men having sex with men, those who use drugs, and more recently incarcerated individuals. Recent cases also have been associated with high morbidity and hospitalizations. As of July 18, 2020, 33 states have reported 33566 cases with 20561 hospitalizations, and 332 deaths. Prevention includes contact precautions, cleaning protocols, and vaccination of high-risk individuals.

Asking about nausea and vomiting (A), other comorbidities such as kidney disease (C), and medications (D) are appropriate but would be of lower priority.[6,7]

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Journal of
EMERGENCY NURSING

# Factors Associated With ED Use Among New Asian Immigrants in New Zealand: A Cross-Sectional Analysis of Secondary Data

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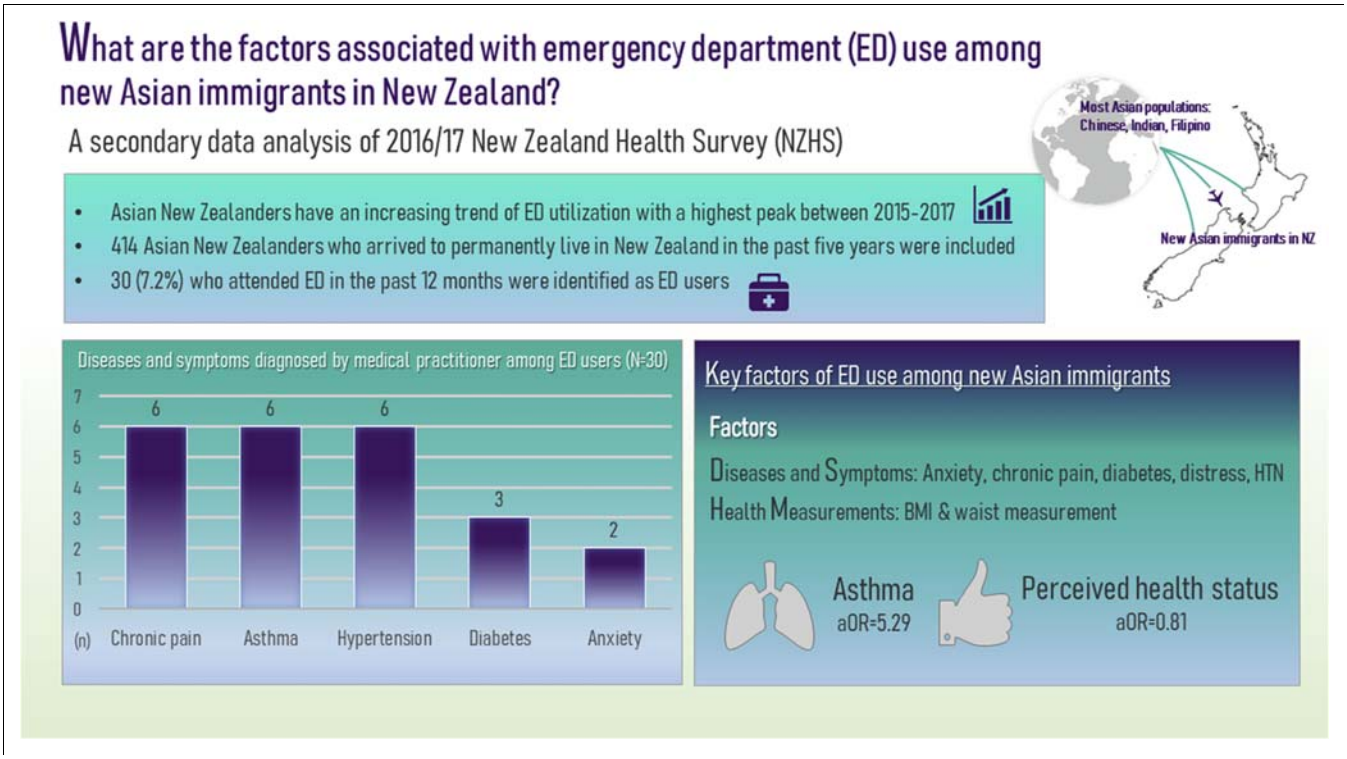




J Emerg Nurs 2021;47:157-66.0099-1767
http://dx.doi.org/10.1016/j.jen.2020.07.011

# Factors Associated With ED Use Among New Asian Immigrants in New Zealand: A Cross-Sectional Analysis of Secondary Data

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### Contribution to Emergency Nursing Practice

- The current state of scientific knowledge on new immigrants' accessing health care in host countries indicates challenges and difficulties in navigating the new health care system.
- The main finding of this research has identified that asthma and perceived health status are the 2 main factors among new Asian immigrants associated with using emergency care.
- Key implications for emergency nursing practice from this research are (1) many new immigrants who are challenged by changing health care systems may access emergency departments as an immediate solution for every asthma episode and (2) individuals presenting in emergency departments, particularly, those who are new to the country might have specific health and psychosocial needs and as well as service use issues, which might need a more focused assessment or referrals.

## Abstract

**Introduction:** New Zealand has an ethnically diverse population and continues to host immigrants from different countries. The present study aimed to examine the factors associated with ED use among new Asian immigrants in New Zealand.

**Methods:** A secondary analysis of 2016-2017 New Zealand Health Survey database. Univariate and multivariate logistic regression models were employed. A total of 414 new Asian immigrants were identified.

**Results:** Asthma, diabetes, chronic pain, anxiety, hypertension, body mass index, waist measurement, perceived health status, and distress were associated with a significantly increased likelihood to ED visits. The multivariate logistic regression analysis revealed that asthma (adjusted odds ratio = 5.29, 95% confidence interval, 1.26-22.24) and perceived health status (adjusted odds ratio = 0.81, 95% confidence interval, 0.66-0.99) were factors associated with ED use among new Asian immigrants.

**Conclusion:** Asthma and perceived health status were the 2 key factors associated with ED use among new Asian immigrants in New Zealand. ED use among new Asian immigrants encompassed both chronic health conditions and mental health indicators.

**Key words:** New Zealand; Secondary analysis; Emergency department; Asian immigrants; Migrant health

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J Emerg Nurs 2021;47:157-66.
Available online 19 September 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.07.011

## Introduction

Unique risk and protective factors affect immigrant health, raising important issues for both immigrants and the host countries. The health care services provided to immigrant groups highly depend on the health entitlements covered within their visa conditions.[1] Most of permanent immigration is composed of work-to-residence visa permits and through family reunification schemes, which in most cases have a comprehensive health care coverage.[2] Several published works address health care delivery and costs relevant to immigration policies.[3-5] Immigrants are frequently required to be "in good health" to be granted residency and work permits in the host countries. The presence of preexisting chronic conditions such as heart and kidney problems, infectious diseases such as tuberculosis and human immunodeficiency virus, and those requiring health care services in a long-term basis are considered during visa application and visa approval.[6] The medical fitness requirement is 1 way to assure host countries that immigrants coming to work or live permanently are in a good state of health. However, the "healthy migrant effect" can diminish over time and is sensitive to the period of residence in the destination countries.[7] Different factors, such as acculturation and economic stability in the host countries, contribute to the changing health status of immigrants.[8,9] This decline in health owing to the unique challenges and vulnerabilities of immigration can create an unanticipated demand for services in the health systems and the overall public health care delivery. This study reports findings of a secondary analysis conducted on new Asian immigrants in New Zealand in terms of their ED use.

### NEW ZEALAND CONTEXT

The 2018 Census revealed that 27.4% of the total population, which is approximately 1.27 million people living in New Zealand, were born overseas.[10] The New Zealand population is increasingly diverse, particularly in major cities such as Auckland.[11] The fastest growing ethnic group is the Asian–New Zealander population, predicted to reach 1.38 million in 2038.[12] The continuous growth of the Asian populations in New Zealand has been historically attributed to permanent residency after immigration and from family reunification pathways.[13] Asians from Chinese and Indian ethnicities are the 2 largest Asian groups in New Zealand.[10] Although the Chinese and Indians have been noted to have a long history of immigration to New Zealand, there are also increasing trends of new immigrants in the country.[10,14]

In terms of migrant health, the New Zealand public health system, which is primarily government-funded, caters to the health care needs and equitable delivery of health care services (eg, full hospitalization coverage) to all New Zealand citizens including immigrant groups with resident visa permits.[15] The New Zealand government has policies and specific mechanisms in providing health care services to all people living in the country with consideration of their visa or permit status. However, a recent literature review examining the status of migrant health in New Zealand indicated challenges in aligning culturally appropriate health services to immigrants' needs, and some of the implemented health interventions were ineffective.[16] For example, many health services, particularly in mental health, were oftentimes delayed because of the inability to reach immigrant groups and the lack of understanding of the common stressors experienced by immigrants living in New Zealand.[16]

Asians living in New Zealand are noted to be generally healthy. A recent New Zealand report, which examined immigrant health against an international benchmark showed that Asian–New Zealanders have comparable and, in most aspects, better health outcomes than Asians located globally, part of which can be explained by the healthy "desirable" migrant characteristics or health status required to be allowed to immigrate in the first place.[10,14,17] However, Asian–New Zealanders, have demonstrated increasing ED use over each year with the highest peak of ED visits between 2015 and 2017.[18] An increasing trend toward emergency care use within the public health care system, particularly from immigrant populations in New Zealand, raises several implications to the current state of health and well-being of these population groups.[10]

ED use among individuals from immigrant backgrounds is associated with chronic conditions.[19] In particular, emergency use was identified as a consequence of changing lifestyles and health behaviors affecting the general health of immigrants with chronic conditions.[10] A qualitative study undertaken among late-life Asian immigrants in New Zealand noted that ED visits were influenced by the lack of awareness of health services that are available in the community such as general practitioner clinics and misunderstanding of the host countries' health systems.[20] The New Zealand Health Survey (NZHS) 2019 results generally indicated that Asian populations in New Zealand have an increasing trend of ED presentations.[18] Although lower than the national prevalence rate of ED use (14%), Asian–New Zealanders' ED use when compared with other ethnic groups did not have a significant decline since 2012 with a prevalence rate of around 9% in the last 7 years.[21] A gap in the literature was also noticeable in terms of the specific chronic diseases or demographic characteristics associated with ED use in Asian–New Zealander immigrants. With Asian–New Zealander immigrants, a focus on new or recent immigrants across age groups is important as

they experience challenges associated with changing environments and cultural adjustments in their host societies.[22]

### AIM

The aim of this secondary data analysis was to examine the factors associated with ED use among new Asian immigrants in New Zealand. The specific research question of this study was what are the factors associated with the ED use within the past year among new Asian immigrants in New Zealand?

## Methods

### STUDY DESIGN AND SETTING

Secondary data analysis was employed in this study. We used a subset of the Asian population extracted from the NZHS database, 2016-2017.

### STUDY SAMPLE

The original NZHS 2016-2017 dataset had a total of 13,598 adults and 4,668 children, who were interviewed face-to-face by 35 professional interviewers between July 1, 2016, and June 30, 2017. From this dataset, the inclusion criteria of our study were (1) age >15 years, (2) Asian ethnicity, and (3) new (last 5 years) immigrants.

The NZHS collected ethnicity data by asking participants to identify their ethnic affiliation using the following question: "Which ethnic group or groups do you belong to?" which included the options New Zealand European, Māori, Samoan, Cook Island Māori, Tongan, Niuean, Chinese, Indian, and other (please specify). To investigate our target sample of new immigrants, only participants who arrived to permanently live in New Zealand in the past 5 years were included. We have extracted the Asian groups from those participants who identified as Chinese, Indian and those who responded as other with specific origin from other Asian countries (eg, Philippines). The data analyzed were all deidentified data from Statistics New Zealand.

The NZHS as a nationwide survey employed a stratified, multistage area sampling design to achieve an area-based sample as well as increase the sample size for the Māori, Pacific, and Asian ethnic groups. With our study focusing on the ED use specifically among new Asian immigrants, the NZHS sampling method allowed us to examine the national-level representative of Asian populations and further identify new Asian immigrants. Thus, a weighted analysis was not applied because of our focus on a specific ethnic group in the NZHS with small subsample sizes.

### NEW ZEALAND HEALTH SURVEY

The NZHS is an important data collection tool developed by the Ministry of Health, New Zealand government to monitor population health and provide supporting evidence for health policy and strategy development. The partial content that was included in this study was summarized (Supplementary Table).

#### *Demographic Characteristics*

Sex, age, educational level, annual total income, and employment status were collected. All demographic data were analyzed as categorical variables.

#### *Diseases and Symptoms*

In the NZHS database, participants' diseases and some symptoms diagnosed by a medical practitioner were collected. For example, the question used to ask participants to ascertain a formal medical diagnosis was "Have you been told by your doctor that you have diabetes." Data of diseases and symptoms (eg, chronic pain, asthma, hypertension, diabetes, anxiety) were extracted; each item was a categorical question (yes/no).

#### *Health Measurements*

The height, weight, and waist measurement data were also extracted. Body mass index (BMI) and waist circumference data were computed and analyzed as continuous variables.

#### *Perceived Health Status*

The Short-Form 12-Item Health Survey version 2 (SF-12v2) has been used widely in measuring the concept of perceived health-related quality of life. The SF-12v2 includes 2 components: physical composite scale and mental health composite scale. The questions include physical functioning, role limitations because of physical health problems, bodily pain, general health perceptions, vitality (energy/fatigue), social functioning, role limitations because of emotional problems, psychological distress, and psychological well-being. In this study, the raw scoring system from the actual NZHS questionnaire was used (details provided in Supplementary Table). The raw scores can range from 12 to 56 points, with higher scores indicating a better perceived health status. The test-retest reliability of SF-12v2 was 0.79 (intraclass correlation coefficient), and a strong convergent/divergent validity related to physical and mental indexes.[23]

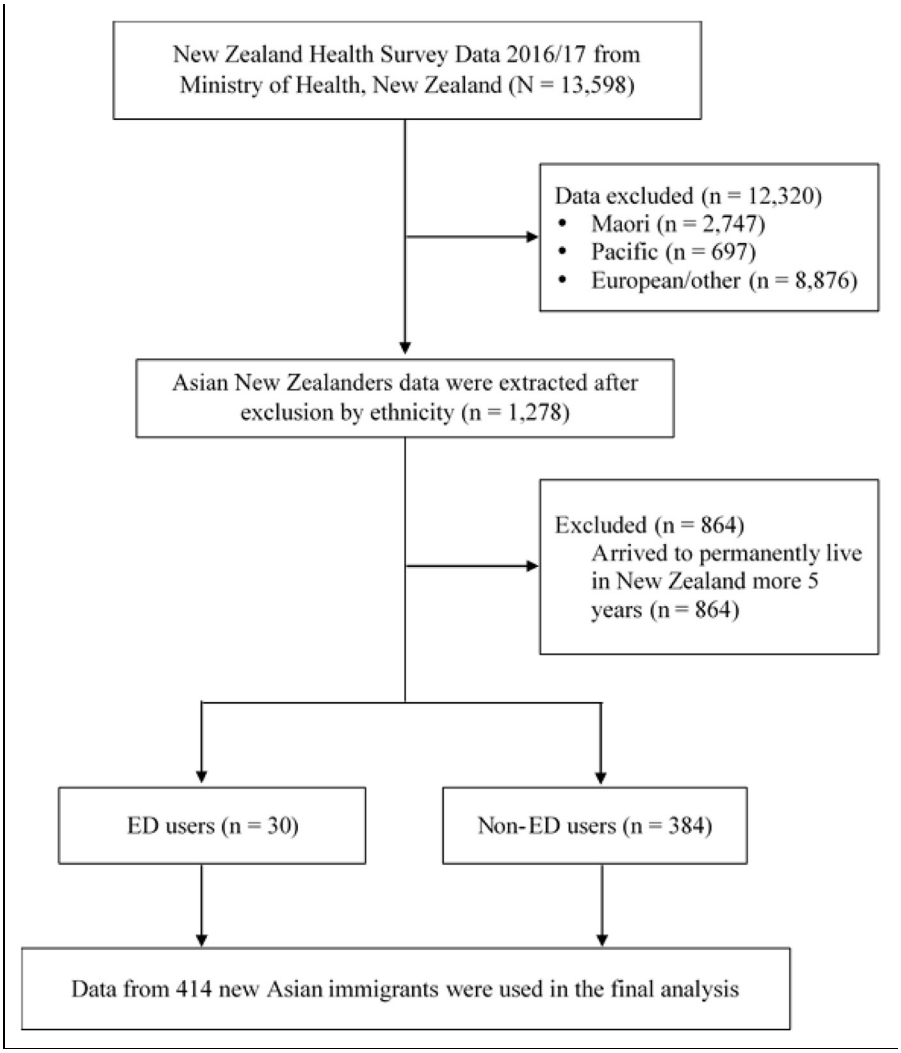


FIGURE
Flow chart of participant selection.

*Distress*

Distress was screened by Kessler Psychological Distress Scale (K10) on the basis of 10 questions about anxiety and depressive symptoms that a person has experienced in the past 30 days. It has been chosen for routine public health survey in Australia.[24] The K10 scores using a 5-point Likert rating scale ranged from 10 to 50. A higher score indicates a higher possibility to have a severe mental disorder. The area under the receiver operating characteristic curve (0.87-0.88) of K10 showed a good accuracy in screening mental disorder.[25]

## DATA COLLECTION PROCEDURES

First, the researchers requested from Statistics New Zealand access to the Confidentialized Unit Records Files (CURFs) from the NZHS dataset. Statistics New Zealand asked permission from the Ministry of Health, New Zealand government to use the CURF data with the approval project reference number CURF-2018-26. Second, accuracy in data extraction was followed with 2 authors (J.M. and M.H.H.) checking the data independently and examining the number of eligible participants and frequencies of variables. Finally, any inconsistency in the data such as agreeing with the number of total eligible participants was resolved by

TABLE 1
**Demographic characteristics of new Asian immigrants (n = 414)**

| | ED use n = 30 | | | No ED use n = 384 | | | | |
|---|---|---|---|---|---|---|---|---|
| **Variables** | **Mean** | **SD** | **n (%)** | **Mean** | **SD** | **n (%)** | $\chi^2/t$ | ***P*** |
| Sex | | | | | | | .29 | 0.59 |
| Female | | | 17 (56.7) | | | 198 (51.6) | | |
| Male | | | 13 (43.3) | | | 186 (48.4) | | |
| Age | 34.3 | 13.4 | | 32.7 | 10.5 | | −0.75 | 0.45 |
| 15–30 y | | | 16 (53.3) | | | 191 (49.7) | | |
| 31–44 y | | | 11 (36.7) | | | 147 (38.3) | | |
| 45–64 y | | | 1 (3.3) | | | 41 (10.7) | | |
| ≥65 y | | | 2 (6.7) | | | 5 (1.3) | | |
| Educational level, n = 397 | | | | | | | 1.48 | 0.48 |
| Under bachelor's degree | | | 14 (50.0) | | | 166 (45.0) | | |
| Bachelor's degree | | | 10 (35.7) | | | 113 (30.6) | | |
| Master's degree or above | | | 4 (14.3) | | | 90 (24.4) | | |
| Annual total income, n = 361 | | | | | | | 0.05 | 0.82 |
| 0 income | | | 6 (25.0) | | | 69 (20.5) | | |
| 1–30,000 NZD | | | 6 (25.0) | | | 107 (31.8) | | |
| 30,001–60,000 NZD | | | 8 (33.3) | | | 120 (35.6) | | |
| ≥60,001 NZD | | | 4 (16.7) | | | 41 (12.1) | | |
| Employment, n = 410 | | | | | | | 0.05 | 0.82 |
| Working in paid employment | | | 18 (60.0) | | | 236 (62.1) | | |
| Not working (looking for a job, retired, a homemaker, or full-time student) | | | 12 (40.0) | | | 144 (37.9) | | |
| Chronic pain, yes, n = 29 | | | 6 (20.0) | | | 23 (6.0) | 8.39 | 0.01 |
| Asthma, yes, n = 25 | | | 6 (20.7) | | | 19 (4.9) | 11.75 | 0.005 |
| Hypertension, yes, n = 25 | | | 6 (20.0) | | | 19 (5.0) | 11.02 | 0.006 |
| Diabetes, yes, n = 14 | | | 3 (10.0) | | | 11 (2.9) | 4.30 | 0.04 |
| Anxiety, yes, n = 4 | | | 2 (0.5) | | | 2 (6.7) | 5.36 | 0.03 |
| BMI, n = 382 | 26.9 | 3.6 | | 24.9 | 4.3 | | −2.77 | 0.01 |
| Waist measurement, n = 378 | 88.8 | 12.0 | | 83.7 | 11.9 | | −2.02 | 0.04 |
| Perceived health status, n = 339 | 40.3 | 3.8 | | 42.2 | 2.4 | | 3.27 | 0.001 |
| Distress, n = 408 | 3.9 | 6.7 | | 2.1 | 3.7 | | −2.35 | 0.02 |

NZD, New Zealand dollar; BMI = body mass index.

a consensus discussion with the authors. The subset of Asian population was used for statistical analyses.

## DATA ANALYSIS

Descriptive statistics, such as means, frequencies, percentages, and SDs, were used for describing the distributions of all variables. The chi-square test and the independent *t* test were adopted to test the differences between ED users and non-ED users. Moreover, univariate and multivariate logistic regression analyses were employed to determine the most high-risk factors associated with ED use in the new Asian immigrants in New Zealand; $P < 0.05$ was considered significant in this study. All data analyses were

TABLE 2
**Univariate and multivariate logistic regression analysis (n = 414)**

| Variables | Crude OR | 95% CI | Adjusted OR | 95% CI |
|---|---|---|---|---|
| Asthma (ref: no) | **5.01**† | **1.83-13.76** | **5.29*** | **1.26-22.24** |
| Diabetes (ref: no) | 3.75 | 0.99-14.24 | 5.53 | 0.41-75.22 |
| Chronic pain (ref: no) | **3.92**† | **1.46-10.55** | 1.12 | 0.17-7.35 |
| Anxiety (ref: no) | **13.64**† | **1.85-100.52** | 4.05 | 0.15-107.08 |
| Hypertension (ref: no) | **4.78**† | **1.75-13.07** | 2.84 | 0.55-14.77 |
| BMI | **1.10*** | **1.02-1.19** | 1.13 | 0.93-1.37 |
| Waist measurement | **1.03*** | **1.00-1.07** | 0.99 | 0.92-1.06 |
| Perceived health status (SF-12) | **0.79**† | **0.69-0.92** | **0.81*** | **0.66-0.99** |
| Distress (K10) | **1.07**† | **1.01-1.15** | 1.00 | 0.89-1.13 |

Statistically significant results as $P < 0.05$ are in bold.
OR, odds ratio; CI, confidence interval; BMI, body mass index; SF-12, Short-Form 12-Item Health Survey; K10, Kessler Psychological Distress Scale.
* $P < 0.05$.
† $P < 0.01$.

performed by Statistics Analysis System version 9.4 (SAS Institute). No survey weights were applied.

### ETHICS

The New Zealand Health and Disability Multi-Region Ethics Committee granted approval for the NZHS (MEC/10/10/103). For this current secondary data analysis, no further ethical approval was required, as data were deidentified from the CURFs requested from Statistics New Zealand, and data sources were duly acknowledged.

## Results

A total of 414 participants were identified as new Asian immigrants on the basis of the selection criteria. From this group, 30 who reported they have visited the emergency department within the past year (ED users) and 384 who did not attend the emergency department within the past year (non-ED users) were used in the final analyses. The Figure presents the flow chart for participant selection in this study. Among the 414 participants, 30 (7.2%) went to the emergency department in the past 12 months, 215 (51.9%) were men, ages were from 15 to 84 years, with a mean age of 32.85 years (SD = 10.7). A total of 180 participants (43.5%) had attained a bachelor's degree, the annual total income of most participants was 30,001-60,000 New Zealand dollar (35.5%), and most of the participants were working in paid employment (62.0%). ED users and non-ED users were compared in relation to demographic characteristic and other health survey items in Table 1.

To assess the important factors associated with ED use among new Asian immigrants, the variables of health survey were tested by univariate and multivariate logistic regression analyses. Results from the univariate logistic regression model showed that asthma, chronic pain, anxiety, hypertension, BMI, waist measurement, perceived health status, and anxiety and depression were associated with a significantly increased likelihood to visit the emergency department. The multivariate logistic regression analysis revealed that asthma (adjusted odds ratio = 5.29, 95% confidence interval, 1.26-22.24) and perceived health status (adjusted odds ratio = 0.81, 95% confidence interval, 0.66, 0.99) were significant factors associated with ED use among new Asian immigrants (Table 2.) A post hoc power analysis was carried out using G*power software (version 3.1). A nonsignificant variable (history of diabetes) in the logistic regression model was chosen, and the results demonstrated a power of 60% with the current sample size.

## Discussion

The current secondary analysis of NZHS data examined the factors associated with ED use of new Asian immigrants in New Zealand from 2016 to 2017. With the increasing population of Asians in New Zealand and the recent arrivals of immigrants from Asia, it is important to understand specific cohorts of the Asian populations in terms of their health service uses.[10,14] From the present study, the presence of chronic conditions was a major factor associated with ED use among new Asians immigrants. The demographic profile of new Asian immigrants in New Zealand such as age, sex, and education levels demonstrated significant differences between

ED users and non-ED users. The same pattern was noted among Asian immigrants in the United States with age as the only factor associated with ED visits among many other demographic indicators.[26] In the present study, there was adequate statistical power to detect asthma and perceived health status as major factors associated with ED use.

Asthma among new Asian immigrants in New Zealand could be linked to the prevalence and increasing incidence of asthma in Asian regions.[27] New Asian immigrants might have been diagnosed with asthma just before immigrating to New Zealand. Within New Zealand immigration health requirements, asthma is not one of those specific conditions listed for serious consideration on visa applications,[6] possibly because of its highly preventable nature. However, long-term management for asthma requires medications such as inhalers, to which new immigrants may not have access, hence accessing emergency care with asthma episodes. In addition, there are known lower enrollment rates of Asian peoples in New Zealand to Primary Health Organizations.[28,29] Moreover, factors such as financial costs for doctors' prescriptions influence medication access and use among immigrants in New Zealand,[30] which could potentially have resulted in ED use of Asian–New Zealanders with asthma.

New Zealand hospital admission rates owing to asthma were at their highest in 2015, which were 6 per 1,000 population.[31] Whereas asthma was found to be a significant factor associated with new Asian immigrants' ED use, asthma incidence in New Zealand is common in children. The Asthma Respiratory Foundation New Zealand–Adult Asthma Guidelines outlined the criteria for hospitalization referrals and predischarged considerations for asthma patients. With the referral to hospitalization, social issues such as "living alone, socially isolated, and psychosocial problems" were one of the criteria.[32] The guideline's recognition of social issues in relation to asthma management has similar implications to new immigrants in New Zealand, who might have some issues with accessing and understanding the New Zealand health care system. It is imperative to consider new immigrants as potentially isolated groups, which can be identified and assessed during ED presentations.

The perceived health status was a significant factor associated with ED use among new Asian immigrants. The self-report section of the NZHS reported physical and mental health dimensions of the perceived health status scale. New Asian immigrants who reported high-perceived health status were less likely to visit the emergency department. These findings are similar to the study on Chinese immigrants in the US, in which poor-perceived health status and existing chronic conditions were associated with higher rates of ED visits.[19] Whereas the physical components relating to the chronic conditions were identified as significant factors, a heavier weight can be interpreted within the mental health dimensions of the perceived health status. This was evident with the significant factors identified in this secondary analysis relating to mental health aspects such as the anxiety and distress scales. Previous studies reported that the frequency of ED use is associated with more severe mental health issues, and ED presentations owing to mental health conditions are increasing.[33-35] One possible reason is that new immigrants from Asia are being challenged by social changes such as health care system differences, language, and cultural views that affect their day-to-day lives in New Zealand.[20] The experience of cultural conflicts from changing dynamics of Asian immigrant families in New Zealand could result in a symptomatic conversion of anger and frustration.[36] Internationally, it has been reported that low levels of acculturation and experiences of discrimination lead to higher depressive symptoms in Korean immigrants in the US.[37] These challenges may result in anxiety and some emotional distress, resulting in new Asian immigrants' presentations in New Zealand emergency departments.

The present study had several strengths. This was the first secondary data analysis exploring ED use among new Asian immigrants in New Zealand. Moreover, the NZHS is a national survey that targeted all ages of the population with a statistically rigorous sampling method. It can be considered as the most representative database, and many studies discussing different public health issues use the NZHS database.[38–40]

## Limitations

The main limitation for this analysis was the nature of using secondary data representing a single calendar year. The Asian sample in the NZHS was predominantly Chinese and Indian Asian subgroups. With the increasing diversity of Asian population in New Zealand, particularly with the new immigrants from the Philippines, the Asian ethnicity category needs to be expanded for accuracy of reporting Asian health profiles and health care access. Owing to the small sample size, the population weights used in a complex survey design were not applied in our analysis. The sample size did not provide adequate power to test all factors associated with ED use. For example, this study only achieved a power of 60% to test a history of diabetes in this model. Replication of our study in additional years and settings is warranted.

## Implications for Emergency Nurses

Practicing emergency nurses worldwide care for patients who are more vulnerable because of their recent immigration status. Nurses and clinicians should recognize that

new immigrants may be likely to access emergency care because of a combination of health and psychosocial issues. Many new immigrants who are experiencing challenges in navigating the health care system, such as not having their own family doctor, are more likely to access emergency departments as an immediate solution for every health issue. Asthma, although an acute and preventable condition, requires long-term management that may be affected by the challenges and experiences of immigration. Recognizing these concerns enables emergency nurses to provide clear and guided referral toward primary health care services available in the host country.

At a policy level, identifying the factors associated with ED use has implications to health policies, particularly in the delivery of public health services in host countries. From the findings of this study, the salient feature common between the 2 significant factors—asthma and perceived health status—is the influence of subjective physical and psychosocial status to using emergency care. From this study, high perceptions of perceived health status while living in the host country were dominated by mental health and well-being indicators and predicted lower chances for ED use. This suggested the link of positive settlement and adjustment of immigrants and their use of available health services.

## Conclusions

This secondary data analysis revealed that factors such as chronic pain, anxiety, hypertension, BMI and waist measurement, and distress are associated with ED use. Furthermore, asthma and perceived health status are the 2 key factors associated with ED use among new Asian immigrants in New Zealand**.** The factors associated with ED use among new Asian immigrants in New Zealand encompasses both chronic health conditions and mental health indicators.

## Acknowledgments

We would like to acknowledge the participants in the 2016-2017 New Zealand Health Survey and Statistics New Zealand and the Ministry of Health for assisting with microdata access.

## Author Disclosures

Conflicts of interest: none to report.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.07.011.

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**Submissions** to this column are encouraged and may be submitted at jenonline.org. Authors are encouraged to contact Section Editors
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## Appendix

SUPPLEMENTARY TABLE
**Variables and original survey questions in the New Zealand Health Survey**

| Variables | Original survey questions | Description |
|---|---|---|
| Demographic characteristics | | |
| Gender | You are male / female…? | 1) Male<br>2) Female |
| Age | Which of these age groups do you belong to? | 1) 15–19 years<br>2) 20–24 years<br>3) 25–34 years<br>4) 35–44 years<br>5) 45–54 years<br>6) 55–64 years<br>7) 65–74 years<br>8) 75+ years |
| Educational level | What is your highest completed qualification? | 0) None<br>1) National Certificate level 1<br>2) National Certificate level 2<br>3) National Certificate level 3<br>4) National Certificate level 4<br>5) Trade Certificate<br>6) Diploma or Certificate level 5<br>7) Advanced Trade Certificate<br>8) Diploma or Certificate level 6<br>9) Teachers Certificate / Diploma<br>10) Nursing Diploma<br>11) Bachelor<br>12) Bachelor Hons<br>13) Postgraduate Certificate / Diploma<br>14) Masters Degree<br>15) PhD<br>77) Other [Specify] _____ |
| Annual total income | What is the total income that you yourself got from all sources, before tax or anything was taken out of it, in the last 12 months? Please read out the number next to the income group. | 1) Loss<br>2) Zero income<br>3) $1 – $5,000<br>4) $5,001 – $10,000<br>5) $10,001 – $15,000<br>6) $15,001 – $20,000<br>7) $20,001 – $25,000<br>8) $25,001 – $30,000<br>9) $30,001 – $35,000<br>10) $35,001 – $40,000<br>11) $40,001 – $50,000<br>12) $50,001 – $60,000<br>13) $60,001 – $70,000<br>14) $70,001 – $100,000<br>15) $100,001 – $150,000<br>16) $150,001 or more |

*continued*

SUPPLEMENTARY TABLE
**Continued**

| Variables | Original survey questions | Description |
|---|---|---|
| Employment status | Which of these statements best describes your current work situation: | 1) Working in paid employment (includes self-employment)<br>2) Not in paid work, and looking for a job<br>3) Not in paid work and not looking for a job (for any reason, such as being retired, a homemaker, caregiver, or full-time student)<br>77) Other [Specify] _____ |
| Diseases and symptoms | | |
| Anxiety | Have you ever been told by a doctor that you have anxiety disorder? This includes panic attacks, phobia, post-traumatic stress disorder, and obsessive compulsive disorder? | 1) Yes<br>2) No |
| Asthma | Have you ever been told by a doctor that you have asthma? | 1) Yes<br>2) No |
| Chronic pain | Do you experience chronic pain? This is pain that is present almost every day, but the intensity of the pain may vary. Please only include pain that has lasted, or is expected to last, for more than six months. | 1) Yes<br>2) No |
| Diabetes | Have you ever been told by a doctor that you have diabetes? | 1) Yes<br>2) No |
| Hypertension | Have you ever been told by a doctor that you have high blood pressure? | 1) Yes<br>2) No |
| Health measurements | | |
| Height | Please stand with your back to the door. Put your feet together and move them back until your heels touch the door. Stand up straight and look straight ahead.<br>1st reading 000.0 (cm) (range 60.0cm–230.0cm) | |
| Weight | Wait until it turns zero. Please step onto the centre of the scale with your weight on both feet. Relax [take reading]. Thank you. You can step off now.<br>1st reading 000.0 (kg) (range 10.0kg–210.0kg) | |
| Waist Circumference | Please stand in a relaxed position. Please take the end of the tape, pass it around your waist and hand it back to me. Please help me to position the tape at the level of your waist. Good, now just breathe normally [take measurement at end of breath out]. Thank you.<br>1st reading 000.0 (cm) (range 10.0cm–200.0cm) | |
| Perceived health status | | |
| SF-12v2 SF-12v2™ Health Survey © 1992, 2003 by Health Assessment Lab, Medical Outcomes Trust and Quality Metric Incorporated. All rights reserved. SF-12® is a registered trademark of Medical Outcomes Trust. (IQOLA SF-12v2 Standard, English (New Zealand), 7/03). | 1. In general, would you say your health is...[Reverse coded item] | 1) Excellent 2) Very good<br>3) Good 4) Fair<br>5) Poor |

*continued*

SUPPLEMENTARY TABLE
**Continued**

| Variables | Original survey questions | Description |
|---|---|---|
| | 2. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf. Does your health now limit you a lot, limit you a little, or not limit you at all? | 1) Yes, limited a lot<br>2) Yes, limited a little<br>3) No, not limited at all |
| | 3. Climbing several flights of stairs. Does your health now limit you a lot, limit you a little, or not limit you at all? | 1) Yes, limited a lot<br>2) Yes, limited a little<br>3) No, not limited at all |
| | 4. During the past 4 weeks, how much of the time have you accomplished less than you would like as a result of your physical health? | 1) All of the time<br>2) Most of the time<br>3) Some of the time<br>4) A little of the time<br>5) None of the time |
| | 5. During the past 4 weeks, how much of the time were you limited in the kind of work or other regular daily activities you do as a result of your physical health? | 1) All of the time<br>2) Most of the time<br>3) Some of the time<br>4) A little of the time<br>5) None of the time |
| | 6. During the past 4 weeks, how much of the time have you accomplished less than you would like as a result of any emotional problems, such as feeling depressed or anxious? | 1) All of the time<br>2) Most of the time 3) Some of the time 4) A little of the time 5) None of the time |
| | 7. During the past 4 weeks, how much of the time did you do work or other regular daily activities less carefully than usual as a result of any emotional problems, such as feeling depressed or anxious? | 1) All of the time<br>2) Most of the time<br>3) Some of the time<br>4) A little of the time<br>5) None of the time |
| | 8. During the past 4 weeks, how much did pain interfere with your normal work, including both work outside the home and housework? [Reverse coded item] | 1) Not at all<br>2) A little bit<br>3) Moderately<br>4) Quite a bit<br>5) Extremely |
| | 9. How much of the time during the past 4 weeks have you felt calm and peaceful? [Reverse coded item] | 1) All of the time<br>2) Most of the time<br>3) Some of the time<br>4) A little of the time<br>5) None of the time |
| | 10. How much of the time during the past 4 weeks did you have a lot of energy? [Reverse coded item] | 1) All of the time<br>2) Most of the time<br>3) Some of the time<br>4) A little of the time<br>5) None of the time |
| | 11. How much of the time during the past 4 weeks have you felt downhearted and depressed? | 1) All of the time<br>2) Most of the time<br>3) Some of the time<br>4) A little of the time<br>5) None of the time |

*continued*

SUPPLEMENTARY TABLE
**Continued**

| Variables | Original survey questions | Description |
|---|---|---|
| | 12. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities like visiting with friends or relatives? Has it interfered? | 1) All of the time<br>2) Most of the time<br>3) Some of the time<br>4) A little of the time<br>5) None of the time |
| Distress | | |
| K10<br>The next questions are again about how you have been feeling during the past 4 weeks. Some of these questions are similar to earlier questions, but we need to ask them again. | 1. During the past 4 weeks, how often did you feel tired out for no good reason - would you say all of the time, most of the time, some of the time, a little of the time, or none of the time?<br>2. During the past 4 weeks, how often did you feel nervous - all of the time, most of the time, some of the time, a little of the time, or none of the time?<br>3. During the past 4 weeks, how often did you feel so nervous that nothing could calm you down?<br>4. During the past 4 weeks, how often did you feel hopeless?<br>5. During the past 4 weeks, how often did you feel restless or fidgety?<br>6. How often did you feel so restless you could not sit still?<br>7. During the past 4 weeks, how often did you feel depressed?<br>8. How often did you feel so depressed that nothing could cheer you up?<br>9. During the past 4 weeks, how often did you feel that everything was an effort?<br>10. During the past 4 weeks, how often did you feel worthless? | 1) All of the time<br>2) Most of the time<br>3) Some of the time<br>4) A little of the time<br>5) None of the time |

Journal of
EMERGENCY NURSING

# Evaluation of a Nurse Pediatric Emergency Care Coordinator–Facilitated Program on Pediatric Readiness and Process of Care in Community Emergency Departments After Collaboration With a Pediatric Academic Medical Center

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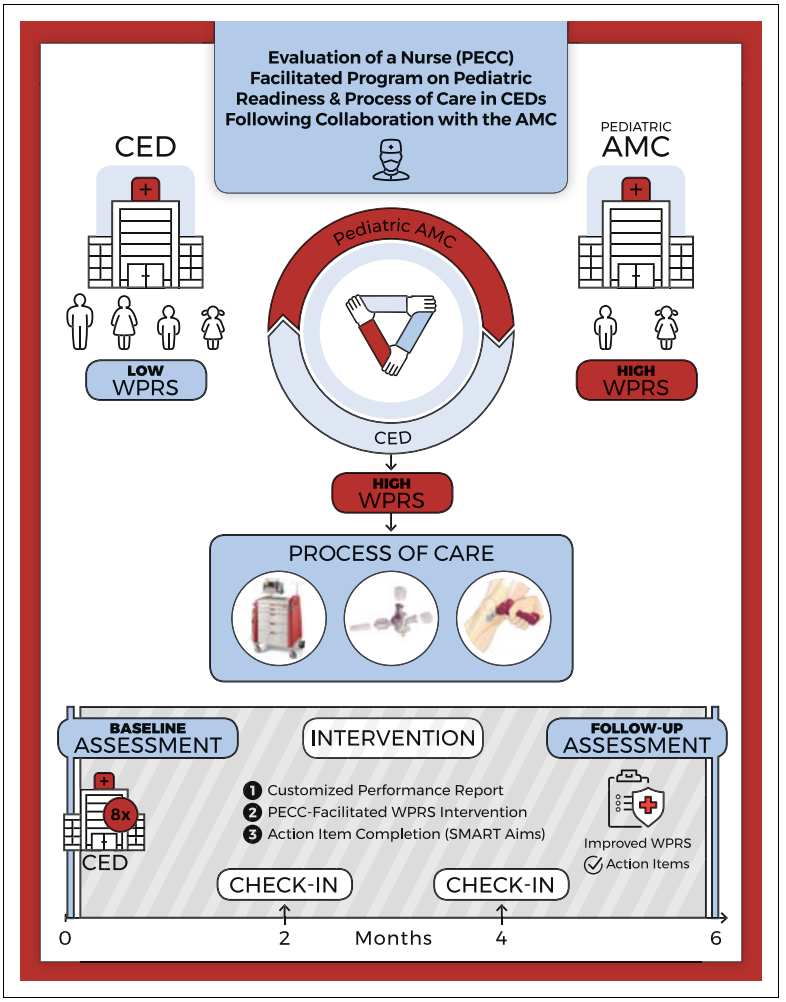




J Emerg Nurs 2021;47:167-80.0099-1767
http://dx.doi.org/10.1016/j.jen.2020.06.006

# Evaluation of a Nurse Pediatric Emergency Care Coordinator–Facilitated Program on Pediatric Readiness and Process of Care in Community Emergency Departments After Collaboration With a Pediatric Academic Medical Center

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**Section Editor:** Patricia Kunz Howard, PhD, RN, CEN, CPEN, TCRN, NE-BC, FAEN, FAAN

### Contribution to Emergency Nursing Practice

- A majority of acutely ill children are seen in community emergency departments that have lower weighted pediatric readiness scores than those of pediatric emergency departments; therefore, readiness improvement initiatives are needed.
- The main finding of this work is the improvement in weighted pediatric readiness scores and the process of care in a set of community emergency departments after collaboration with a pediatric academic medical center.
- Key implications for emergency nursing practice found in this article are the central role of a nurse pediatric emergency care coordinator in pediatric emergency readiness improvement and the potential role of simulation-based collaborative initiatives between community emergency departments and a pediatric academic medical center in optimizing pediatric readiness efforts.

## Introduction

Each year, more than 30 million ill and injured children are cared for in 5,000 emergency departments in the United States, of which most children access care in 1 of 4,500 community emergency departments (CEDs) that are not solely prepared to care for children.[1,2] These CEDs vary in terms of the total volume of pediatric patients where many of them care for fewer than 5 children a day. In 2006, the Institute of Medicine described pediatric emergency care in the US as "uneven."[3] In response to this report, key stakeholders—including the American Academy of Pediatrics, the American College of Emergency Physicians, and the Emergency Nurses Association—developed Joint Policy Statement Guidelines (JPSG) for the emergency care of children.[4-6] Compliance with these guidelines forms the basis for the term "pediatric emergency readiness."

In 2013, the 3 stakeholder groups, along with the federal Emergency Medical Services for Children program, formed a coalition called the National Pediatric Readiness Project as a multiphase quality initiative to ensure that all emergency departments have the essential resources and guidelines to provide high-quality care to pediatric

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patients.[5] In the first phase, the pediatric readiness survey was conducted across 4,137 US emergency departments and noted a median 69/100 weighted pediatric readiness score (WPRS), which helped to identify gaps and disparities in the WPRS among emergency departments where lower-volume emergency departments had lower WPRS than higher-volume emergency departments.[5] The main gaps included but were not limited to deficiencies in the presence of pediatric emergency care coordinators (PECCs) and in the development of a quality improvement plan and pediatric patient safety and disaster plans.

These disparities in pediatric readiness have reflected on the quality of care provided in both simulated and clinical settings. Emergency departments with lower WPRS were less likely to comply with evidence-based treatment guidelines for high-acuity conditions, including cardiac arrest,[7] sepsis,[8] and seizure.[9,10] Recently, a few studies reported on the disparities in health outcomes where presentation to an emergency department with lower WPRS was associated with an increased risk of death for children with critical illness, making efforts to improve pediatric readiness in emergency departments more necessary.[11,12]

In previous reports, the most common reasons for low WPRS were the lack of implementation of ED policies dedicated to children and the absence of a PECC.[5] A nurse PECC is defined as a registered nurse who possesses special interest, knowledge, and skill in the emergency nursing care of children through clinical experience and has demonstrated competence in critical thinking and clinical skills. These nurse PECCs would work collaboratively with physician PECCs to promote the preparedness of their emergency department to care for children.[5,6] Despite the JPSG statement that all emergency departments should designate a PECC,[6] only 59% of the emergency departments had a nurse PECC, and 48% had a physician PECC.[5] Furthermore, the updated JPSG highlights the importance of collaboration between CEDs, their designated PECC, and pediatric academic medical centers (AMCs) to enhance pediatric emergency readiness to ensure optimal health outcomes for all children in the US.[13] To achieve this goal, AMCs need to expand their network to support community hospitals and maintain a continuum of care initiated in the CED.

We previously reported a collaborative improvement program between a state pediatric AMC and a spectrum of CEDs to improve pediatric emergency readiness.[14] Our initial iteration included a baseline assessment of the WPRS and in situ simulation–based measurement of the process of care that was followed by a standardized "assessment report" as a guide for improvement. In each CED, a pediatric champion (a physician or nurse) worked independently to accomplish local improvement. These champions functioned as nurse PECCs and were supported by the AMC and provided with the necessary resources and materials, but they worked voluntarily and were not formally designated as PECCs in their CEDs; nor did they have regular interactions with the AMC team. Despite the 15% improvement in the WPRS, wide variations were noted in improvement because some champions did not complete their assigned items, given the lack of a prescribed intervention with the study team and limited access to improvement resources. This has highlighted recurrent deficiencies and themes in the process of care provided, such as failure to rapidly establish intraosseous (IO) access or appropriate weight-based volume fluid resuscitation in the context of a pediatric patient presenting with shock. The deficiencies identified during our WPRS assessment were system gaps that had a strong potential to be associated with poor outcomes if performed in an actual clinical setting and provided strong targeted action items for our next iterative intervention.

The objective of the current study was to update and evaluate the effectiveness of our established WPRS model and the process of care across a set of new CEDs. We hypothesize that a collaborative program between a pediatric AMC and CEDs and designating a nurse PECC in each CED will (1) improve the structure of care as measured by the WPRS and (2) improve the process of care provided in these CEDs by completing these targeted action items.

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J Emerg Nurs 2021;47:167-80.
Available online 6 October 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.06.006

## Methods

### STUDY DESIGN

We conducted a prospective pre- and postinterventional study using in situ simulation to evaluate our updated collaborative model in improving the WPRS and the process of care across a set CEDs. Process of care, defined as an evidence-based action or intervention performed during the delivery of patient care, was assessed in a simulated setting in the participating CEDs. The project was exempted from review by the Indiana University as the pediatric AMC for this work.

### INSTRUMENT

The WPRS was developed as a 55-question Web-based assessment (http://www.pedsready.org) on the basis of certain sections of the 2009 guidelines by a subpanel of experts from the national steering committee who developed the weighting criteria. Piloting and further weighting of the assessment items were conducted in California, given its diverse patient population. On the basis of the results of the study by the subpanel of experts and the results of the California Pediatric Readiness Project, 24 of the questions were weighted in the national assessment to generate an overall WPRS for each hospital. The WPRS was then normalized to a 100-point scale, where a higher score equals higher pediatric readiness. In 2013, the most comprehensive evaluation of pediatric readiness of US emergency departments revealed that low-volume emergency departments had a median WPRS of 61.4 points (interquartile range [IQR], 49.5-73.6); medium-volume emergency departments, 69.3 points (IQR, 57.9-81.8); medium- to high-volume emergency departments, 74.8 points (IQR, 60.9-87.9); and high-volume emergency departments, 89.8 points (IQR, 74.7-97.2). In addition, it showed an improvement in the median WPRS from the reported 55 points in 2003 to 68.9 points in 2013.[5]

### STUDY SETTING AND POPULATION

The participating sites were 8 CEDs in the state of Indiana. These medium-volume CEDs (1,800 to 4,999 annual pediatric patients) were chosen on the basis of their geographic location and historical transfer of patients to our academic center. In addition, they represent a set of CEDs that are not affiliated with our AMC or from our previously reported collaborative projects. All site visits were scheduled in coordination with each hospital's ED director and/or manager, who served as a point person for their site. Staff were recruited to participate in the simulation sessions by the study coordinators through this point person. The participating CEDs agreed to identify a nurse PECC to serve as the site contact and to coordinate all phases of the intervention with the AMC team. Each CED signed a letter of agreement, which outlined the program's mission/vision and set expectations before enrollment.

### STUDY PROTOCOL

Our project was conducted over 12 months. The project consisted of 3 phases: (1) baseline on-site assessment, (2) pediatric readiness interventions, and (3) postintervention assessment.

A logic model of this program is provided in Figure 1. The study timeline is shown in Figure 2.

#### *Baseline On-Site Assessment*

The baseline on-site assessment consisted of the following:

**On-site weighted pediatric readiness score assessment.** The WPRS consists of 6 domains outlined in the National Pediatric Readiness Project: (1) administration and coordination of care; (2) competencies for providers; (3) quality improvement; (4) patient and medications safety; (5) policies/procedures; and (6) equipment, supplies, and medications.[5] During the baseline assessment visit, an in-person WPRS was completed for each CED by the study facilitator, a registered nurse content expert in pediatric emergency care, simulation, and quality improvement from the pediatric AMC. All items in the WPRS were verified during an in-person discussion with the CED manager or director at each site. This visit involved directly examining all the scored items on the checklist across the 6 domains (locating each piece of equipment, reviewing policies/guidelines in paper or electronic form, and reviewing staffing).

**In situ simulation–based assessment.** A multiprofessional team of educators and experts in pediatric critical care medicine, pediatric emergency medicine, and pediatric critical care transport from the pediatric AMC previously formed an educator team named Pediatric Community Outreach Mobile Education. The educator team conducted baseline in situ simulation sessions.

CED participant teams were composed of 5 to 6 health care providers, including emergency medicine

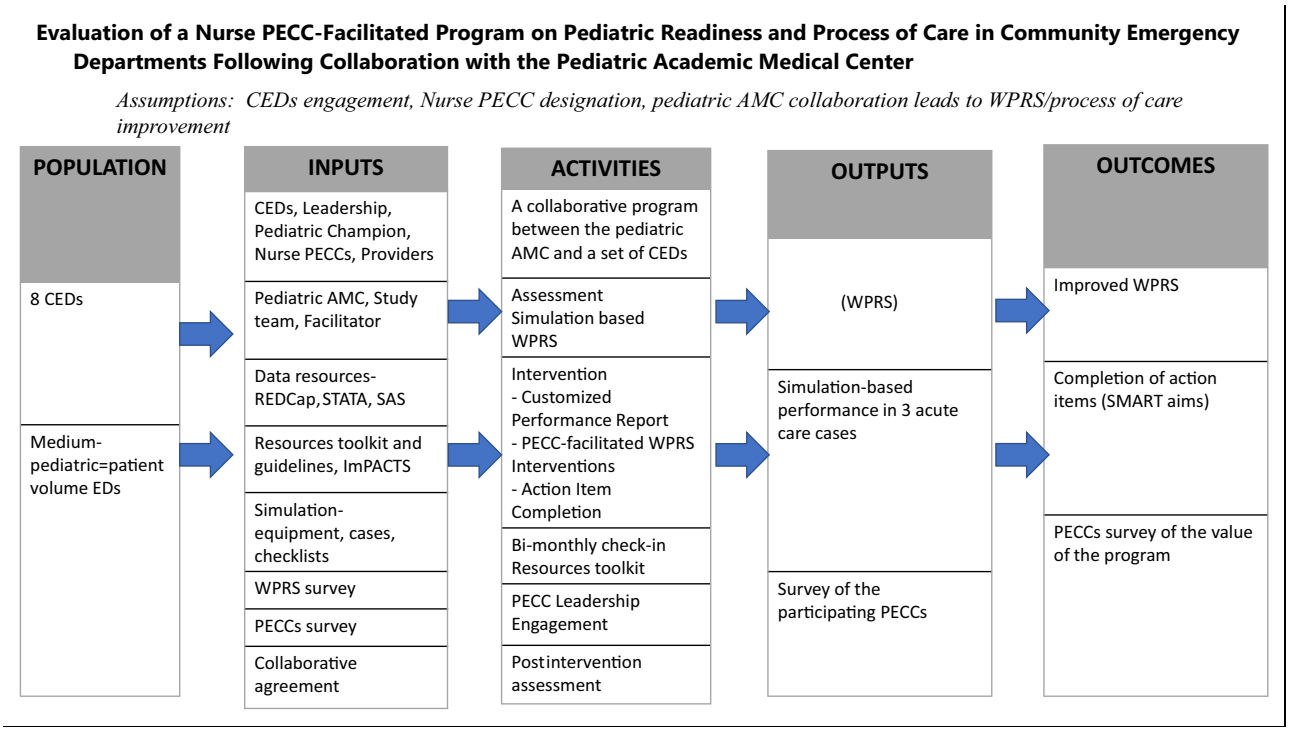


FIGURE 1

Logic model. PECC, pediatric emergency care coordinator; CED, community emergency department; WPRS, weighted pediatric readiness score; AMC, academic medical center; ImPACTS, Improving Pediatric Acute Care Through Simulation; SMART, specific, measurable, achievable, relevant, and time-sensitive.

physicians, nurses, respiratory therapists, and other members. The participants were protected from any clinical responsibilities during the simulations and debriefings. Each team participated in a 3-hour in situ simulation session that included a 10-day-old neonate with critical coarctation of the aorta, a 6-year-old child presenting with status epilepticus, and a 6-month-old infant presenting with a nonaccidental head injury. All sessions were conducted in the actual CED resuscitation bay using its existing resources. Each session began with a standardized orientation, including an introduction to the team, the mission of the project, and the day's agenda. The participants were oriented to the functionality of the high-fidelity simulators (SimJunior and SimBaby, Laerdal Medical). Laboratory data were provided on preprinted laminated cards on request, including standard point-of-care testing and relevant radiographs. After each simulation, the educators scored all the teams using critical action checklists (Figure 3).

Content validation of the simulation checklists was obtained using an approach similar to the one used in our previously published work.[14] All simulation materials are provided in Supplementary Appendix 1.

*Pediatric Readiness Interventions*

This was conducted over 6 to 8 months and involved 3 phases: (1) Customized performance report, (2) PECC-facilitated WPRS interventions, and (3) action item completion.

**Customized performance report.** Within 2 weeks after the baseline assessment conducted by the study team, each CED site designated a registered nurse PECC to execute selected recommendations from the JPSG list.[13] The designated PECC at each CED received a customized report that included a summary of its WPRS and simulation performance data in comparison with other CEDs and a description of the prescribed interventions and the action item(s) that the PECC would implement over the subsequent 6 months. Each CED had its customized report to address its score and guide its improvement efforts throughout the project. Each PECC, CED medical director, and the study facilitator reviewed this performance report within 2 weeks of the baseline assessment and selected 1 action item for improvement. An example of the

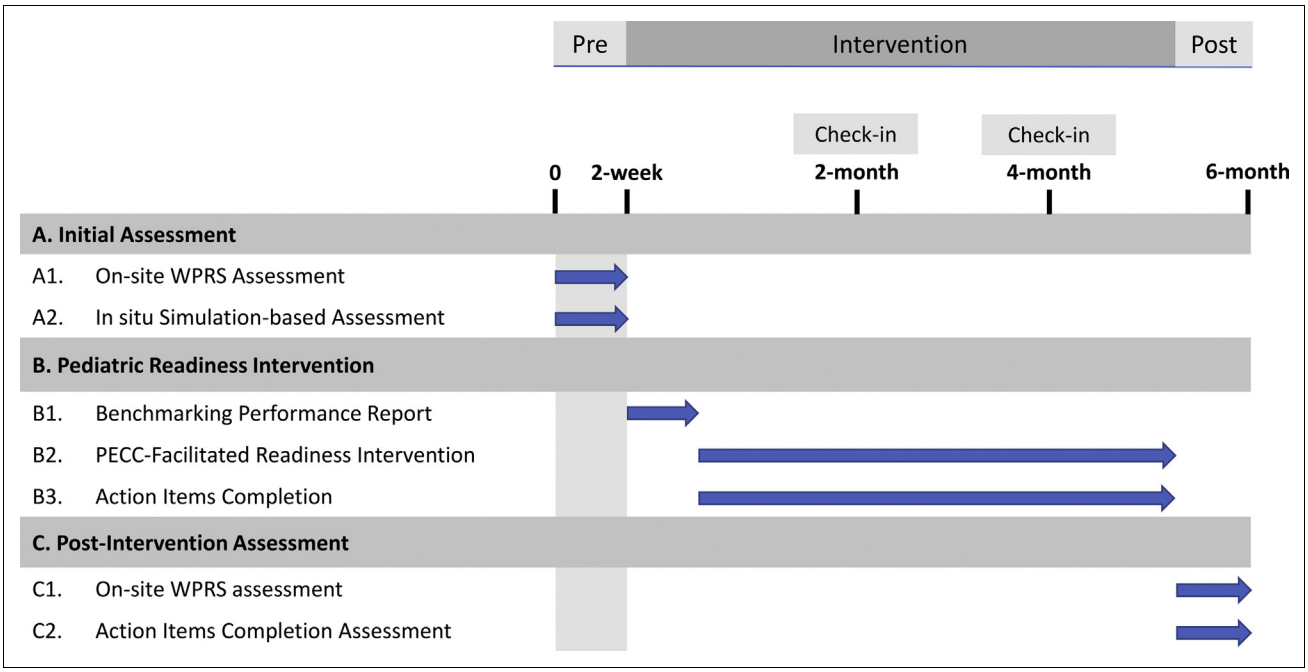


FIGURE 2

Study timeline. PECC, pediatric emergency care coordinator; WPRS, weighted pediatric readiness score.

customized performance report is provided in Supplementary Appendix 2.

**Pediatric emergency care coordinators-facilitated weighted pediatric readiness score interventions.** On designation of a nurse PECC at each participating CED, an average of 2 hours per week was dedicated to each PECC to this role, during which each PECC worked to achieve improvement in at least 1 of the 6 total domains. The PECCs had access to the needed resources and a detailed schedule of standardized bimonthly check-ins with the study facilitator throughout the 6-month intervention. During these check-ins, the PECCs reviewed achievements of the progress made in the WPRS and the plan for the next 2 months and were provided with any additional resources as needed. All PECCs were also encouraged to reach out to the study facilitator outside the "check-in" if needed. Examples of the PECCs' activities are described in the Supplementary Appendix 3.

**Action item completion.** We had compiled a list of action items for improvement in the CEDs on the basis of our existing program. This led to the development of specific, measurable, achievable, relevant, and time-sensitive (SMART) aims that linked the WPRS to the process of care as observed during the simulated sessions. Each SMART aim included resources and a timeline for completion of the individual action item by the designated PECC. The execution of aims was conducted in a simulated setting and facilitated by each site PECC. Every 2 months, each PECC and study facilitator interacted to review the progress of the selected action item. These interactions addressed any issues affecting the successful completion of the action item and ensured provision of the needed resources. Action items were considered completed on the basis of the SMART aim of each action as demonstrated in Supplementary Appendix 4. Examples of these SMART aims were as follows:

Rapid fluid resuscitation using a push/pull technique: to increase the percentage of staff who could demonstrate delivery of 40 cc/kg to 60 cc/kg in less than 10 minutes using push/pull by 25% within 6 months.

IO access training: to increase the percentage of staff who could demonstrate competency in pediatric IO placement by an additional 25% within 6 months.

Weight-based dosing for resuscitation: to increase the percentage of staff who could demonstrate correct weight on the basis of dosing calculations in under 2 minutes for resuscitation medications using local resources/guidelines/tools by an additional 25% within 6 months.

Pediatric basic life support training: to increase the percentage of staff who could demonstrate greater than 75%

FIGURE 3
CED providers during the simulation sessions.

basic life support–quality score in the emergency department using local equipment/guidelines by an additional 25% within 6 months.

All action items and resources were compiled on the collaborative website and made available to the participating PECCs (https://www.impactscollaborative.com/resources). An example of a SMART action item is provided in Supplementary Appendix 5.

### *Postintervention Assessment*

Six months after the baseline assessment, the study facilitator conducted a follow-up assessment of the WPRS and the completion of the SMART aims. An on-site WPRS follow-up assessment was conducted using the same methodology used in the baseline visits. In addition, the completion of the assigned SMART aims was measured in each CED.

## MEASURES

### *Weighted Pediatric Readiness Scores*

The WPRS was measured in person using the surveys twice: once during the baseline visits and then again during the follow-up visits with an interval of 6 months between the 2 measurements.

### *Simulation-Based Performance*

The performances of the CED teams based on the simulated scenarios checklists were calculated by adding the number of correct items in each checklist. The performance was scored in real time on the basis of the number of items performed correctly, with the use of individual checklists for each scenario by 2 separate instructors who scored each checklist independently, and then the scores were discussed among these individuals until a consensus was reached. Each case performance score was calculated using equal weighting for all subcomponents and dividing by the total number of possible elements to derive a score on a scale of 0 to 100.

### *Action Items*

The completion of each action item was measured on the basis of the SMART aim; the item was considered complete after the measurable evidence as described in the study protocol. The completion status of these action items was determined by direct reporting from each PECC from the participating CEDs.

### *Surveys of Participating Pediatric Emergency Care Coordinators*

To understand the perception of PECCs regarding the value of the overall collaborative program and the potential barriers or facilitators that have contributed to the WPRS improvement, we surveyed these PECCs using a 5-question survey that used a 5-point Likert scale (eg, 5 = "strongly agree" and 1 = "strongly disagree"), followed by the comments section. The comments section was used to encourage the PECC to provide a detailed description of the potential facilitators/barriers from the PECC's perspective. These forms were filled and collected on the same day the follow-up WPRS was measured.

### *Statistical Analysis*

A Microsoft Excel version 14.0 (Microsoft Corporation) spreadsheet was created for all data entry (WPRS and simulation-based performance). All analytic assumptions were verified, and all analyses were performed using SAS version 9.4 (SAS Institute Inc). Basic descriptive statistics were given as frequencies (percentages) for categorical variables and medians (IQR) for continuous variables. Values are given as means (SD) and medians (IQR). Changes in domain scores were analyzed using the Wilcoxon signed-rank nonparametric test to account for the paired aspect of the data; owing to many of the domains having results that were nonlinear, they could not be transformed into linearity.

## Results

### WEIGHTED PEDIATRIC READINESS SCORES

Sixteen interprofessional teams from 8 medium–pediatric-volume CEDs participated in this study (Table 1). The average time between the initial and follow-up assessments across all CEDs was 6 months. The WPRS significantly improved by 16.7 points from the initial assessment (mean [SD] 53.82 [5.12]) to the follow-up assessment (mean [SD] 70.52 [4.25]). Significant improvement was noted in the administration and coordination of care by 8.25 points (out of a total of 19 points; $P = 0.008$); competencies for providers by 3.75 points (out of a total of 10 points; $P = 0.016$); patient and medication safety by 2.64 points (out of a total of 14 points; $P = 0.004$); and equipment, supplies, and medications by 1.42 points (out of a total of 33 points; $P = 0.004$). Detailed results of the improvements in each WPRS domain are presented in Table 2.

TABLE 1
**Community emergency departments and team characteristics**

| Team characteristics | Total number (%) |
|---|---|
| Number of teams | 16 |
| Number of participants | 80 |
| Number of MDs, n (%) | 15 (18.5) |
| Number of RNs, n (%) | 54 (67.5) |
| Number of RTs, n (%) | 3 (3.7) |
| Number of others, n (%) | 8 (10.0) |
| CED characteristics | |
| Number of emergency departments | 8 |
| CED pediatric volume | |
| Medium, n (%) | 8 (100) |
| Type of CED | |
| Trauma center | 3 (37.5) |
| Affiliation with the pediatric AMC | 0 (0) |
| Presence of pediatric inpatient unit | 2 (25) |
| Initial PRS (PRS) | 53.82 (5.12) |

Data presented as n (%) or median (25th, 75th interquartile range)
MD, physician; RN, nurse; RT, respiratory therapist; CED, community emergency department; AMC, academic medical center; PRS, total number (%).

### SIMULATION-BASED PERFORMANCE

A total of 16 interprofessional teams (80 providers) participated in the simulation sessions. Of the 80 providers, 15 (18.5%) were general emergency physicians, 54 (67.7%) were registered nurses, 3 (3.7%) were respiratory therapists, and 8 (10%) were other ancillary staff. The total performance scores were 57% for nonaccidental head injury, 82% for status epilepticus, and 80% for coarctation of the aorta. None of the participating teams had 100% adherence scores for any of the scenarios. Table 3 shows the detailed simulation performance scores and checklists.

### ACTION ITEMS

Among all the action items, 4 were completed by 8 CEDs ([1] rapid fluid resuscitation using a push/pull technique, [2] IO access training, [3] weight-based dosing for resuscitation, and [4] pediatric basic life support training). The assigned PECC in each CED was the main facilitator for its ED action item. A total of 50% of these action items were completed within the 6-month intervention period, whereas 50% extended beyond the intervention period. Table 4 summarizes all action items and their related WPRS domains.

### SURVEYS OF ED SITE PEDIATRIC EMERGENCY CARE COORDINATORS

The PECCs from all participating CEDs completed the survey (Supplementary Appendix 5). The survey revealed a high degree of agreement with all the components of the survey, with 96% of the survey items receiving a "strongly agree" response. In particular, all PECCs chose the in situ simulation as the most helpful component. The comments section revealed the following themes: "This program is tremendous and is a great help and source to nonpediatrics hospitals"; "Collaborative has helped boosting the pediatric care in our ED"; "It has provided us with education/resources/tools to continue to improve our pediatric acute care"; and "We would appreciate any onsite simulations you offer or extra resources to help prepare our staff for the pediatric population."

## Discussion

Disparities in pediatric emergency readiness, the process of care, and subsequent patient outcomes exist in emergency departments across the US.[5,10,12,13,15] Efforts to address these disparities might include local and state collaborations designed to provide resources, educational materials, pediatric policies and guidelines, and appointment of PECCs.[14,16-19] A majority of the prior initiatives between pediatric AMCs and CEDs to enhance pediatric

TABLE 2
**Results of the improvement in weighted pediatric readiness score in each domain**

| Variable | Initial WPRS | Follow-up WPRS | Change | *P* value |
|---|---|---|---|---|
| Mean WPRS | 53.82 (5.12) | 70.52 (4.25) | 16.7 (2.81) | 0.004 |
| Administration and coordination of care (out of 19) | 3.56 (4.60) | 11.81 (4.15) | 8.25 (3.12) | 0.008 |
| Competencies for providers (out of 10) | 1.88 (2.42) | 5.63 (1.65) | 3.75 (2.17) | 0.016 |
| Quality improvement (out of 7) | 0 (0) | 0 (0) | 0 (0) | N/A |
| Patient and medication safety (out of 14) | 10.06 (1.16) | 12.70 (0.53) | 2.64 (0.77) | 0.004 |
| Policies and procedures (out of 17) | 8.55 (1.81) | 9.18 (1.50) | 0.64 (0.82) | 0.125 |
| Equipment, supplies, and medications (out of 33) | 29.78 (0.34) | 31.20 (0.36) | 1.42 (0.54) | 0.004 |

Values are means (SD), with *P* values from the paired signed-rank nonparametric test.
WPRS, weighted pediatric readiness score; N/A, not applicable.

emergency readiness have mainly focused on improving the WPRS. These initiatives did not assess the transfer of WPRS improvement to the process of care and were limited by the lack of measures of actionable item improvement, making the impact of their WPRS improvement on the process of care undetermined.

In this report, we describe a collaborative improvement program between the state pediatric AMC and a set of CEDs that resulted in significant improvement in pediatric readiness after the designation of a formal nurse PECC in the participating CEDs. A marked improvement was noted in the domains of administration and coordination of care; competencies for providers; patient and medication safety; and equipment, supplies, and medications. Furthermore, the PECC-facilitated improvement in the WPRS was associated with improvements in the process of care in the simulated setting as demonstrated by the completion of the action items in the participating CEDs. Our findings mirror the national guidelines that endorse the central role of a PECC in ensuring day-to-day pediatric preparedness and promoting the quality of pediatric emergency care.[6]

In this study, all participating CEDs agreed to designate a nurse PECC during the intervention period, which catalyzed the improvement not only in the WPRS, but subsequently in the execution of action items revealed during the simulation-based assessment. The PECCs were nurses who had special interest, knowledge, and skillset in the emergency care of children and served as champions in their emergency departments. This central component of our intervention allowed the designated PECCs to potentiate their roles through a formal agreement with their ED administrative entity. Furthermore, in collaboration with their CED leadership, the PECCs were successful in transforming baseline data into actionable items, which was demonstrated by the completion of the action items among the 8 participating CEDs. For example, the PECCs were in charge of promoting rapid fluid resuscitation using push/pull technique and IO access training skills among CED providers through educational sessions and pediatric mock-codes to ensure provider competency. This resulted in a marked improvement in the second domain of the WPRS (competencies for providers) that reflected the completion of all 4 action items throughout the study as highlighted in Table 4. Another example included PECCs ensuring that equipment and supplies (IO, push/pull set-up, and chest compression backboard during basic life support training) were readily available and systematically organized and restocked for the training to be conducted. This led to a marked improvement in the sixth domain (equipment, supplies, and medications), which had a positive impact on the successful completion of 3 of the relevant action items. These findings are aligned with the most recent published guidelines that recognized that the presence of a PECC is strongly correlated with improved pediatric readiness, independent from other hospital factors.[5]

In this study, the in situ simulation provided a robust tool for the assessment of the care provided in these CEDs and formed a foundation for the development of customized action plans. In situ simulation, defined as a simulation that takes place "in the actual patient care setting," can promote a high level of fidelity and realism that allows CED teams to apply their knowledge using their equipment in real clinical surroundings.[20-24] For example, the simulated coarctation case revealed that only 31% of the teams obtained blood pressure in a neonate owing to a lack of appropriate neonatal-size blood pressure cuffs, which is part of the

TABLE 3
**Detailed simulation performances and checklists**

| Checklist items | Number of teams that performed correctly (%) |
|---|---|
| Nonaccidental trauma | |
| Assess airway and breathing | 16 (100) |
| Assess circulation | 10 (52) |
| Perform neurological assessment | 9 (56) |
| Exposure | 9 (56) |
| Place IV/IO | 16 (100) |
| Send BMP to lab | 10 (52) |
| Verbalize concerns for NAT | 15 (94) |
| Verbalize concerns of increased ICP | 11 (67) |
| Applying C collar | 1 (6) |
| Verbalize the need of head CT | 14 (87) |
| Apply neuroprotective measures | 3 (18) |
| Use appropriate hyperosmolar agent | 4 (25) |
| Discuss potential need of intubation | 10 (52) |
| Notify CPS social worker | 12 (75) |
| Apply transfer guidelines | 14 (87) |
| Overall composite score of the 15 items | 57 (53, 63) |
| Status epilepticus | |
| Verbalize respiratory depression | 11 (67) |
| Begin supplemental oxygen | 16 (100) |
| Perform chin lift/jaw thrust | 10 (52) |
| Verbalize seizure onset | 16 (100) |
| Check bedside glucose | 13 (81) |
| Send BMP to lab | 10 (52) |
| Place IV/IO | 16 (100) |
| Appropriate dose of benzodiazepine | 14 (87.5) |
| Appropriate frequency of benzodiazepine used | 10 (52) |
| Appropriate second agent | 14 (87.5) |
| Verbalize the need for transfer/admit | 9 (56) |
| Overall composite score of the 11 items | 82 (73, 91) |
| Coarctation of the aorta | |
| Obtain weight | 16 (100) |
| Obtain brief history | 16 (100) |
| Perform focused exam | 6 (37.5) |
| Attach to monitor | 16 (100) |
| Obtain BP in UE/LE | 5 (31) |
| Obtain CXR | 11 (69) |
| Obtain IV access | 16 (100) |
| Obtain labs/septic workup | 13 (81) |
| Administer an initial fluid bolus | 8 (50) |
| Provide supplemental $O_2$ for hypoxemia | 16 (100) |
| Initiate prostin infusion with correct dose | 5 (31) |
| Recognize apnea | 16 (100) |
| Initiate BVM with appropriate technique | 16 (100) |
| Verbalize the need for intubation | 16 (100) |
| Verbalize/arrange need for transfer | 9 (56) |
| Overall composite score of the 15 items | 80 (70, 83) |

Values are means (SD) of proportion correct (except last line which is composite sum).
IV, intravenous infusion; IO, intraosseous infusion; BMP, basic metabolic panel; NAT, nonaccidental trauma; ICP, intracranial pressure; C collar, cervical collar; CT, computed tomography; CPS, child protective service; UE, upper extremity; LE, lower extremity; CXR, chest x-ray; $O_2$, oxygen; BVM, bag mask ventilation.

equipment and supplies domain of the WPRS. Similarly, in the simulated status epilepticus, only 52% of the teams used benzodiazepines appropriately, whereas only 6% of the teams in the nonaccidental head injury case applied the appropriate-size cervical collar, which provided a strong argument to the CED leadership to ensure that adequate attention is paid to the provider competency and availability of equipment domains of the WPRS. Our use of in situ simulation as an investigative methodology is aligned with the literature report in acute care settings.[8,23,25-27]

A unique component of our study was the customized performance report and the scheduled check-ins. This

TABLE 4
**Action item completion**

| CED site | Action item | Related WPRS domain | Completed within 6-month period | Completed overall |
|---|---|---|---|---|
| CED 1 | Rapid fluid resuscitation using push/pull technique | • Providers' competency<br>• Equipment, supplies, and medications | No | Yes |
| CED 2 | Intraosseous access training | • Providers' competency<br>• Equipment, supplies, and medications | Yes | N/A |
| CED 3 | Rapid fluid resuscitation using push/pull technique | • Providers' competency<br>• Equipment, supplies, and medications | Yes | N/A |
| CED 4 | Weight-based dosing for resuscitation | • Providers' competency<br>• Patient safety | No | Yes |
| CED 5 | Rapid fluid resuscitation using push/pull technique | • Providers' competency<br>• Equipment, supplies, and medications | No | Yes |
| CED 6 | Improved pediatric basic life support training | • Providers' competency<br>• Equipment, supplies, and medications | Yes | N/A |
| CED 7 | Weight-based dosing for resuscitation | • Providers' competency<br>• Patient safety | Yes | N/A |
| CED 8 | Intraosseous access training | • Providers' competency<br>• Equipment, supplies, and medications | No | Yes |

CED, community emergency department; WPRS, weighted pediatric readiness score; N/A, not applicable.

report, derived by simulation-based data combined with pediatric readiness assessment, provided a snapshot of each CED's performance in simulation and its WPRS, and a direct comparison with the other participating CEDs. In addition, this report was a supportive tool for the PECCs to engage the CED leadership in addressing their readiness score and it empowered them in executing the action item to promote pediatric care. The bimonthly check-ins with the study facilitator to guide the improvement process and provide resources and material served as a "platform" to create a sustainable partnership and maintain ongoing communication between the CEDs and the study team. This component likely augmented the improvement efforts in each CED, which was demonstrated by a significant increase in the follow-up WPRS compared with the initial score.

When the PECCs were surveyed, they expressed that all components of the collaborative program were valuable in the improvement process; however, the in situ simulation team was cited as the most important component of the program for their CEDs. Outreach simulation programs conducted by a pediatric AMC for their community partners have been described in the literature and been demonstrated to be a promising approach to address the disparity in care.[19,28-30] This highlights the importance of collaboration between children's hospitals and the resources inherent therein and local and regional CEDs to facilitate readiness improvement and advance the quality of care provided to pediatric patients as emphasized by the published guidelines.[6] Interestingly, in this study, 50% of these action items were completed within the 6-month intervention period, whereas 50% extended beyond the

intervention period. This likely represents variances between CEDs' capabilities and resources to engage in pediatric readiness initiatives, and highlights the need for flexibility when engaging CEDs in these initiatives.

## Limitations

Our study has a few limitations. First, it is a small study limited to 8 medium-size CEDs out of more than 100 CEDs statewide, making our findings less generalizable to other CEDs. However, with the marked improvement in many WPRS domains, our study sample gave us adequate power to detect a significant change in future studies. Second, despite the successful completion of action items in all participating CEDs, we did not obtain explicit details of the process used by the designated PECCs to complete these action items. Instead, each PECC was empowered to serve as a pediatric champion and provided with support from the pediatric AMC. Third, it is unclear if the improvement in the WPRS and the completion of action items would be associated with improvement in the quality of clinical care and/or patient outcomes in these CEDs. However, recent findings have associated improvement in the WPRS with improved patient outcomes.[11,12] We hope to improve patient care by increasing pediatric emergency readiness and addressing certain gaps in the process of care that can prove transferable and sustainable. Furthermore, it is not clear whether this improvement will be sustained beyond the study period. To mitigate that, the study team facilitator will continue to follow up with these sites periodically. Another limitation is that the PECC surveys were collected on the same day that the follow-up WPRS was measured by the study facilitator, which could have introduced some reporting bias. In addition, overall buy-in from the CED leadership and other staff to participate in the education sessions varied among sites, which added an additional challenge to the study team during recruitment. Our model may not be generalizable to other pediatric AMCs with limited resources or capability to establish this collaboration with their CEDs. Finally, all participating CEDs agreed to designate a nurse PECC who used an average of 2 hours per week working through this improvement study. Allocating these resources may not be feasible for other CEDs with limited staffing. However, our main purpose was to identify nurse PECCs and have their roles shared with their other administrative duties through a formal agreement with their leadership within their hospital system rather than creating a whole new position.

Our future work will focus on describing the impact of our intervention on the outcomes of patients presenting to CEDs. We are currently evaluating the impact of these interventions on the quality of clinical care provided in these CEDs and correlating the findings noted in the simulated setting to potential improvements in the clinical setting.

## Conclusion

A collaborative improvement program between pediatric AMCs and CEDs facilitated by nurse PECCs is associated with an improvement in pediatric readiness and the process of simulated care. This model of collaboration can serve as a platform to enhance pediatric emergency readiness at CEDs and potentially link these improvements to downstream clinical care and patient outcomes.

## Acknowledgments

Special thanks to Dr Marc A. Auerbach and Mr Travis Whitfill for support and contributions to this project. The authors would like to acknowledge the contributions of members of the Improving Pediatric Acute Care Through Simulation (ImPACTS) network and members of the International Network for Simulation-Based Pediatric Innovation, Research, and Education who have helped to shape this project through sharing resources and expertise. Special thanks to James E Slaven, Department of Biostatistics, Indiana University School of Medicine.

## Author Disclosures

This study was funded by an Indiana University Health Values grant (VFE-342: Samer Abu-Sultaneh).

Conflicts of interest: none to report.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.06.006.

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# Cost Savings of Frequent, Concise Skills Competency Training in the Emergency Department

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**Contribution to Emergency Nursing Practice**

- The current literature indicates that frequent, concise skills training may prove beneficial in knowledge retention, staff satisfaction, and cost-effectiveness.
- This article contributes an example of the methods employed at 2 military hospital emergency departments and displays the cost savings and increased staff compliance after the implementation of frequent, concise skills training sessions.
- Key implications for emergency nursing practice found in this article include that frequent, concise skills training may prove beneficial for increasing staff compliance and cost containment in the ED environment.

**Abstract**

Nurse educators are confronted with ensuring skills competency and staff compliance to support the provision of safe and quality care. The ED setting presents additional challenges when conducting skills competency training. One military hospital's emergency department implemented a method of frequent, concise skills training sessions to overcome barriers unique to the ED setting; the same method was then implemented at a second military organization owing to the effectiveness of the training approach to increase staff compliance. This article outlines the methods for the implementation of frequent, concise skills training sessions, and it displays the cost savings and increased compliance experienced by the 2 health care organizations after the implementation of this frequent, concise skills training method.

**Key words:** Emergency department; Skills competency training; Cost savings; Skills fairs; Competency

Emergency departments remain a common health care access point for acute, chronic, and emergent conditions within the United States and the world. ED crowding is a problem discussed throughout the literature.[1-4] The challenge of providing adequate staffing levels in the emergency department is related to the unpredictability of the hourly patient census and this potential for crowding. Ensuring regular, relevant training to maintain competency in this busy atmosphere proves challenging. Ensuring that nurses are not away from direct patient care for long periods while maintaining an adequate staffing schedule for the high volume of patients presents a complex puzzle concerning education. One military emergency department developed an efficient skills competency training (SCT) schedule to ensure the provision of frequent education in conjunction with cost

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J Emerg Nurs 2021;47:181-5.
Available online 24 September 2020

0099-1767



https://doi.org/10.1016/j.jen.2020.07.013

containment. This same education model was then replicated at another, smaller military hospital.

## Background

The Joint Commission (TJC)[5] defines competency as a measurable way to identify knowledge, skills, and abilities, but states that this definition is fluid and not formal. TJC standards state that the goal is to demonstrate and perform safe and quality care.[5] TJC does not define what competencies resemble. These competencies should be determined by the specific patient population, the skills, and the knowledge needed to render appropriate care.[5]

Traditionally, SCT has been conducted in the form of a skills fair in 1 6-hour to 8-hour day in our setting. All skills for the year for an entire organization were conducted in a large room with multiple stations. Collaboratively, educators, nursing leaders, and risk managers determine the contents of the fair. Yet, these types of fairs are often time-consuming, and the learner becomes disengaged.[6] One study identified that the learners considered that the goal was to "check the box" (an idiom meaning "complete to the barest minimum standard"), and complete the stations, rather than learn content in direct relation to their clinical practice.[7] Only 52% of the nurses felt that the content at traditional skills fairs was relevant to their practice.[7] In a second study, the nurses reported minimal influence regarding the content and felt that the training was repetitive and boring despite using distractors such as themes and games.[6]

Alternatively, unit-based training has been shown to promote confidence among the nursing staff and contribute to positive patient outcomes management. The skills were perceived as more relevant to patient care provided on that specific unit. The skills education was developed using recent case reviews and input from the clinical staff. The learners also felt that the time allocated to the training was a huge contributor to positive perceptions because the staff were already at work when the training took place, and it did not require them to come on their day off or work overtime.[7] Ogle and Harville[8] innovated training at 1 military field hospital and found that the participants perceived that presenting all required skills in 1 continuous session was overwhelming. In response, the authors elected to space out the timing for each skill over multiple days in 1-hour blocks of instruction. The problems and innovations in the literature aligned with the feedback and results experienced by the 2 military organizations described in this article.

## Setting

The first hospital for implementation of the SCT approach was a military treatment facility, with an emergency department of 38 beds and 65 nurses on staff to treat an average of 200 patients a day. The leadership staff included 2 team leaders (assistant chief nurses), 1 head nurse (chief nurse), and the chief nurse of emergency operations (encompassing the urgent care clinic, the emergency department, and emergency medical services). There was a full-time nurse educator who led the military medic training and required certifications for the department to include cardiopulmonary resuscitation. The annual nursing skills training was performed by 2 master's-prepared nurse educators who also provided bedside nursing care when not providing education to the department. All 3 of the nurse educators were paid hourly and provided bedside clinical staffing in addition to their educator duties. The nursing care model for the department encompassed a primary nurse model with a 4:1 ratio, with 2 nurses assigned per zone to assist one another. Both of the nurse educators who provided the annual skills training held their certifications in emergency nursing (CEN) and pediatric emergency nursing (CPEN). The staff was paid at the same government-service level, with different steps on the basis of experience and time in service. Therefore, the charge role was rotated among the staff. The charge nurse for the day did not routinely take a direct patient assignment.

## Training Relevance

Before each SCT session, the nurse educators reviewed the evidence-based guidelines through the hospital's access to Elsevier Clinical Skills (Elsevier BV). In addition, the nurse educators reviewed the relevant hospital policies for the skills being delivered to update the staff on any policy changes that may have occurred. Furthermore, the staff provided the nurse educators with initial learner engagement input on concerns and challenges in the delivery of bedside care. This staff information was used for future SCT sessions. The communication was shared with the leadership to ensure that the feedback was delivered up and down the chain of command.

## Training Method/Trigger for Change

The same military treatment facility created a different approach to SCT in their emergency department, and the same method was then adopted at another military facility. Before these changes, many of the staff were noncompliant with completing their educational competency training.

| *Inputs* | *Activities* | *Outputs* | *Outcomes* | | |
|---|---|---|---|---|---|
| | | | *Short* | *Intermediate* | *Long* |
| Educators<br>Training Supplies<br>Time<br>Risk Management<br>Review<br>Quality Improvement<br>Evidence-Based Practice Guidelines | Hands-on Training<br>Practice ESI Scenarios<br>Check on Learning Quizzes | Training provided to > 80% of staff each session accounting for vacations and time off<br>Six sessions provided throughout the year for each track of nurses | >95% staff compliance with annual skills training | 100% of staff receive 100% of skills training each year | Staff demonstrate improvement in knowledge retention as evidence by skills check off and post test<br>Decreased morbidity and mortality |

FIGURE

Logic model application to the program. ESI, Emergency Severity Index.

Although the specific information regarding the levels of staff compliance was not available to the authors, the trigger for the implementation of this training method was because of multiple adverse events that required a department-wide increase in the compliance of skills training for the staff. After the implementation of the hands-on SCT program, only 2 of the 65 nurses did not meet the standard in the first year of the new approach (Figure).

The hands-on SCT was conducted in 6 sessions spread throughout the year, delivered to 2 nursing teams (for a total of 12 sessions) in the emergency department. Each session contained 3 to 4 skills that were taught to each team. Each session was limited to 1 hour or less, and the nurses covered each other's patient assignments just as they did for meal breaks. The education team (nurse educators and a clinical nurse specialist) and leadership team (chief nurse of the emergency department, nurse managers, and team leaders) met frequently to re-evaluate the skills and to adjust any requirements on the basis of new risk-management cases and topics presented for just-in-time education. Just-in-time education addressed a facility change in health care procedures, facility policy, or change in evidence-based practices. In addition, the staff was empowered to provide suggestions for future content to be demonstrated or reinforced.

The staff members in the emergency department were scheduled in 12-hour shifts with 7 AM, 11 AM, and 7 PM starts. The ED volume was reviewed for low-volume hours. On the basis of this review, the hours of 4 AM to 12 PM were selected to deliver the education. The staff attended the training during their regular scheduled shift.

Because there are only 3 or 4 skills at a time, the training was delivered in the trauma bay or the department conference room. This allowed the nursing staff to never be far away from patient care; the staff could return quickly to clinical care if needed. Depending on hospital requirements, departmental needs, and trending patient safety reports, skills checkoffs are performed once a year, and others are done more frequently (rapid infuser utilization, porta cath access/deaccess, ESI triage). Most of the skills were hands-on with return demonstration, with approximately 2 critical-thinking case studies followed by a quiz. All skills sessions were designed to meet the educational objectives and to efficiently return the staff to their patient care assignment. The skills stations were constructed to be broken down quickly for the room to accept a patient with trauma if needed.

## Further Implementation

On the basis of this hands-on SCT model, a similar plan was implemented at the second military hospital. The second facility was smaller, with a 28-bed emergency department seeing an average of 150 patients a day, and 48 nurses on staff. The training method was the same, except that the times were changed slightly to accommodate the late midshift of 3 PM. In this case, the morning sessions were the same as above, but a 1-hour session from 2:30 PM to 3:30 PM was allowed for those who worked that later shift. These evening shift nurses would go immediately into

TABLE
**Comparing the costs of the 2 approaches**

| Hospital 1 | | Hospital 2 | |
|---|---|---|---|
| Traditional annual skills competency training | | Traditional annual skills competency training | |
| Staff nurses, total | 65 | Staff nurses, total | 48 |
| Hourly rate, $ | 40 | Hourly rate, $ | 40 |
| Total sessions | 1 | Total sessions | 1 |
| Hours per session | 6 | Hours per session | 6 |
| Educators' cost, $ (40 × 6) | 480 | Educators' cost, $ (40 × 6) | 240 |
| Total cost, $ | 16,080 | Total cost, $ | 11,760 |
| Frequent, concise skills competency training | | Frequent, concise skills competency training | |
| Educators, total | 2 | Educators, total | 1 |
| Hourly rate, $ | 40 | Hourly rate, $ | 40 |
| Total sessions | 12 | Total sessions | 12 |
| Hours per session | 8 | Hours per session | 8 |
| Total cost, $ | 7,680 | Total cost, $ | 3,840 |

Cost savings at the 2 military health care systems' emergency departments after the implementation of frequent, short skills sessions. There were 2 educators at Hospital 1 that provided 12 sessions. 65 (nurses) × $40 (hourly rate) × 1 (traditional training session) × 6 (hours per session) + $40 (hourly rate) × 6 hours (educator training the individuals for one day) × 2 (total educators)= $16,080; same method utilized for $11,760 cost.

training on arrival to work before taking a patient assignment.

## Cost Savings

The government nurses' hourly rate was used to demonstrate the cost savings because both nurse educators are hourly staff nurses. The Table illustrates the costs and the savings resulting from this approach. The cost savings for both military emergency departments discussed in this article were more than 50%, as illustrated in the Table.

## Evaluation Metrics for SCT Replication

On the basis of the postimplementation proportion of nurses who were in compliance with annual competency training, we evaluated the hands-on SCT method as beneficial to ensure staff compliance with attendance to annual skills training. Future data collection is also needed to assess the benefits of improving knowledge, skills, and attitudes or perceptions when performing the skills pre- and posttraining. In addition, further analysis of the long-term outcomes on the reduction of morbidity and mortality after frequent skills training is required to assess the benefits of this method.

## Implications for Emergency Nurses

Despite the busy nature of the ED environment, frequent, concise skills training is achievable. Considering patient volume and staffing hours, different strategies can be adopted to meet the varied needs of the organization. Health care procedures, facility policies, and evidence-based practices change regularly. Frequent unit-based training is a potential solution to overcome the challenges faced by nurse educators in busy ED environments. In addition, at 2 health care organizations, this hands-on SCT education schedule was cost-effective when compared with the traditional annual SCT arrangement.

## Conclusion

A competency assessment must be completed by the nursing staff to ensure that safe, competent, and reliable care is being performed daily. The traditional skills fair schedule is less reliable and retainable, and lacks cost-effectiveness. Frequent, concise skills training may improve the confidence of the nursing staff and unit leaders in their care of patients in the emergency department. Future systematic literature reviews and continued program evaluation of our hands-on SCT training methods are needed in the ED environment.

## Acknowledgments

We thank Monique Wallace, MSN, RN, CEN, CPEN, for her assistance and contributions in developing the frequent skills training sessions at the military organization.

## Author Disclosures

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Womack Army Medical Center, Fort Belvoir Community Hospital, Defense Health Agency, Department of Defense, or the US government.

Conflicts of interest: none to report.

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# Consideration of Testicular Torsion in Young Males With Abdominal Pain Is Essential: A Case Review

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**Section Editor:** Patricia A. Normandin, DNP, RN, CEN, CPN, CPEN, FAEN

**Contribution to Emergency Nursing Practice**

- The current literature on testicular torsion indicates that a testicular torsion is a surgical emergency that needs to be evaluated expeditiously to avoid loss of the testicle.
- This article contributes a review of testicular torsion and the imperative need to perform a genitourinary examination on any male who presents with abdominal pain to prevent a missed diagnosis of testicular torsion.
- Key implications for emergency nursing practice are consideration of testicular pain in any male who presents with abdominal pain and the significance of diagnosing a testicular torsion in a timely fashion.

**Abstract**

Testicular torsion is a surgical emergency and requires prompt recognition and treatment. Health care personnel often forget this differential diagnosis in males who present with abdominal pain as their only complaint. There is a 4- to 6-hour window from the onset of symptoms to the surgical intervention to salvage the testes. It is imperative for health care personnel to consider testicular torsion in any male presenting with abdominal pain and to complete a genitourinary examination. The purpose of this case review is to highlight the importance of a genitourinary examination in recognizing testicular torsion.

**Key words:** Testicular torsion; Abdominal pain; Pediatrics; Case report

## Case 1

A 14-year-old previously healthy male with no medical or surgical history and up-to-date immunizations presented to urgent care with complaints of sudden onset of left-sided abdominal pain and vomiting. The pain started the previous hour while he was sitting in class. He stated that he felt well before the onset of pain and denied any trauma to his abdomen. He denied fever, upper respiratory symptoms, diarrhea, urinary symptoms, or any other complaints. His last normal bowel movement was that morning. On examination, the patient had pain with palpation in his left lower quadrant without any other abdominal findings. The remainder of his documented examination was benign. A genitourinary examination was not performed. On the basis of the patient's abdominal pain and the provider's suspicions, the patient was referred immediately to the local pediatric emergency department for further evaluation of suspected appendicitis.

On arrival to the emergency department with his mother, the adolescent male was alert and oriented, had pale coloring and diaphoretic skin, and was hunched over holding his abdomen. The patient reported that he continued to have severe pain on the left side of his abdomen with accompanying nausea. The triage nurse assigned the patient an emergency severity index (ESI) of 2 because of his appearance, history of sudden onset of abdominal pain, and distress. The nurse practitioner examined the patient and found that his abdomen was soft and nondistended with mild tenderness on palpation of the left lower quadrant. There was no pain on palpation of

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J Emerg Nurs 2021;47:186-91.
Available online 10 November 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.09.006

the right lower quadrant or over McBurney's point. The nurse practitioner then questioned the patient if he had testicular pain. The patient shyly admitted that his left testicle was quite painful, and the pain increased to his scrotum when ambulating. On the genitourinary examination, the patient's left testicle was found to be swollen, discolored, and tender on palpation. The patient was barely able to tolerate the examination because of the pain and stated that this was the location of the maximum point of tenderness. The examination was halted, and the nurse practitioner immediately exited the room to inform the supervising attending provider of the high suspicion for a testicular torsion. Urology was immediately consulted, presented to the bedside a short time later, and confirmed that the patient had a testicular torsion. A manual bedside detorsion was attempted by urology, which was unsuccessful in reducing the torsion. The patient was taken urgently to the operating room (OR) for an open reduction of the testicular torsion. Owing to the short time frame between the patient's symptoms and the diagnosis of testicular torsion (approximately 3 hours), the testis was able to be salvaged.

## Case 2

A 13-year-old previously healthy male with no medical or surgical history and up-to-date immunizations presented to urgent care with sudden onset of periumbilical abdominal pain. However, he admitted that he had experienced intermittent abdominal pain for the past 3 days. The patient stated that he had 1 episode of vomiting before arrival. He was unsure when his last bowel movement was but thought it was a week ago. He denied any other associated symptoms. On examination, the patient had no abnormal physical findings; his abdomen was noted to be soft, nontender, and nondistended on palpation. Of importance, a genitourinary history and examination was not completed. Because of his report of no bowel movement for a week, the patient was diagnosed with constipation and instructed to take a laxative.

Two days later the patient and his father presented to the emergency department, stating that he had experienced right-sided abdominal pain for the past 5 days. The patient reported that the pain was located on the right side of his abdomen and increased with ambulation. On physical examination, the abdomen was noted to be soft and nondistended with mild tenderness in the right lower quadrant with palpation. With the genitourinary examination, the patient had significant scrotal swelling, ecchymosis, and tenderness over the right testis. The provider noted that it was difficult to palpate the testes because of the degree of swelling. After discovering significant scrotal findings, the patient admitted to having testicular pain for the past few days but did not tell anyone else because of embarrassment. An emergent ultrasound and a urology consult were ordered. The ultrasound confirmed right testicular torsion, and urology took the patient to the OR. Unfortunately, the patient's right testis was not able to be salvaged because of the prolonged time he had the torsion that resulted in a testicular infarction, which resulted in the patient undergoing an orchiectomy.

## Introduction

Testicular torsion is a surgical emergency that requires immediate attention. Delayed evaluation, identification, and reversal of the testicular torsion could result in adverse patient outcomes, including a possible loss of the testes.[1,2] If the patient endorses scrotal, groin, or testicular pain, the patient should be made a high priority and triaged as an ESI of 2. The patient needs to be seen urgently for evaluation by an ED provider so that a physical examination and the appropriate studies may be expedited to preserve the testis in the case of torsion.[3] Unfortunately, not every patient with testicular torsion presents to the emergency department with straightforward complaints of testicular pain. The patient may complain of vague abdominal or inguinal pain with other associated symptoms (ie, nausea, vomiting, shortness of breath, dysuria) that do not give health care personnel a clear indication of the etiology of the patient's pain.[2] Younger males may not be able to differentiate or focalize their pain and may be too embarrassed to admit that they have testicular pain.[4] It is imperative that every examining provider ask the patient directly if they have penile, scrotal, or testicular pain when they enter the emergency department with complaints of abdominal pain. Despite the answer they may give regarding the presence or absence of testicular or scrotal pain, the provider should perform a physical examination of the genitourinary system to assess and identify a potential testicular torsion. The consequences of missing or delaying the diagnosis of testicular torsion can be catastrophic for the patient. Permanent ischemic injury may occur within 6 hours after testicular torsion with spermatic cord occlusion.[1,2] Ischemic tissue injury related to testicular torsion and the risk of undergoing an orchiectomy are dependent on the length of time that the

testis has been torsed and the severity of the torsion.[1,2] The longer the patient has pain, the higher the chance that the testis cannot be recovered.

## WHAT IS A TESTICULAR TORSION?

Testicular torsion occurs when the testicle rotates and twists on the spermatic cord.[1,2] The spermatic cord provides blood flow to the testicle. Twisting of the cord will obstruct blood flow to the testicle. If the blood flow to the testicle is compromised, there will be an equalization of the venous and arterial pressures that will compromise arterial flow to the testicle leading to ischemia, venous congestion, testicular swelling, and severe pain.[1,2] The severity of the ischemia depends on the interval of time that the torsion has been present and the degree of the spermatic cord rotation.[1,2]

The incidence of testicular torsion is greatest during the neonatal period and between the ages of 13 to 16 years; however testicular torsion can occur anytime during the lifespan.[2] Approximately 65% of all torsions occur at the onset of puberty when the prepubescent male experiences rapidly increasing testicular mass that increases the chance of testes rotation.[1] A testicular torsion can also occur after minor injury to the genitourinary area and can also be hereditary when a patient is born with an anomaly in which the testes float freely in the scrotum (referred to as Bell-Clapper deformity).[5] Other causes that may be related to testicular torsion are low temperatures and sleep causing the contraction of the cremasteric muscle, which leads to shortening and twisting of the spermatic cord.[1]

## PHYSICAL EXAMINATION FINDINGS OF TESTICULAR TORSION

Common signs and symptoms of testicular torsion include a sudden onset of scrotal/testicular pain with subsequent swelling and discoloration of the scrotum, as well as an abrupt onset of nausea and vomiting.[2] However, some patients will present with vague abdominal or inguinal pain that gradually moves to the scrotal area hours after the onset of the abdominal pain.[2] Therefore, a genitourinary examination is essential when a male presents with abdominal pain. The patient may have feelings that his abdomen is the focal point of pain, but once a genitourinary examination is completed and the testis are palpated, it is recognized where the source of the pain is radiating from.

On physical examination, the patient will have tenderness over the site of the torsion, with possible radiation of pain into the groin and the abdomen. Many patients, especially young children, will only localize their pain to their abdomen. A complete abdominal examination should be performed including inspection, auscultation, palpation, and percussion of the abdomen. The scrotum may appear erythematous, swollen, and possibly discolored. The affected testis may be enlarged compared with the unaffected testis because of the venous congestion.[1] With the twisting of the spermatic cord, the cord itself will shorten, causing the testicle to become high-riding within the scrotum.[1] Another finding with a testicular torsion is the absence of a cremasteric reflex. The cremaster muscle is found within the inguinal canal and the scrotum. If an examiner lightly strokes the inner thigh of the patient, this will normally elicit a contraction or elevation of the testis toward the inguinal canal. Almost all patients with testicular torsion will have an absent cremasteric reflex; an absent cremasteric reflex has been found to be specific for testicular torsion, but its presence does not rule out testicular torsion in the setting of genital pain.[6] Another test to evaluate for a possible torsion is the Prehn sign. If the examiner lifts the testis and the patient has relief of pain, the probability of a torsion is low because lifting the testicle will not relieve the pain with a torsion.[6] However, the occurrence of pain with lifting the testis by the examiner may be due to epididymitis.[6]

Epididymitis should be considered on every patient that presents with testicular pain. On examination of a patient with epididymitis, the spermatic cord and the epididymis will be tender and swollen on palpation causing unilateral testicular pain.[7] Many times with epididymitis, patients will have fever, erythema of the scrotal skin, involvement of the adjacent testis, and reports of gradual swelling over the past few days.[7] In most cases, an ultrasound, which can differentiate between a testicular torsion and epididymitis, is required.[7] Other differential diagnoses based on the history and age of the patient to consider include sexually transmitted infection, urinary tract infection, orchitis, abscess, cellulitis, varicocele, hematoma, or malignancy.

## DIAGNOSTIC EVALUATION

Any male who presents with concerns related to a possible testicular torsion should undergo an immediate ultrasound and a urology consult. If the patient has multiple signs and symptoms that make the diagnosis of a torsion highly suspicious, urology should be contacted as soon as possible. Time is valuable in these cases because of the short period of time before ischemia takes place. If your institution does not have urology on staff, make every effort to transport the patient to the nearest facility where urology is readily available.

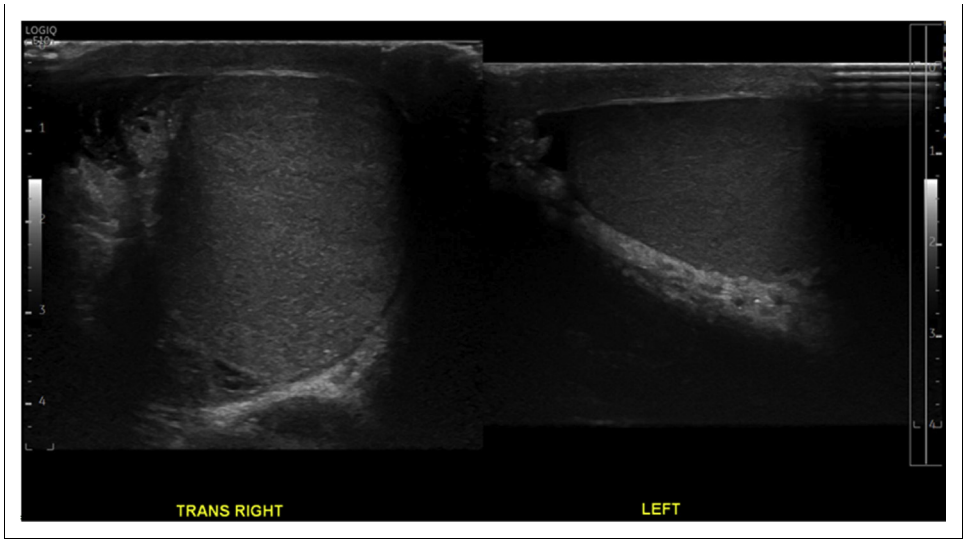


FIGURE 1

Images revealing a right testicular torsion and a left normal testis. Right testicle with an enlarged spermatic cord (10 o'clock) and venous congestion. Ultrasound images courtesy of Michael Lu, MD, University of Rochester Medical Center, Department of Emergency Medicine, Rochester, NY. (Permission received from the University of Rochester Medical Center to use such images).

If the physical examination does not reveal a straightforward torsion but remains on the examiner's differential diagnosis, an urgent ultrasound of the scrotum and testes should be ordered. It is crucial to note that the Doppler ultrasound is the key diagnostic tool in identifying a testicular torsion.[7] An ultrasound that reveals a "whirlpool sign" is significant in diagnosing testicular torsion.[8] The unexpected change in the progression of the spermatic cord with a spiral twist into the inguinal canal or into the scrotal sac defines what consists of a whirlpool sign (Figures 1 and 2).[9]

Other findings that may be consistent with a diagnosis of a testicular torsion by an ultrasound include decreased blood flow to the testis, horizontal lie of the testis, testicular enlargement, and/or heterogeneous echotexture (patchy or ill-defined tissue).[8] Normal testicular tissue has a homogenous echotexture.[8] Abnormal testicular findings on an ultrasound may show a heterogenous pattern that may indicate inflammation if there is decreased blood flow or atrophy.[8]

Other studies to consider include a urinalysis to evaluate for a possible urinary tract infection. If there is a concern of a sexually transmitted infection, urine or a urethral culture should be obtained. Blood work such as a complete blood count with differential may be helpful to differentiate between a testicular torsion and another diagnosis.[1] An elevated white blood cell count has been correlated with testicular torsion most likely because of tissue necrosis.[1] However, an ultrasound is a priority and should not be delayed because of obtaining laboratory results or waiting for the results of the blood work or the urinalysis.

## TREATMENT

Treatment for a testicular torsion requires surgical intervention.[5] In some cases, a manual reduction may be successful at the bedside, but the procedure is very painful and should

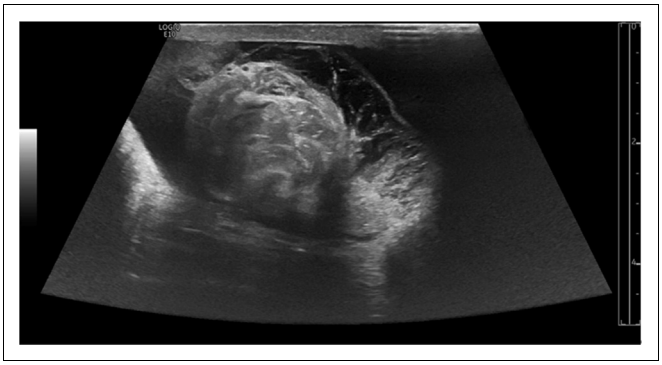

FIGURE 2

Image revealing a testicular torsion with a whirlpool sign. Ultrasound image courtesy of Michael Lu, MD, University of Rochester Medical Center, Department of Emergency Medicine, Rochester, NY. (Permission received from the University of Rochester Medical Center to use such images).

only be attempted by individuals who have been trained to do so.[10] A manual detorsion should be performed if the time to surgical intervention is unclear or will be delayed. If the manual reduction is successful, the patient should still undergo surgical intervention to secure the testes down to the scrotal sac to prevent future occurrences of a testicular torsion.[10] Most cases of torsion will go immediately to the OR for surgical exploration to salvage the testes.[5] The goal is to get the patient with testicular torsion to the OR within 6 hours from the onset of pain to detorse the testis and avoid an orchiectomy.[5] If the testicular torsion is detorsed within 4 to 6 hours from the onset of symptoms, there is a 98% probability of saving the testicle; detorsion within 12 hours leads to a 20% likelihood of saving the testicle; more than 24 hours of symptoms leads to a 0% chance of testicular salvage.[2]

## Discussion

Testicular pain is a complaint that is viewed as high risk for any male patient that presents to a health care facility. Unfortunately, not every patient with testicular torsion presents with straightforward testicular pain but endorses vague abdominal pain, inguinal pain, or sudden onset of nausea and vomiting. Testicular torsion can occur at any age but is usually seen in children up to 1 year and again between the ages of 13 and 16 years.[2] Triage nurses must include testicular torsion as a differential diagnosis in all males who present with abdominal pain. Questions surrounding scrotal or testicular pain should be asked in triage to help differentiate possible diagnoses. If the patient does have scrotal pain, they should be triaged as an ESI of 2. A testicular torsion is a high-risk situation because of the danger of losing a testicle.[3]

It is imperative that every male, despite their age, who presents with abdominal pain undergo a thorough genitourinary history and examination. A genitourinary evaluation by a provider should include wearing gloves, maintaining patient privacy, and including another health care provider at the bedside to chaperone the examination. It is recommended to have a chaperone during a sensitive examination such as a genitourinary or pelvic examination. Literature supports the use of a chaperone to make the examination more comfortable for the patient by having another person present but also supports the provider in having a witness for the procedure that is performed.[11]

As noted in the case studies, adolescents may not be forthcoming with details that they find embarrassing, especially if it involves their genitals. Even if patients report no discomfort in this region, an examination by a health care provider is essential. In both cases, if the urgent care provider had examined the patient's genitourinary area, suspicions of testicular torsion may have been raised. In the second case, if the scrotum had been examined, a torsion would have been identified, and the patient would have been sent to the emergency department for immediate intervention. Unfortunately, this portion of the examination was not completed, and the diagnosis was missed for an additional 3 days until the patient went to the emergency department. Despite the examination in the emergency department, it is highly unlikely that the testis would have been salvaged because of the prolonged time that the testis had been torsed.

## Emergency Nursing Implications

Emergency nurses have an important role to play in the recognition, diagnosis, and care of patients with testicular torsion. On arrival to the emergency department, patients with a chief complaint of scrotal redness or swelling should be triaged as an ESI of 2. Nurses should keep in mind that any male who presents with abdominal pain may potentially have a genitourinary issue. Timely evaluation is crucial for these patients. After placing the patient in an examination room, the emergency nurse should ensure the patient is placed in a gown, with underwear removed, to facilitate a chaperoned genital examination using gloves and appropriate personal protective equipment. Patients and caregivers will need to understand that care, including imaging and transfer to the OR, may proceed swiftly if the problem is determined to be emergent.

Therapeutic communication is essential for this patient population. Genitourinary issues can produce anxiety and cause embarrassment for pediatric patients, especially adolescents. Direct questions regarding genitourinary pain, redness, or swelling may be intimidating. Using a gentle and reassuring manner while providing privacy and real time education will promote trust and decrease psychologic trauma for patients with suspected testicular torsion. Education regarding testicular self-examination is available through online sources, including kidshealth.org and urologyhealth.org.

## Conclusion

Pediatric patients presenting with abdominal or scrotal pain require a prompt and thorough evaluation to rule out testicular torsion. Males who present with abdominal pain must

have a thorough genitourinary examination to ensure the evaluation for a possible testicular torsion. If this is not done, a testicular torsion may be missed, which is a life-altering event with catastrophic consequences. If testicular torsion is highly suspected, immediate surgical intervention is required to prevent the loss of the testicle. Positive outcomes are associated with patients who are evaluated and diagnosed with a torsion within 4 to 6 hours of the onset of symptoms.

## Author Disclosures

Conflicts of interest: none of report.

The authors confirm that all aspects of the manuscript adhere to Elsevier's patient consent policy.

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Submissions to this column are encouraged and may be sent to Patricia A. Normandin at: pnormandinrn@aol.com or submitted at jenonline.org where submission instructions can be found in the Author Instructions.

# Perceptions of the Essential Components of Triage: A Qualitative Analysis

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**Section Editor:** Andi Foley, DNP, RN, ACCNS-AG, CEN

### Contribution to Emergency Nursing Practice

- The current state of scientific knowledge on triage indicates that the time to complete triage is increasing owing to additional risk-screening questions.
- The main finding of this research is that emergency nurses perceive there are essential questions that must be asked in triage, whereas some questions are not urgent or appropriate to ask during triage making them nonessential.
- Key implications for emergency nursing practice from this research are emergency departments should evaluate their triage process and determine which questions are essential to ask in triage and which questions could wait to be asked by the bedside emergency nurse.

## Abstract

**Introduction:** Triage is an important process to determine severity of illness and prioritize patient emergencies while also ensuring patient safety. The emergency nurse must use critical thinking and decision-making to identify life-threatening emergencies and improve patient outcomes. However, the addition of risk screenings and quality improvement initiatives has extended the triage process time, which may increase interruptions and opportunities for errors. The purpose of this descriptive qualitative study was to determine emergency nurse perceptions of current triage processes and categorize essential and nonessential triage components.

**Methods:** Focus groups of frontline emergency nurses who regularly conduct triage in the emergency department were conducted to discuss perceptions of triage assessments and questions. The 3 focus group discussions were digitally recorded and transcribed. Data analysis consisted of descriptive statistics of the sample and the conventional content analysis of the transcripts.

**Results:** A total of 12 emergency nurses participated in the study. The overall theme that emerged surrounding essential triage components was a perceived conflict between individualized care and maintaining systems and processes. This theme consisted of 4: (a) must ask, (b) actions of triage, (c) relevant but not urgent for triage, and (d) not perceived as relevant.

**Conclusion:** This study identified the perceptions of emergency nurses surrounding the urgency of triage components in the emergency department. Emergency nurses perceived some assessments as essential to determining "sick versus not sick," and other triage components were able to be delayed, streamlining the triage process.

**Key words:** Triage; Risk screening; Essential questions; Triage nurse

## Introduction

Each year in the United States, more than 139 million patients visit the emergency department,[1] and each one receives a triage assessment. Triage is an essential process to determine the degree of urgency and prioritize patient emergencies. The triage process has implications for safety; it is essential that the emergency nurse uses decision-making and critical thinking to determine who has life-threatening conditions and needs immediate attention. Yet, the process of triage is ever-evolving owing to influences such as throughput, fluctuating patient volumes, and health system/departmental metrics with lasting implications for patient satisfaction, quality of care, and timeliness of the triage process.

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J Emerg Nurs 2021;47:192-7.
Available online 20 October 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.08.009

Because every patient who visits the emergency department receives this acuity-driven assessment, triage is a likely placeholder for screening questions and assessments to ensure everyone is asked the same important questions. Yet, owing to the addition of a constellation of screening questions, point-of-care testing, interruptions, and crowding, triage assessment times have risen over the past 20 years from an average of under 5 minutes to now up to 20 minutes to finish.[2,3] These extended triage times contribute to longer patient wait times, increased patient walk-outs, and more opportunities for interruptions and errors.[3,4] In addition, these delays may have detrimental impacts on patients who are critically ill waiting in the triage queue.

The purpose of this qualitative descriptive study was to determine emergency nurse perceptions of current triage processes and categorize essential and nonessential triage components. Essential questions were defined as questions to include in the initial triage assessment, whereas nonessential questions could be delayed to later in the emergency visit. Although all questions present in triage assessments have intended purpose, we hypothesized that nurses would deem some triage questions as critical to patient triage and others as nonemergent.

## Methods

### DESIGN

A qualitative descriptive study was conducted in 2019 after receiving institutional review board approval from the University of Cincinnati (#2019-0467). Sites included 1 urban level 1 trauma academic health center (75 000 patient visits per year) and 1 suburban level 3 trauma center (42 000 patient visits per year), both verified by the Committee on Trauma of the American College of Surgeons[5] and within the same health system. Convenience sampling methods were used to invite frontline triage emergency nurses (ie, not in a management or clinical educator type role) from the 2 sites to participate in the study through email and word-of-mouth. Nurses interested in participating contacted the research team to be screened and determine eligibility. To be eligible, participants needed to have at least 1 year of experience in any emergency department, as well as experience in conducting triage assessments.

### DATA COLLECTION

Data were collected during 3 focus groups held in August 2019 at the medical campus of the participants. Saturation was obtained during the third focus group when no new ideas were introduced; therefore, no further focus groups were conducted. Participants attended 1 of the 60- to 90-minute focus groups held in a private conference room and led by a nurse researcher (B.E.P.) with a research assistant present to collect field notes. The focus group discussion was facilitated with a semistructured interview guide discussing emergency care, which included 3 main questions: (1) What are essential parts of triage?; (2) What are nonessential parts of triage?; and (3) What questions should be asked in triage but are currently lacking in the triage assessment? Focus group discussions were digitally recorded and transcribed verbatim.

### DATA ANALYSIS

Qualitative conventional content analysis guided the data analysis and consisted of 3 phases: preparation, organizing, and reporting.[6,7] During the preparation phase, the team (all with previous qualitative research experience) immersed themselves in the data by independently and then jointly reviewing transcripts to get a sense of the whole. The team agreed that the unit of analysis would be key phrases and that latent content (ie, what the text talks about) was important to consider when analyzing the data. In the organization phase, 2 researchers conducted independent line-by-line analysis of the transcripts and developed initial codes on the basis of experience and previous research. After each transcript was coded, the 2 researchers met to discuss proposed codes and obtain consensus. Descriptions for categories were generated, and the codes were organized within categories and subcategories. Finally, the reporting phase entailed finalizing the categories, the subcategories, and the overall theme and selecting exemplars reflective of the data, the categories, and the overall story line (ie, theme).

Several strategies were employed throughout the study to increase the overall trustworthiness of findings.[8] An audit trail (eg, complete study record) was maintained throughout the study and included researchers' reflexive thoughts, focus group audio files and transcripts, initial codes generated, intercoder decisions, definitions of codes and categories created by the team, and development of the overall theme to improve dependability and confirmability of findings. To ensure credibility, the verbatim focus group transcripts were verified by reviewing the audio files to ensure that they accurately reflected the discussions. Investigator triangulation was employed during data analysis by having 2 authors (B.E.P. and C.R.S.), each with experience conducting qualitative conventional content analysis, complete independent coding of the transcripts before collaborating to develop the categories and the subcategories. To address the credibility and confirmability of results, the other author (K.D.J.), who is an experienced emergency nurse and researcher

and was not involved in the data analysis, conducted a peer review to ensure results represented the data and not the team's assumptions. Finally, to increase authenticity of the findings, verbatim quotes were included as exemplars in the results section to give participant voice to the categories and the subcategories generated.

## Results

A total of 12 frontline emergency nurses who regularly conduct triage assessments participated in the study. No participants refused or withdrew from the study. Table describes the participant characteristics. In critically examining the data in relation to the distinct theme that emerged surrounding essential triage components, there was a conflict between individualized care and maintaining systems and processes. This theme consisted of 4 categories: (a) must ask, (b) actions of triage, (c) relevant but not urgent for triage, and (d) not perceived as relevant. Representative quotes were obtained from 8 of the focus group participants.

### OVERARCHING THEME: INDIVIDUALIZED CARE VERSUS MAINTAINING SYSTEMS AND PROCESSES

As the focus group participants discussed essential and nonessential triage components, it became clear that there was a conflict between what they were required to ask by their facility and what they needed to ask to adequately care for the patient. The focus group participants discussed the conflict between meeting patient expectations of care and following hospital protocols. There was a struggle between eliciting all the pertinent information needed "that all makes up the story of that patient" while completing the hospital-mandated questions as efficiently as possible so that they can get to the next patient in the queue. The participants described a perceived pressure that they felt so "they go through it like, I gotta get through this system to get these questions to get to the next person because it's busy." The participants also highlighted the concern of patients when asked the same questions repeatedly (eg, "They already asked me that."). Reflecting poor communication, one of the participants stated "… this is the third time [someone has] asked…. so, now it just sounds like we're not listening."

TABLE
**Demographic characteristics of emergency nurse participants***

| Characteristic | n (%) |
|---|---|
| Total participants | 12 |
| Age, y, *mean (range)* | 42 (23-66) |
| Female sex | 11 (92) |
| Caucasian/white race | 11 (92) |
| Married/cohabitating | 8 (80) |
| Years of practice, *mean (range)* | 15.3 (1-44) |
| Years of emergency nursing, *mean (range)* | 14.8 (1-40) |

Data are given as number (%) of study participants unless otherwise indicated.
* Missing demographic data for 2 participants.

### CATEGORY 1: MUST ASK

Participants described specific question components that they must ask in triage as a critical piece of the assessment. This category consisted of 3 subcategories including (a) the patient's story, (b) pertinent details, and (c) hospital-mandated questions. The nurses described the **patient's story** as being crucial, "that all makes up the story of that patient and those things can … influence their care." Obtaining the patient's story is how the triage nurse gets a more holistic view of the patient's reason for coming to the emergency department.

Next, the emergency nurses stated they must ask the **pertinent details** that are related to the patient's visit today. These details, guided by the chief complaint, are necessary to determine acuity—the primary purpose of the triage interview. The nurses described the mental sorting of questions that helped them determine the severity of the illness: "We try to sift pertinent questions… whether or not somebody's up to date on their tetanus vaccine might not have anything to do with if they're having abdominal pain, and they're 70, and they're throwing up." Additional details may include history of diabetes, blood thinners, or recent surgery as examples.

Finally, nurses described the last component of "Must Ask" questions as **hospital-mandated questions**. These questions were considered as essential to fulfilling hospital protocol but not to providing high-quality patient care. As the nurses stated, they are a priority of the hospital/department, "just hitting the ones … [I'm] gonna get an email about if … [I] don't fill it out." These mandated questions may vary by institution (eg, suicidal intent, fall risk, HIV risk, domestic violence). The participants felt that questions focusing on pertinent details to understand the patient's story were essential to providing more efficient triaging and emergency care to patients and that hospital-mandated questions were not essential to triage but needed to be asked because of hospital protocol. Thus, hospital-mandated questions may become barriers to streamlined triage processes.

### CATEGORY 2: ACTIONS OF TRIAGE

The second category identified by the nurses was the "Actions of Triage," which encompassed the physical actions every emergency nurse must take to complete the triage assessment. The physical "Actions of Triage" included (a) assign acuity, (b) visual assessment, and (c) vital signs. Emergency nurses felt that it was crucial to **assign acuity** to a patient as outlined by the emergency severity index.[9] "It's really just sick and not sick"…"that's the definition of triage … sorting." Next, the nurses described the importance of conducting a **visual assessment**, the holistic aspect of a nursing assessment that takes in the picture of the patient to determine severity. "[It is] your across-the-room assessment. Make sure they're breathing okay, how [do] they look? Are they diaphoretic? What's their color like? How [are they] walking?" The final detail included in the "Actions of Triage" category was patient **vital signs**. This action contributed information to the triage assessments, "vital signs … do they match how [the patient] look[s]?" The participants felt that it was essential that the actions of triage focused on individualized care for each patient, which included assigning acuity, visually assessing the patient, and assessing vital signs.

### CATEGORY 3: RELEVANT BUT NOT URGENT FOR TRIAGE

The third category identified, "Relevant but not Urgent for Triage" was a more tense and passionate discussion than the almost "clear cut" opinions of categories 1 and 2. The "Relevant but not Urgent" categories of triage were (a) Do risk factors even matter for triage?, (b) Bedside assessment is more thorough and in-depth, and (c) methods to ask questions. The first subcategory was **Do risk factors even matter for triage?** in which the nurses were conflicted as to whether they should ask about risk factors such as substance use or sexual history in the triage assessment. They concluded that although the information was important, it did not change the triage process for the patient: "[Smoking or drinking alcohol] doesn't impact my decision when I'm deciding what bed he's going to." The next category outlined by the nurses was that **bedside assessment is more thorough and in-depth**. The nurses stated that many of the questions that are collected in triage assessment sections are more appropriate for the bedside assessment/primary nurse to ask: "Triage at its core is deciding who's sick and who's not. It's not … information gathering ... [then] it's not really triage anymore." Finally, the nurses described **methods to ask questions**, stating that the questions added to triage did not have to be asked by a registered nurse: "Questions that are not triage decisions … not going to change the nursing [assessment] could be done by somebody else." The participants emphasized that although the questions they were required to ask in triage were important, they were not urgent and could wait for a later time during the ED visit.

### CATEGORY 4: NOT PERCEIVED AS RELEVANT

The final category of the triage assessment components noted by the nurses included those questions they thought were not pertinent to the patient and not perceived as relevant. This category was composed of (a) just skip, (b) unrelated questions, and (c) What is the purpose of the question? The nurses identified many questions that they stated they "**just skip**" because they were not relevant for the patient (eg, sexual history, tetanus): "Very rarely do I ask the question about if they're sexually active. Very, very rarely will I ask that." The next category was **unrelated questions,** and the nurses thought that these questions were unimportant for patients when their chief complaint was not related to the question being asked: "I think it's very irrelevant .... If you're not there for that, I should not ask. And if you are there for [sexually transmitted infection] related, why am I asking [about sexual history]? Of course you had sex. So, I think it's … irrelevant … I don't think it adds anything." Finally, there was a category of questions that the nurses were unsure about–what they were for and what happens with the answers: **What is the purpose of the question?** The nurses described confusion around what the question was even about and were unsure if they were ever told about the question in orientation or missed a communication about the question when it showed up in the triage assessment section. "I ask it sometimes. But I'm not quite sure the origin of that or why [and] where that information is going. I don't think we were really told. I mean we were told – I think I read that it was coming, but I'm not really sure what happens to that data or what the purpose of that question was."

## Discussion

Results of this study illustrated emergency nurses' perceptions regarding the essential questions of a triage assessment and the struggle they feel in balancing between individualized care and maintaining systems and processes. Categories identified by the nurses sorted the questions asked in a triage assessment into groups: if the questions determine patient severity, or if they could wait until later in the encounter. These results mirror the results of a previous study that also identified the struggle between quickly assessing a patient to determine their acuity versus doing what would help the department processes.[10] In 2016, the boards of directors for both the

American College of Emergency Physicians and the Emergency Nurses Association supported limiting the focus of triage questions to information that was pertinent to the patient's condition to prioritize patients for emergency care treatment.[11]

Emergency nurses are put in a difficult position of deciding between prioritizing care for the patient in front of them versus completing mandatory screening questions to get to the next patient. This conflict may impede emergency care. In a study of emergency nurse decision-making in triage, competing systems, fluctuating patient volume, and individual capacity/experience had a large impact on individual emergency nurse decision-making in triage.[12] In our study, nurses recognized that some questions currently asked in triage are relevant to patient care in the emergency department but may not be urgent for triage. For example, risk behaviors and lifestyle may affect the patient's current illness/injury (wound healing, medication potency, etc); however, these questions were not perceived as critical to the triage assessment.

The nurses described in clear certainty the essential component of triage, as identified by category 1 "Must Ask" and category 2 "Actions of Triage." These 2 categories comprised the essential pieces of triage that ensured an adequate assessment of severity. Once again, our study results aligned with the study by Wolf et al[10] that reported that the primary purpose of triage was to determine who is "sick and not sick." Perhaps the "Actions of Triage" are the most critical component to accurately sort patients who are sick from those who are not. A recent study from Denmark found that a quick clinical assessment was a more accurate predictor of short-term mortality in ED patients than the more formalized triage assessment.[13]

Beyond the categories of "Must Ask" and "Actions of Triage," the nurses explained hesitation with asking questions or simply skipping them because they were not pertinent to the patient's emergency care. However, it was noted that each question is of importance for the health care of the patient but not necessarily urgent and to be included in the triage process. This supports the findings of previous studies that have demonstrated that screening questions were insufficient to accurately assess risk, such as with fall assessments that require a functional test of balance to adequately assess.[14] Although a falls risk assessment is an important safety procedure, there is insufficient time in triage to adequately assess this risk. Having such assessments done by the bedside nurse may be more feasible, efficient, and efficacious, while also ensuring adequate throughput in triage.

In 2019, best practices for ED triage were published and highlighted the need for an effective physical layout and appropriate staffing.[15] However, the results of our study introduce a novel approach to improve ED throughput through the development of a multiphased triaging system for a more efficient emergency care encounter. The essential components of triage included in categories 1 and 2 would be asked immediately and, depending on the capacity of the triage process (factors individual to ED site operations), categories 3 and 4 could be delayed for later in the emergency care visit.

## Limitations

Limitations of this study included the use of focus groups to collect data and recruitment from 1 health system. Collection of data using focus groups may have limited results in that the group setting may have unduly influenced an individual participant's view expressed owing to peer pressure, groupthink, or desirability bias.[16] Although the focus group method does promote a synergistic discussion and debate among participants, it is possible that data collected using individual interviews may have resulted in data that represented everyone's opinion and experience. Another limitation was that recruitment was limited to triage registered nurses employed within 1 health system in a Midwestern US city. All triage nurses in this system obtain the same triage orientation and have a standardized electronic triage assessment shared by the hospital system. Including participants from other health systems with other triage protocols could have strengthened this study.

## Implications for Emergency Nurses

According to the findings of our study, emergency departments with an increased patient volume and waiting times may want to consider adopting a phased triage assessment process. Essential questions (categories 1 and 2) would be asked immediately, and nonessential questions (categories 3 and 4) would be reserved for later in the emergency care visit. In addition, emergency departments could consider a 3-tiered triage: (1) must ask, (2) actions of triage, and (3) relevant but not urgent/not perceived as relevant. This would allow the emergency nurse to adequately assess the patient's severity and need for care, streamlining appropriate treatments to be initiated.

## Conclusion

Emergency nurses are faced with a difficult burden when triaging patient severity, but they also must decide between prioritizing individualized care for the emergency patient

versus juggling mandatory screening question burdens and timeliness of triage. Essential questions for triage appear to be common across ED settings; however, nonessential questions may be different based on ED demographic. Emergency departments plagued with long wait times and high volumes of patients should consider a phased patient assessment removing nonessential questions from the triage burden.

## Author Disclosures

Conflicts of interest: none to report.

This work was funded by the Emergency Nurses Association Foundation for Dr Punches' study "Emergency Healthcare Providers' Perceptions of Opioids and the Emergency Department."

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# Scientific Approach to Assess if Change Led to Improvement—Methods for Statistical Process Control Analysis in Quality Improvement

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CE Earn Up to 10.5 Hours. See page 206.

**Contribution to Emergency Nursing Practice**

- The current quality improvement literature and varying methodologies advocate for the use of statistical process control charts for analysis and ability to infer causation from interventions.
- This article contributes a guide for creating and analyzing statistical process control charts to assess for change in quality improvement projects.
- Key implications for emergency nursing practice found in this article include education for nurses and nurse managers to improve understanding of statistical process control, intervention analysis, and process changes in quality improvement projects.

**Key words:** Quality improvement methodology; Statistical process control charts; Quality improvement analysis; Nelson rules

Quality improvement is an expectation in most hospitals and emergency departments throughout the United States. With hospitals requiring reporting on key metrics such as readmission rates, time to thrombolytic administration in stroke, or time to cardiac catheterization laboratory activation for ST-elevation myocardial infarctions, many emergency departments deploy quality improvement teams to monitor and improve these metrics and others to promote quality and safety. Emergency nurses and managers are key members and leaders of these quality improvement teams. Knowledge of the process and methodology employed to analyze the results of quality improvement initiatives will help the emergency nurse contribute to and lead projects.

In the 1920s, the "Father of QI," Dr W. Edwards Deming, described quality improvement for industry as a "never-ending cycle of continuous improvement." Quality improvement continued to evolve throughout the 1950s and '60s both in industry with Toyota Production Systems' emphasis on decreasing variation, and in health care with the adoption of review committees such as the Joint Commission on Accreditation of Healthcare Organizations.[1] Multiple models for organizing quality improvement projects exist, including Lean Six Sigma's Define, Measure, Analyze, Improve, Control, and the Institute for Healthcare Improvement's Plan-Do-Study-Act (PDSA) cycles.[2-4] Models for translation and replication of projects to other environments

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J Emerg Nurs 2021;47:198-205.
Available online 23 October 2020
0099-1767



https://doi.org/10.1016/j.jen.2020.09.002

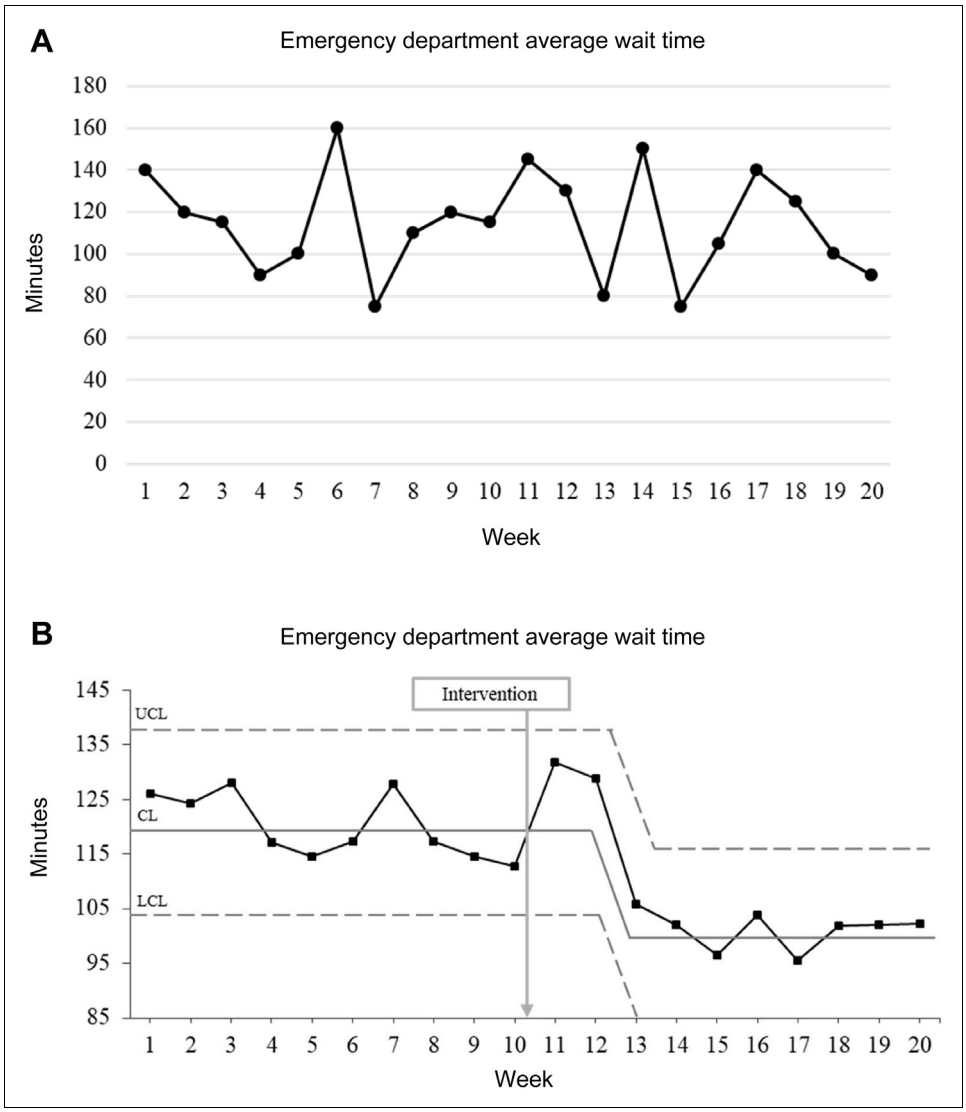


FIGURE 1

Run chart vs control chart. (A) Run chart of average emergency department wait times per week. Y-axis: average emergency department wait time, x-axis: week. (B) Control chart of average emergency department wait times per week. Note the addition of a center line and upper and lower control limits. A shift in the data is present with a subsequent shift in the center line and upper and lower control limits at week 12. UCL, upper control limit; LCL, lower control limit; CL, center line.

include the Reach, Effectiveness, Adoption, Implementation, and Maintenance framework.[5] Our hospital uses the Institute for Healthcare Improvement's framework for organizing quality improvement projects, using tools such as process maps, fishbone diagrams, key driver diagrams, and Pareto charts. Regardless of which framework is chosen for a quality improvement project, the measurement of data changes is essential to establish if an intervention leads to change. In addition, quality improvement best practices focus on establishing the baseline performance of a process before formulating and implementing an intervention. By using statistical process control charts to follow key metrics over time, quality improvement teams analyze if their intervention leads to change.

A key difference between quality improvement projects and traditional research is the statistical models used to analyze the data. Dr Deming described 2 types of studies: (1) "enumerative" studies done on a static population, and what we think of as traditional health care research; and (2) "analytic" studies done on a dynamic or real-life process tracked over time and more associated with quality improvement.[6] Traditional research statistical analysis requires a static control group to compare with an intervention group.

Alternatively, quality improvement focuses on a "stream" of people/patients exposed to a process over time where a large amount of inherent variation within the system and patient population is expected. In quality improvement analysis, one does not control how many, or which type of, patients present to the process. Thus, quality improvement statistical models analyze if changes are due to random variation inherent to the process, or if they are true markers of change.

## Basics of Control Charts

Dr Walter Shewhart, considered the "father of statistical quality control," first proposed the use of control charts within the electric industry. Shewhart proposed the use of control charts to measure a process over time, and detect if an intervention led to a change in process. In collaboration with Dr Deming and Dr Joseph Juran, Shewhart created this foundation of quality improvement analysis for the manufacturing industry more than 100 years ago.[7] Medicine only recently adopted these methods.

Shewhart introduced 2 charts to assess a change in process. In all charts, the metric is plotted over time, where the x-axis is a unit of time, and the y-axis is the data value at each time point such as averaged emergency department wait time each week (x-axis: week, y-axis: average emergency department wait time). The first type of chart is a "run chart" in which the data points (ideally a minimum of 15 points) are plotted with a line connecting the points sequentially and a horizontal line at the median (Figure 1A). Run charts can show trends or shifts, but analysis of run charts is limited because they can miss significant process changes, and they are unreliable in assessing the capability of the process or predicting the future.[8]

Shewhart thus proposed applying statistical methods to produce the second type of chart, a "control chart." Control charts similarly plot increments of time on the x-axis, with the key quality metric being measured on the y-axis, but they also include upper and lower control limits and a center line. Shewhart noted that all processes have natural variation, and the distribution of this natural variation will follow the distribution of a traditional bell-shaped curve. For example, in the course of a week, the emergency department average wait time will vary from day to day, but will predictably fall in a specific range more than 95% of the time. In a normal bell-shaped distribution curve, the center line is the median, mean, and mode, and approximately 68% of the data points are within $\pm 1$ SD, approximately 95% of the data points are within $\pm 2$ SDs, and 99.7% of the data points are within $\pm 3$ SDs of the center line. A control chart defines the upper control limit as $+3$ SDs above the mean/center line, and the lower control limit as $-3$ SDs below the mean/center line (Figure 2). Returning to the emergency department wait time example, when the emergency department average wait time is plotted over time, 99.7% of the time the wait time will be between the upper control limit and lower control limit (Figure 1B). However, special factors (eg, a national pandemic such as coronavirus disease [COVID-19]) may cause the average emergency department wait time to be outside the range of the calculated upper and lower control limits. Shewhart created multiple types of control charts to account for several different types of variables.

## How to Choose the Appropriate Control Chart

When selecting the appropriate Shewhart chart for process analysis, the quality improvement team must consider both the kind of data being analyzed and the distribution (spread around the center point) of the data (Figure 3). Data is first classified as either "attribute" (frequency of event, ex: percentage of time ED length of stay is less than three hours) or "continuous" (measurement on a scale, ex: they daily average ED length of stay in minutes).

For attribute data, where we are classifying (yes/no), we see binominal distribution as a percentage and use the "p-chart." Where we count/rate the proportion of the events, we see Poisson distribution and select either the "c-chart" (fixed opportunity) or the "u-chart" (variable opportunity).

For continuous data, we see binominal distribution, and with a sub-group size of 1, we may use the ImR chart; or with a sub-group $<8$ to 10, the Xbar & R chart; or with a sub-group $>8$ to 10, the Xbar & S chart. Algebraic formulas for manual computation are available in many standard quality improvement texts and robust statistical tools such as Minitab (Minitab, LLC); or Microsoft Excel (Microsoft Corporation) add-ons such as QI Macros (KnowWare International, Inc) are available to automate the calculations for the various charts' center lines and upper/lower control limits (Table).

## Common or Special Cause Variation?

Once the data is plotted using a control chart, the team must look at the variation within the data. Variation can be visualized in the movement of the data points around the center line. Some variation is expected or predictable. Examples of expected variation include hospital census from weekday to weekend (larger hospital census on weekdays), or emergency department wait times over a 24-hour period (longer wait

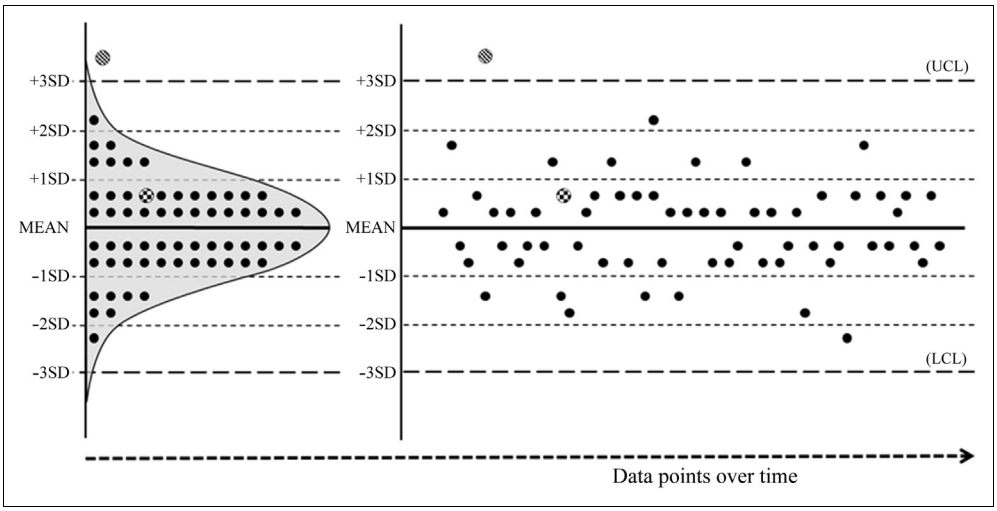


FIGURE 2

Bell-shaped curve distribution of data on a statistical process control chart. LCL, lower control limit; UCL, upper control limit.

times at 4 PM than at 4 AM). This type of variation is called "Common Cause Variation" because it is inherent within the system, and therefore affects everyone working on the process and all outcomes of the process.[13] If a process only exhibits "common cause," the process is stable and in a state of statistical control. Common cause variation can generally be identified on a statistical process control chart by data points between the upper and lower control limits without an identifiable pattern.

Variation that is irregular or unpredictable is called "Special Cause Variation." Special cause variation demonstrates an unstable system that results from causes not inherent to the system, may not affect everyone working on the process, and generally arise from special circumstances.[13] Examples of this include changes in emergency department daily census volumes owing to COVID-19, or laboratory turnaround times when a machine is broken. Importantly, special cause variation may arise from

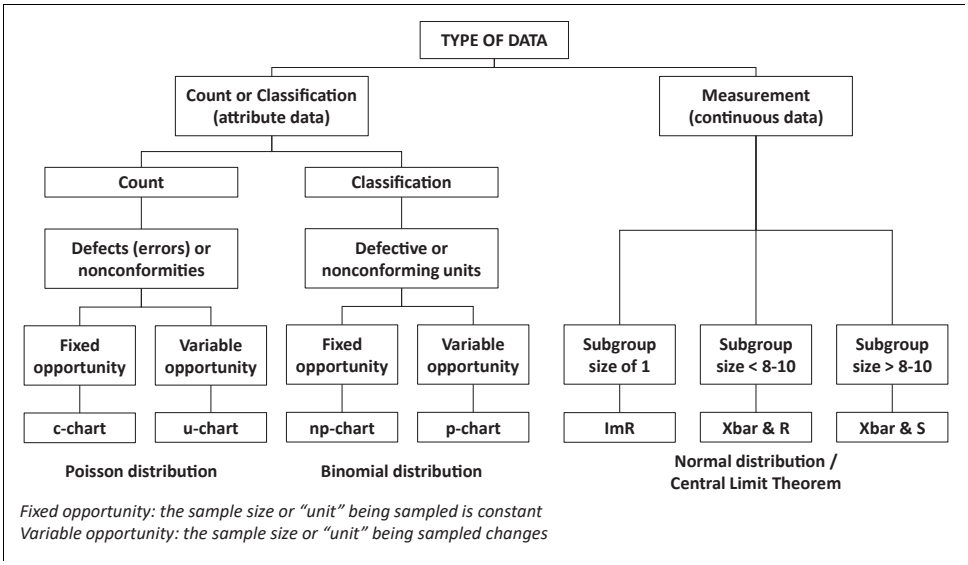


FIGURE 3

Flowchart for how to choose the appropriate statistical process control chart. Adapted with permission from *The Lean Six Sigma Pocket Tool Book*. G. Michael, D. Rowlands, M. Price. McGraw-Hill, 2005.

TABLE
**A sample list of available resources on statistical process control analysis**[9-15]

| Learning level | Published resources |
|---|---|
| Basic | Carey RG, Lloyd RC. *Measuring Quality Improvement in Healthcare: A Guide to Statistical Process Control Applications*. 1st ed. American Society of Quality Press; 2001. |
| | Arthur J. *Lean Six Sigma for Hospitals: Improving Patient Safety, Patient Flow and the Bottom Line*. 2nd ed. McGraw-Hill Education; 2016. |
| | Arthur J. *Breakthrough Improvement with QI Macros and Excel: Finding the Invisible Low-Hanging Fruit*. 1st ed. McGraw-Hill Education; 2014. |
| Intermediate | Carey RG, Staker LV. *Improving Healthcare with Control Charts: Basic and Advanced SPC Methods and Case Studies*. ASQ Quality Press; 2002. |
| | Langley GJ, Nolan TW, Provost LP, Norman CL, Moen RD, Nolan KM. *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance*. 2nd ed. Jossey-Bass; 2009. |
| Advanced | Provost LP, Murray SK. *The Health Care Data Guide: Learning from Data for Improvement*. Jossey-Bass; 2011. |
| | Sollecito WA, Johnson JK. *McLaughlin & Kaluzny's Continuous Quality Improvement in Health Care*. 5th ed. Jones & Bartlett Learning; 2018. |

interventions in PDSA cycles implemented in quality improvement projects. Special cause variation can be identified on a statistical process control chart by data points outside the upper or lower control limits, or points with an identifiable pattern. Quality improvement teams look for special cause variation associated with interventions to evaluate if these interventions are changing the system.

A key to maintaining valid statistical methods in quality improvement analysis is to first establish a baseline, and use it to establish the control chart center line and upper and lower control limits. If the baseline period shows that the process is in control, that is, only common cause variation is evident, and no instances of special cause variation exist, the quality improvement team can then implement an intervention. However, if a quality improvement team plots a control chart, and sees that there are multiple cases of special cause variation, then the team must standardize the process or define the data before implementing any interventions. If a quality improvement team implements their intervention on an unstable process, identification of a special cause variation may be falsely attributed to an intervention, leading the team to inappropriately assume that the intervention created the change.

## Application of Nelson Rules to Control Charts

After creating a control chart, the team determines whether the process demonstrates common cause variation or special cause variation. Eight rules assess for special cause; the initial 4 were postulated by Western Electric in the 1950s, and then were later updated by Lloyd S. Nelson in 1984.[16] The special cause rules are as described in Figure 4. Once a sign of a special cause manifests itself, this indicates a shift in the process, and the quality improvement team should recalculate a new mean and new control limits (Figure 1B). The most frequently used rule to validate a center line shift is when nine consecutive points above or below the mean are noted on the control chart.

In some cases, a change in data immediately follows a quality improvement team's PDSA intervention. In other cases, a change may lag behind the intervention, or no change may be seen at all after an intervention. Assessing the data over time allows the quality improvement team to determine if a center line shift has occurred in relation to an intervention. Then the quality improvement team can assert that their interventions led to a meaningful change (Figure 5).

## Why Cannot We Just Compare Data From Before and After an Intervention?

Most researchers are accustomed to working with defined populations. Often this is 2 groups—a control group and an intervention group—or alternatively 1 group that is evaluated before and after an intervention. Familiarity with this way of evaluating the effects of an intervention often leads to quality improvement teams using the same evaluative methods to assess the effects of an intervention applied to an ongoing process. However, this is a fatal mistake because combining all the data from before the intervention and combining all the data from after the intervention introduces a time break in the data that may or may not be correlated with when the data changed. The goal with quality improvement is not to see if the data are different after the intervention; it is

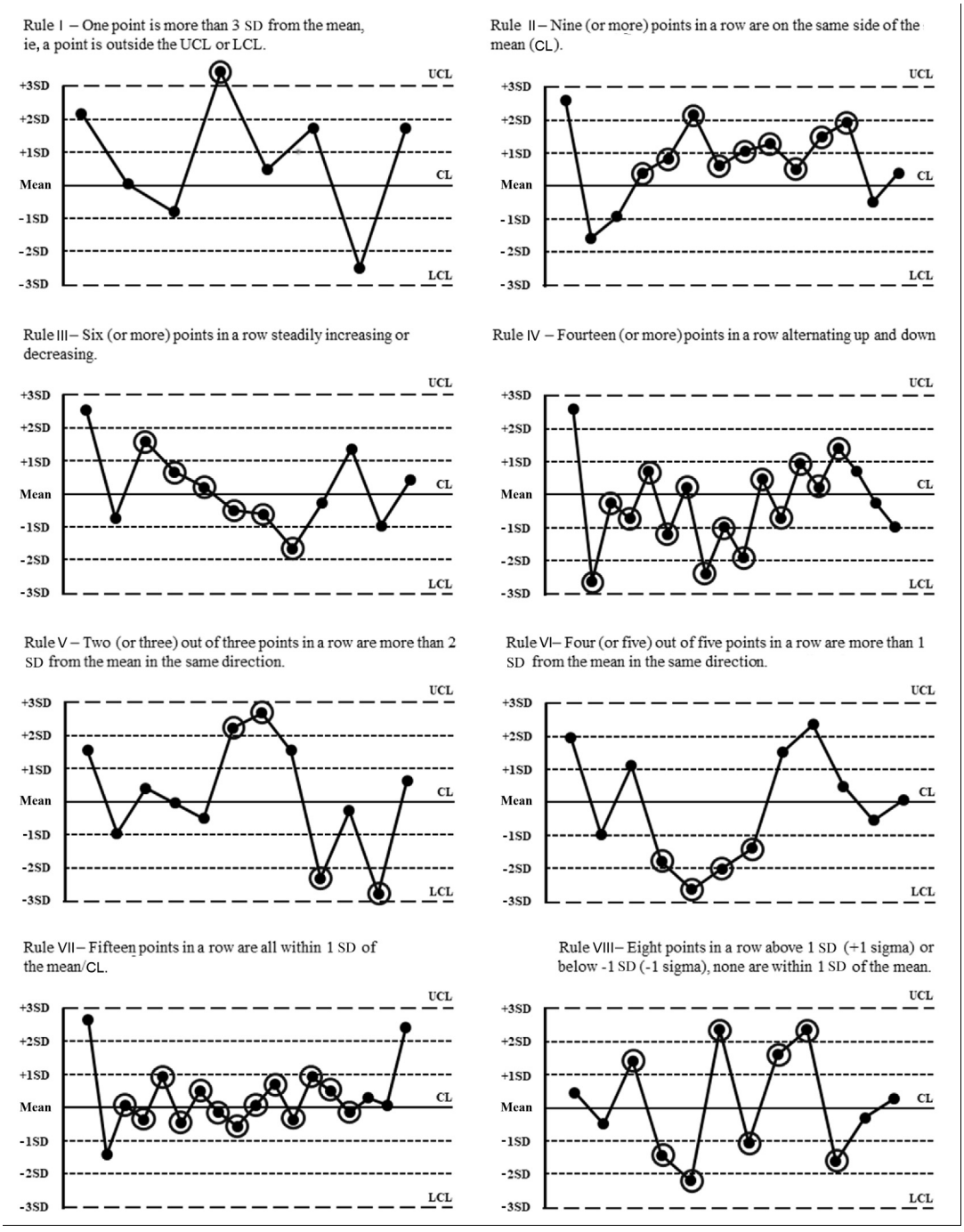


FIGURE 4

Nelson rules for tests of special cause. Each panel provides a rule and its graphical demonstration on a statistical process control chart with the center line, upper control limit, and lower control limit. CL, center line; UCL, upper control limit; LCL, lower control limit.

to see if the data are different because of the intervention. The only way to know this is to plot the data repeatedly over time, annotate when the intervention took place, observe for when the data changed (if at all), and see if the intervention and the data change are temporally correlated.

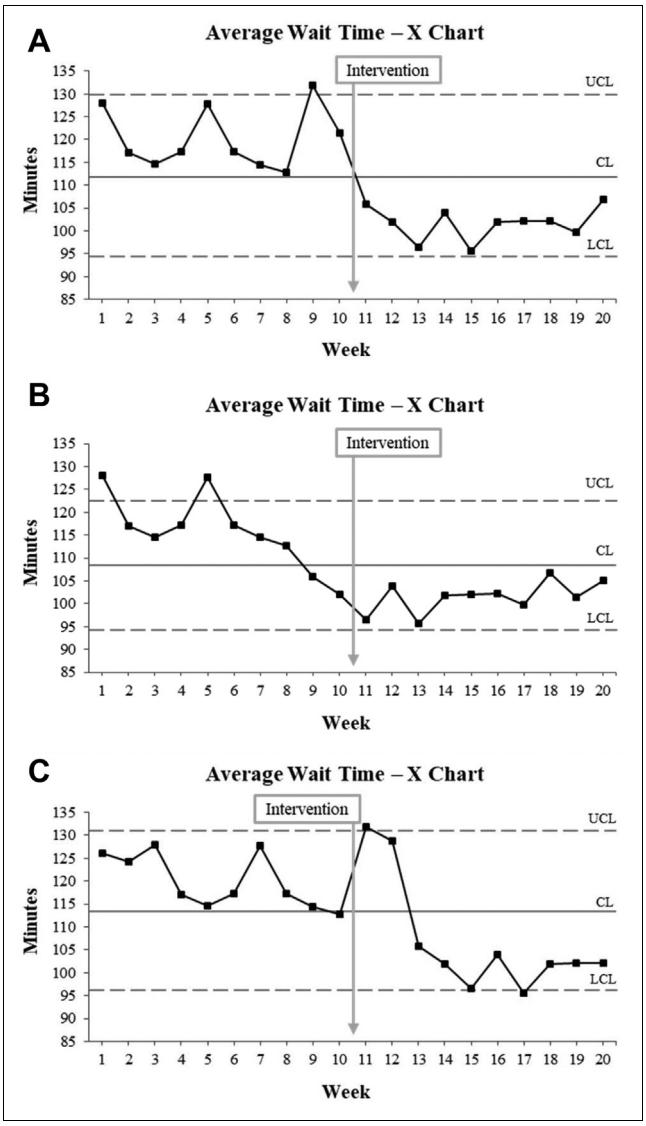


FIGURE 5

Statistical process control charts demonstrating change after an intervention. Data on average wait time collected for 20 weeks and plotted on an x-bar chart, with an intervention occurring at the end of week 10. (A) The shift in wait times occurs directly after the intervention at the end of week 10. (B) The shift in wait times begins in week 8, 2 weeks before the intervention, indicating that the change was occurring before the intervention. (C) The shift in wait times occurs after week 12, 2 weeks after the intervention. UCL, upper control limit; LCL, lower control limit; CL, center line.

Consider an example of an emergency department quality improvement team tasked with improving their emergency department length of stay. A new process was implemented on New Year's Day 2020. The team compared the average and SD of the emergency department length of stay for the last 6 months of 2019 and the first 6 months of 2020, and indeed there was a statistically significant difference. Does this mean that the intervention was responsible for the change? It is quite possible that the length of stay had a sudden and stable improvement 2 months before the intervention, or 2 months after the intervention. Or, alternatively, did the emergency department length of stay improvement in 2020 result from the overall decrease in emergency department volumes seen at many places in the US in March and April because of COVID-19? There would be no way to see this external cause if the data from 2019 and 2020 were grouped into annual statistics. By plotting the data on a statistical process control chart, the quality improvement team would see a significant change starting in March 2020—2 months after the intervention—that caused a noticeable change in the data, that is, COVID-19. Thus, the improvement cannot be attributed to the intervention implemented in January 2020.

Unfortunately, while some authors may appropriately plot data over time, it is not accurate to force a break in their data sets for statistical analysis at the time of the intervention. Consider the scenario presented in Figure 5 where 20 weeks of average wait time is plotted on an SPC x-bar chart and the team enacted an intervention at the end of week 10. For all three panels a traditional statistical test (t-test) comparing the 1st ten weeks to the 2nd ten weeks would give a Pvalue of $<0.001$. In Figure 5A, the change occurs directly after the intervention in week 10 suggesting a cause and effect relationship, and the QI team would correctly conclude their intervention lead to the change. However, in Figure 5B wait times begin shifting in week 8, 2 weeks prior to the intervention and indicating change was occurring prior to the intervention. Therefore, the QI team should conclude that another factor besides the intervention lead to the change. Alternatively, in Figure 5C, the shift in wait times occurs after week 12, 2 weeks after the intervention, indicating that unless the QI team can account for the lag, ie. provider hesitancy in adoption of new protocol, the intervention did not directly lead to the change. Thus, without analysis through SPC charting and Nelson's rules, cause and effect conclusions cannot be made. So while data cumulative analysis of data before and after an intervention may create an illusion that the data changed concurrently with the intervention, the only way to make the correct correlation is to plot the data over time, and create a new data phase only when a Nelson rule[16] is met.

## Implications for Emergency Nursing Practice

In the emergency department, nurses and nurse managers are integral to quality improvement projects. From this article, nurses and nurse managers will learn how to improve their ability to read and understand control charts, and their

ability to assess for change in a process due to an intervention from accurate interpretation of the statistical process control charts. Ample opportunities for quality improvement projects exist in the emergency department, and through understanding of quality improvement statistical process control analysis, emergency nurses can act as leaders in process changes.

## Conclusions

Ultimately, emergency nurses working at the bedside play vital roles on emergency department quality improvement teams. Knowledge of quality improvement methodology allows emergency nurses to contribute as leaders on quality improvement teams. Using data and quality improvement statistical methods helps teams better understand the effect that interventions have on the process. Only after establishing a baseline and plotting the data over time on the appropriate statistical process control chart can a quality improvement team assess for a special cause variation or a center line shift. Statistical process control charts show special cause temporally related to an intervention more accurately than before-and-after studies by allowing the quality improvement team to demonstrate clear cause and effect from their planned changes. This fundamental understanding of statistical process control charting allows the emergency nurse to lead quality improvement teams and implement effective quality improvement projects.

## Acknowledgments

Doug MacDowell, BA, Division of Emergency Medicine, Nationwide Children's Hospital, Columbus, OH, for assistance with reference management and formatting.

## Author Disclosures

The authors' academic support is funded from internal funding from Nationwide Children's Hospital and the Department of Pediatrics at The Ohio State University, Columbus, OH.

Conflicts of interest: none to report.

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