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# Hope—We Are Seeing a Light at the End of the Tunnel

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I am writing my second message as the president of the Emergency Nurses Association. At the time of my writing, we are at the close of 2020. A year that seemed like a lifetime—2020. A year that cast many shadows on our lives and left many of us with feelings of uncertainty and fear. Fortunately, we are experiencing some hope now that the first coronavirus disease vaccine has been administered to frontline health care workers around the world. At the time of your reading this message, I am hopeful that we are getting close to or actually vaccinating the general public. As nurses, we are instrumental in educating the public in the science and evidence of the vaccine. We have to step up and dispel rumors and misinformation. Nursing has been considered the most trusted profession for the last 19 years,[1] and we need to use that trust to help get the public vaccinated and put an end to this pandemic for all of us.

This pandemic has taken a toll on all of us mentally and physically. We have to make sure we practice self-care and look out for each other. Only our fellow colleagues truly know what we have gone through…the only people that really get us is us. We face burnout and moral injury. Burnout is defined as a state of emotional, mental, and often physical exhaustion brought on by prolonged or repeated stress.[2]

Moral injury is defined as "…the challenge of simultaneously knowing what care patients need but being unable to provide it due to constraints that are beyond our control."[3] Both of these need our attention to help ourselves heal from the toll of the pandemic. We shall not subscribe to the negative stigma around mental health and the belief of some that those who reach out for help are weak. On the contrary, I believe those who seek out help and assistance in a time of need are the strongest.

In my message in the January issue of *Journal of Emergency Nursing*, I introduced the theme Elevate for 2021. Elevate yourself, your colleagues, our specialty of emergency nursing, our profession, and our communities around us. I challenged each of us to do something to elevate ourselves and our profession. What was your accomplishment? For the next issue, what will you be able to report back to yourself and others around you? Keep in mind the question: "What will I elevate and who will I elevate?"

As we are wrapping up the first quarter of 2021, we are certainly not done with the pandemic, but we are getting closer. We will still continue this fight. We are tired, but we will not give up. Remember the quote from Winston Churchill, "Never give in. Never give in. Never, never, never, never—in nothing, great or small, large or petty—never give in…."

Stay positive, stay focused, and be the good!
ELEVATE

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# Commentary on "Syncope in the Emergency Department: A Guide for Clinicians"

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Syncope is an important cause of ED visits. It is a potential life-threat, frightening for the patient and family, uses health care dollars and resources, and yet, most of the time, has a benign cause. The authors El-Hussein and Cuncannon[1] address the approach to the patient with syncope in the ED patient population in their recent manuscript entitled "Syncope in the Emergency Department: A Guide for Clinicians." This diagnosis epitomizes the emergency-licensed independent provider's primary duty—to sort the nonthreatening from the malignant in a single patient encounter. The authors synthesize the existing guidance around the patient with syncope and simplify this approach for the reader.

"The history taking in syncope has been referred to as history *building* to emphasize it's mutuality and diagnostic value" per the authors.[2] This sentence embodies the construct of the approach to the patient with syncope and illustrates that the relevant clues are often found in the history. Many of the clinical decision rules do not incorporate the historical features of the event itself; rather, they reveal the underlying clinical conditions of the patients, such as heart failure.[2] The adult and pediatric literature diverge in this regard, highlighting that the malignant causes of syncope differ across age ranges.[3] The authors correctly identify the difficulty generalizing 1 approach to syncope. The history should be taken carefully and questions asked to those that witnessed the event: considerations such as prodrome, exertion, syncope related to recent medications, position of the patient during the event—supine or during sleep indicating a more malignant cause. The history should involve asking for sudden death in any family members or a history of uncontrolled seizures, near drowning, and single vehicle car crashes.[4] Bystanders will often describe the event as seizure-like. We have previously shown that patients presenting with syncope versus seizure were 10 times more likely to get an electrocardiogram (ECG) in the emergency department, despite seizure being a common presentation of malignant syncope.[5] ED patients by definition have inherent selection bias; these patients were very concerned about this event, enough to present to an emergency department rather than wait for their primary provider's office to open.[6]

The physical examination clues such as facial trauma should alert the clinician that the patient did not have time to catch themselves–that there was no prodrome.[7] Tongue biting or incontinence may suggest seizure over syncope, although seizure may be the first presentation of an inherited sudden death condition.[8] A murmur could indicate aortic stenosis or hypertrophic cardiomyopathy, which alone has significant morbidity and mortality associated with it. The physical examination, with emphasis on the location of injury to the patient, should not be ignored, as described by the authors.[9] The physical examination, however, may be unrevealing because many ED patients present well-appearing after the concerning event.

Syncope caused by cardiac events portend the highest mortality and have resulted in an abundance of research in this arena. The single most important diagnostic test obtained by the emergency provider in the setting of syncope, including convulsive syncope, is the 12-lead ECG.[10] The ECG should be interpreted in the setting of syncope instead of chest pain. This distinction is important; the provider should obviously not miss ischemia but should be more concerned for subtle findings indicating conduction system abnormalities such as heart block or inherited channelopathies such as long QT syndrome or Brugada syndrome.[11]

Patients with dilated cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy[12] also have characteristic ECG findings that should alert the provider to the younger person with a malignant cause of syncope.[13] The reason most clinical decision rules incorporate acute coronary syndrome or previous myocardial infarction is that patients with damaged myocardium are more vulnerable to scar-inducing ventricular tachycardia.[14] Age ranges for ECG commonly missed abnormalities are difficult to identify in the emergency department, which is why the story plus the ECG in this population are so vital in distinguishing malignant from benign.[6]

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Older patients with syncope should be considered with a different lens than younger patients presenting with syncope. The "FAINT" score, one of the more recent syncope clinical decision scores that has not been externally validated yet, is mentioned in El-Hussein and Cuncannon's article. Probst et al performed a robust prospective, multicenter trial evaluating older adults presenting to the emergency department with syncope looking at 30-day all-cause mortality or serious cardiac outcomes.[15] They derived the FAINT score including the following: history of heart failure, history of cardiac arrythmias, initial abnormal ECG, elevated pro–B-type natriuretic peptide, and elevated high-sensitivity troponin. A point was associated with each of the categories. A FAINT score of 0 was associated with a 96.7% sensitivity for excluding death in the next 30 days.[15] Thus, the older patient with syncope warrants a more comprehensive approach, as the authors pointed out. The history should include preceding events, a medication reconciliation, history of falls, and reasons for underlying orthostasis. Although we have shown that abnormal orthostatic vital signs in the emergency department do not predict 30-day mortality in the elderly, it is still an important cause of syncope and preventable falls in this population.[16]

The problem is not in identifying a high-risk population that can be safely discharged from the emergency department, the problem is identifying those that may have had aborted sudden cardiac death. Many ED observation pathways focus on the patient with syncope; however, even if admitted to the hospital, another event would be unlikely in the next 24 to 72 hours.[17] Admission to the hospital, which is sometimes used as the final protective action for the emergency provider in the case of syncope, not only fails to prevent sudden death but is expensive and a waste of resources.[18]

Is the answer shared decision-making instead of clinical decision rules?[19,20] The authors make a solid case for this approach, which is particularly relevant for this syncope diagnosis.[1] Shared decision-making was meant for a common ED complaint that could happen again remote from the ED visit, affect other members of the same family, and cause sudden death. This conversation involves discussion of the relevant parts of the history, physical examination, ECG, and ancillary test findings. The shared decision-making must encompass the risk of inherited sudden cardiac death conditions, highlighting the need for a detailed and extended family history and emphasizing the need for subspecialty follow-up if indicated. The provider and the patient and patient's family must engage in a discussion around the real and perceived risks of the first faint, and the possibility of this faint being a warning signal. The shared decision-making discussion can walk through the clinical decision rules of their choice but highlight that admission to the hospital is not the way to prevent downstream bad outcomes.[21] Rather, this discussion should emphasize the specific next steps and the importance of the after-visit instructions because syncope can herald sudden death in not just the patient but the entire family.

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# Proning Pains: Recognizing the Red Flags of Body Mechanics for Health Care Workers Involved in Prone Positioning Techniques

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It is without doubt that the coronavirus disease (COVID-19) pandemic has significantly affected the emergency and critical care communities in how health care professionals treat patients, both ventilated and nonventilated, with acute respiratory distress syndrome (ARDS). The practice of placing a patient with COVID-19–associated ARDS in the prone position has become part of the routine treatment because this position allows for greater expansion of the posterior portion of the lungs, resulting in more efficient removal of pulmonary secretions and, ultimately, improved oxygenation of the patient.[1,2] From a health care clinician's standpoint, however, this positioning technique can be quite labor-intensive because several health care clinicians and direct care aides are required to safely transition the patient from a supine position to a prone position, all the while maintaining hemodynamic and oxygenation stability.[3] Even more concerning is the recognition that placing a patient in the prone position greatly increases the health care worker's risk for musculoskeletal low back injury[4] (Figure), resulting in negative consequences for the injured worker, the staffing needs of the organization, and the overall health care pandemic response.

Although Wendt et al[2] examined responsive patients who were able to primarily reposition themselves with assistance to a prone position, not all patients who would benefit from the prone position are able to reposition themselves and the health care team must perform the position change. Whether manually positioning or using a mechanical lifting device, the harsh reality remains that placing a patient in the prone position requires significant physical handling. In basic terms, initiation of the prone position means that the patient is transferred to 1 side of the bed, rotated into a lateral side-lying position, then carefully transitioned downward onto the abdomen and into the prone position. Such movements necessitate a well-coordinated team effort that can safely and efficiently manage the patient physically and medically, while also promoting proper body mechanics and musculoskeletal preservation of the health care team performing the movements. The biomechanical findings of previous research indicate that the tissues of a health care worker's lumbar spine fail at a higher rate when in a flexed position, specifically at a position greater than 22.5° flexion.[5] Although such positioning is difficult for the health care worker to avoid altogether, it must be limited to protect the overall musculoskeletal health of the worker's lower back.

Although seasoned health care workers perform countless patient positioning movements during any given shift at work without giving them much thought, each portion of these common movements places the worker at risk for a musculoskeletal injury. We advocate for conscious attention and respect of musculoskeletal movement and potential for injury during patient positioning. The first step in preparing a patient for prone positioning is to place a draw sheet or lifting straps under the patient.[3] From a lumbar spine protection perspective for the clinician, having 1 of these placed before the patient is placed on the bed or gurney would be ideal. To do this, members of the team first flank the patient. With the bed or gurney raised to working hip height (recognized as a consensus among health care workers of approximately the same height)[6] to midthigh as discussed later in the article, at least 2 team members are needed to reach across the patient to the opposite side; this movement places the nurse in a position of extension for the lumbar spine,[5,7,8] which is the first red flag for musculoskeletal injury. Ideally, 1 member grips the patient's shoulder and hip, while the other member grips the patient's upper thighs and midtorso, creating an interlocked force with the first team member.[9]

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On a count of 3, the 2 team members will generate the force required to rotate the patient into a lateral or side-lying position[4] (musculoskeletal injury red flag 2). Typically, health care workers generate this force from the muscles of the lower back or from the arms and shoulders.[10] Although the force exerted for smaller-statured patients may not pose a significant risk for injury among multiple health care workers, an increased force is required if the number of staff members is reduced or the patient is larger in mass.[4] From here, the patient's body weight is held and supported by the team members, while another team member places a draw sheet or lifting straps. At this point in time, we recommend that any slide boards being used are placed under the patient as well.[11] After rotating the patient back into a supine position, the procedure is then repeated from the opposite side of the bed to facilitate the correct and complete placement of the draw sheet or lifting straps.

The next phase of placing a patient into the prone position involves rolling the patient into a lateral position again and transferring them to the opposite edge of the bed[3] (musculoskeletal injury red flag 3). For this, some members of the team will use a pulling motion of the draw sheet/lifting straps, while those on the opposite side work to support the patient in this side-lying position. Pulling motions typically involve the use of the worker's lower back muscles; starting in a position of extension, the worker reaches forward to grip the load, then moves to a position of flexion, often with a rapid motion.[4,7] This rapid movement from extension to flexion uses the muscles of the lower back to complete the movement rather than those of the legs (as recommended), thus increasing their likelihood for injury.[4] Having a slide board or friction-reduction device under the patient takes up to 70% of the load away from those pulling the patient,[11] which is why such devices are highly recommended, if not altogether required.

The final phase of prone positioning involves lowering the patient to their abdomen.[3] This motion requires team members on 1 side to push and support the weight of the patient, while those on the other side implement pulling movements to support the weight of the patient[4] (musculoskeletal injury red flag 4). Here, all team members find themselves in positions of extension while they work to support the weight of the patient as the patient is gently lowered into the prone position. Final repositioning with pillow placement and limb positioning occurs at this point, and the prone positioning technique is successfully completed.[3]

As emphasized here, although prone positioning techniques have demonstrable benefits for patients with COVID-19–associated ARDS who are poorly oxygenated,[2] when the health care team must perform the position change there are greater risks for musculoskeletal injury associated. Despite an evident reduction of weight-bearing load associated with the use of overhead lifting devices, many emergency departments simply are not outfitted with this type of lift equipment. Furthermore, manual lifting, turning, and repositioning of the patient can never truly be eliminated. Even when using overhead lifting devices, the health care worker must still manually reposition the patient so that the lifting straps can be placed.

1. Lumbar spine in position of extension for the moving of patient to lateral position.
2. Generating force with the lumbar spine in an extended position.
3. Rapid movement of the spine from position of extension to position of flexion to both rotate the patient lateral and then move the patient to edge of bed.
4. Supporting of the body weight to lower the patient while in a position of lumbar spine extension.

FIGURE

Red flags for musculoskeletal injury.

Despite the lack of access to overhead lifting equipment in many emergency departments, best practice continues to indicate the use of these and friction reduction devices whenever available. These devices provide a significant reduction in patient load,[12-14] thus reducing the force on the lower back and shoulders of the worker using them. The principles of basic body mechanics also continue to remain important[15]: our recent research advances the science to consider the bed height should be positioned at approximately midthigh for the shortest member of the lifting team. This allows all participants to get into a squatting position for the lift. Lifters should aim for neutrality of their spine when possible, which may require the lifter to grip the sheet further away from the patient.[15] A neutral spine and squatting position best allows the lifter to generate force for the movement with their arms and legs rather than their lower back.[16] Furthermore, when gripping sheets, it is recommended that the lifter use an underhand grip, which best allows the shoulders to remain in proper alignment throughout the lift,[4] resulting in less strain on the joint and surrounding tissue.

Although lifting in these recommended positions does not completely eliminate the risks of musculoskeletal injury for health care workers, it does greatly reduce such risks.[15] Learning to recognize the red flags (Figure) of body mechanics among those involved in prone positioning of patients with COVID-19 can only help to better protect the safety of our patients, our workforce, and our health care organizations as we continue our fight in providing effective care during this time of pandemic.

## Author Disclosures

Conflicts of interest: none to report.

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# Leading and Accelerating Change

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For over a year, emergency nurses around the world have been at the forefront of the coronavirus disease pandemic response. The emergency care sector was already at the breaking point, especially in the United States, well before the onset of the pandemic.[1] The pandemic has led to a loss of life among the general population, the loved ones of our emergency nursing community, and our own health care workers. Public outcry about the need to change health care, fueled by problems exacerbated by the pandemic, has created an urgency and priority for care reforms and improvements.

Over 50 years ago, the Emergency Nurses Association (ENA) founders, Anita Dorr and Judith Kelleher, created the organization as a vehicle to advance training and skills among nurses in the emergency care setting and to institute widespread improvements in patient care.[2,3] Our founders' and our own subsequent collective efforts through ENA's first 50 years modeled for us how successfully and adeptly we can envision, create, and accelerate positive and meaningful change. Now, we are responding to the deadliest pandemic since the ENA's inception, which has continuously tested the knowledge, skill, endurance, and dedication of emergency clinicians beyond most human limits. We collectively lift up in solidarity each emergency clinician who has been surrounded by the prolonged physical, mental, emotional, and spiritual devastation and isolation of this global disaster. For some, the severity and scarcity inherent to this pandemic lifted their capabilities to new heights. The challenge awakened their tremendous personal and professional skill, strength, creativity, and tenacity. For many, the challenges of the pandemic have often seemed too much for any one person to bear. Too difficult to endure. Too demoralizing to soldier on.

After taking time to rest, to grieve, and to replenish, let us join together to recalibrate our perspective to envision what possibilities stretch beyond this last year's exhaustion, shortages, needs, and fatalities. We carry the struggles with us, not to be discouraged and dejected by these trials but to rededicate ourselves to the clearly unfinished work to optimize clinical care and patient outcomes in the emergency care setting. Providing emergency nursing care during the pandemic may have left scar tissue physically at infection sites, emotionally through loss, and spiritually as we press through times of potential cynicism and hopelessness. Collectively, one path to healing is finding new meaning and purpose in the challenges we share and overcome in any major disaster.

This editorial is my call that we not give in to cynically accepting the flaws and limitations of the health care system, so clearly evident under the pandemic's demands. Let's not give in to normalizing avoidably poor patient outcomes. Let's not give in to unacceptable working conditions. In the metaphorical ashes and aftermath of the coronavirus disease pandemic, let us dedicate ourselves anew to lifting up one another and accelerating the needed change to better emergency nursing care. It is now up to us to create important ways to honor those we lost in this disaster. It is up to us to emerge, look for strength within and among us, and dedicate ourselves collectively to continue to push for positive change. It is up to us to ensure a purpose in emergency nursing so that, in the words of Abraham Lincoln, "these dead shall not have died in vain."

Each emergency clinician can easily generate a list of system and unit changes that can improve their work environments and patient outcomes. Emergency clinicians also have the superb prioritization skills to determine the timeliness and importance of each of these problems, and to focus on the problems most likely to generate an impact. No one is exempt from the responsibility of organizational change and improvement. If every person at every level of a hospital or emergency care system is not leading the change in a positive manner, it is unlikely that any planned change will be sustainable long-term. Even though emergency nurses are often expert at identifying and prioritizing both organizational and patient problems, we often do not have the processes or tools at hand to lead and accelerate change. Kotter's

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8 steps of change is an excellent, shared mental model for leading successful, sustainable change.[4] Briefly, Kotter's 8 steps to lead and accelerate change are:[4]

- CREATE a sense of urgency
- BUILD a guiding coalition
- FORM a strategic vision
- ENLIST a volunteer army
- ENABLE action by removing barriers
- GENERATE short-term wins
- SUSTAIN acceleration
- INSTITUTE change

I first learned about Kotter's 8 steps of change as part of a hospital-system-wide TeamSTEPPS communication intervention.[5] A brief ebook is freely available at the author's website, along with additional tools and learning aids for emergency nurses who wish to apply the process of leading change in their organizations.

We emergency nurses, as part of a professional specialty organization, have a proud and successful history of leading and accelerating change. In the final manuscript in our ENA 50th Anniversary celebration, Milbrath and Snyder[3] provide a historical analysis of the top 3 policy issues addressed in the ENA's history: (1) provision of care for vulnerable populations, (2) trauma and injury prevention, and (3) patient quality and safety. Many of our in-person 2020 anniversary year celebrations were cancelled and delayed due to the pandemic. I am writing this editorial as vaccination campaigns are just beginning to protect our health care workers and vulnerable lay population. In the hopes that March of 2021 will mark the date when we can begin to emerge from our isolation to celebrate together once again, I envision that the pandemic can serve as the inflection point marking when ENA progresses from leading change to also accelerating the needed improvements in our health care system.

## In This Issue of the *Journal of Emergency Nursing*

In addition to our 50th Anniversary celebration article, this issue of *Journal of Emergency Nursing (JEN)* includes a collection of articles focused on novel technology, coronavirus disease 2019 leadership, and cardiovascular care. Ivanov et al's research begins to bring emergency triage into the advanced digital age by testing the accuracy of a machine learning algorithm for assigning Emergency Severity Index acuity.[6] The results tantalize the imagination with a future where patient care is more accurate and precise with human decision-making augmented and supported by real-time supercomputing tools. As part of an ongoing quality improvement project to reduce blood culture contamination rates, Arenas et al[7] test the monthly outcomes as new initial specimen diversion devices are introduced into the unit supply chain. The compelling data demonstrate the need for further clinical trials and provide initial evidence to support device use as part of a quality improvement bundle at adult emergency care sites with baseline contamination rates above national benchmarks.

Binder, Torres, and Elwell[8] provide the reader insights into the initial ED leaders' response to the early and emerging pandemic in the United States in a suburb of New York City. The potential for unscheduled staff absences is part of any infectious disease surge capacity disaster planning, and the authors uniquely quantify that up to 18.5% of the scheduled nursing staff called in sick at their March 25, 2020 peak. This may serve as an important percentage for future infectious disease disaster response planning and estimated reserve staffing needs. By relaying how the facility leaders flexibly adapted structures and processes at their site in the face of uncertainty and little previous evidence, the authors provide an important contribution to the literature on considerations for emergency care leadership in future, major infectious disease disasters. Implementing telehealth is an important and noteworthy facility intervention in the Binder et al manuscript. Brown[9] provides an explanation of the policy changes to the Emergency Medicine Treatment and Active Labor Act, or EMTALA, that have been temporarily implemented in response to the pandemic. One crucial area for continued change leadership and change acceleration continues to be the use of telehealth, and specifically telenursing, as an extension or alternative to future emergency nursing services and emergency nursing work redesign.[10,11] Wendt et al[12] describe the patient outcomes associated with awake proning for non-intubated emergency department patients. This project is the subject of two invited commentaries to clarify the potential of occupational back injury and the proning procedure for the clinical reader.

Several manuscripts in this issue of *JEN* have implications for cardiac skills and training in the global emergency nursing workforce. Picard et al[13] measured cardiopulmonary resuscitation compression quality using the CPRmeter 2 device as part of their quality improvement project. The authors' findings indicate that clinicians may be poor judges of the quality of the compressions we deliver, and objective feedback using these devices in education or practice promises to enhance the quality of care delivered during resuscitation. Hight et al[14] tested the time-to-results differences between the point of care and in-laboratory biomarker troponin testing. At this site where high sensitivity troponins had not been incorporated, the point of care troponin result was obtained, on average, 29 minutes faster than when specimens were sent to the laboratory. Penalo et al[15] clarify priority electrocardiograph rhythms for emergency

nurse competency, professional development, and orientation education. Their findings can easily be translated into a priority order for cardiac rhythm teaching in the specialty. *JEN* continues to welcome case reviews of rare or unusual presentations associated with cardiac dysrhythmias. Uhm and Jung[16] demonstrate an important area where emergency nurses technically proficient in defibrillator use can contribute to overall hospital nursing care quality. Here, among hospital nurses, only 13.6% had experience using a defibrillator during patient resuscitation, and only 32% reported self-confidence in defibrillator use. In this South Korean setting, deference to the physician's role was an important, potentially contributing factor to the nurses' reluctance to use a defibrillator. The international emergency nursing community is in an important position to model and educate on the knowledge, skills, and behaviors to optimize the independent nursing role during resuscitation and defibrillator use. Aligned with the theme of cardiac dysrhythmia and emergency resuscitation skills, Adams and Adams[17] provide a technical review of transcutaneous pacing procedures while El-Hussein and Cuncannon[18] provide readers with a guide for evaluating patients who present with syncope. Last, the morbidity and mortality found in Hanifi, Rezaee, and Rohani's[19] retrospective cohort study of patients in Iran presenting to the emergency department with a myocardial infarction reminds readers of the importance of emergency nurses' role in population health education. The study's implications remind all emergency nurses around the globe to include discharge instructions for all patients with cardiovascular risk advising not to delay seeking treatment for cardiac symptoms, provide smoking cessation resources and behavior change interventions, and address hypertension control follow-up.

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# Letters To The Editor

Letters to the Editor are encouraged and may be submitted at jenonline.org where submission instructions can be found in the Author Instructions.

## Impact of ED Triage Symptom- and Travel-Screening Strategy

*Dear Editor:*

Thank you for publishing the article entitled "Can you catch it? Lessons learned and modification of ED triage symptom- and travel-screening strategy" by Schwedhelm et al.[1] The authors' subsequent discussion on a recent Emergency Nurses Association podcast episode provided some additional helpful information ("Behind the Research in November *Journal of Emergency Nursing*," 2020).[2] The successful efforts to identify, isolate, and inform on patients with potentially communicable exposure, thereby reducing staff exposures, certainly warrant applause. However, certain additional pieces of information may be helpful for organizations discerning whether or not to apply this approach. These include, but are not limited to, clarification of the staffing model, further details regarding the 75% compliance rate, and the observed pre- and postimplementation metrics for (1) door-to-triage times, (2) door-to-provider times, and (3) left without being seen (LWBS) rates, at a minimum.

The article mentioned the use of a 24/7 "greeter nurse." Was the greeter nurse a distinctly separate person from the nurse performing triage duties? If yes, was a cost analysis done to evaluate the return on investment of this additional role, which is approximately 4.2 full-time equivalents, against the total cost of exposure, which would include time off and potential turnover?

For more than a decade, there has been ongoing discourse regarding what questions belong in an arrival/triage process and what questions should occur later in a visit.[3,4] More recently, the 2020 Emergency Nurses Association General Assembly adopted a resolution to further opine on screening questions during triage.[5,6] Identifying and isolating patients with potentially communicable diseases are certainly crucial. Although the authors discussed potential delays for the patients who had been positively screened, it is also important to note what impact, if any, occurred on preprovider evaluation times for all patients. Specifically, did the creation of this process lengthen the door-to-provider interval for all patients or have a negative impact on the LWBS rates?

Finally, can the authors further detail the "approximate 75% compliance rate"? Are there separate compliance rates for outpatient clinics compared with the emergency department? Were there any trends observed among the ED patients who did not have the screening completed?

In summary, it would be beneficial if future articles discussing the use of screening questions before provider evaluation also identify the impact of the process, if any, on ED throughput metrics, including, but not limited to, the door-to-provider interval and LWBS rate.—*Nicholas Alen Chmielewski, DNP, RN, CEN, CENP, NEA-BC, FAEN, Senior Managing Consultant, Berkeley Research Group, LLC, Emeryville, CA; E-mail: nchmielewski@thinkbrg.com.* ***ORCID identifier:*** *https://orcid.org/0000-0002-6543-9669.*

### Disclaimer

The views and opinions expressed are those of the author and do not necessarily reflect the opinions, position, or policy of his employer or its other employees and affiliates.

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## Response to Chmielewski Letter

*Dear Editor:*

We would like to thank Dr Chmielewski for his comments on our article "Can you catch it? Lessons learned and modification of ED triage symptom- and travel-screening."[1] Dr Chmielewski raises some important clarifying points that we hope will be addressed below.

The first set of questions posed by Dr Chmielewski is related to the use of a greeter nurse, available 24-7, who screens each patient as they present to the emergency department. The greeter nurse role was implemented at our hospital several years ago to optimize a quick clinical visual scan and collection of chief complaints to identify those needing immediate care (eg, chest pain and stroke symptoms) as well as to enhance overall patient and family experience. The greeter nurse also handles incoming phone calls from clinics or private offices wanting to move individuals who need a higher level of care to the emergency department, thereby reducing the burden on the charge nurse in the emergency department and enabling them to focus on ambulance traffic and overall clinical care. The greeter nurse performs triage duties only when the ED volume is low (between 3 AM and 7 AM); at all other times, 1 to 2 other triage nurses perform triage functions. With the ongoing coronavirus disease pandemic, the greeter nurse (donned in an N95 respirator and face shield) now also serves the role of relaying expectations related to the visitors of those seeking emergency care. As Dr. Chmielewski notes, the position requires additional full time equivalents. Anytime additional full time equivalents are considered, a cost benefit analysis should be performed. However, the role of greeter nurse can and has absorbed additional routine tasks and is multifactorial, from screening patients on arrival to reducing burden on the ED charge nurse by coordinating incoming calls to optimizing overall patient and family experience. Smaller hospitals with less ED volume and demand looking to replicate this model can be creative in adapting front end spaces to include the greeter nurse. This creative flexibility might translate into the triage nurse being out front and serving as both the greeter and triage nurse. Having a registered nurse in the role of a greeter nurse act as the first contact of any patient presenting to the emergency department improves patient safety and serves as a structured risk mitigation strategy for the registration staff.

The implementation of the detailed screening process did not lengthen the door-to-provider interval for all patients or otherwise have a negative impact on the left-without-being-seen (LWBS) rates; in fact, the creation and implementation of this process improved most ED metrics. Adverse safety events in the ED waiting room were reduced to near zero owing to the immediate visual assessment, chief-complaint analysis, and appropriate triage. Immediate masking on arrival and symptom assessment mitigated exposures for other patients and families as well as health care workers. Metrics such as LWBS and door-to-provider rates improved. Several strategies contributed to having a less than 1.58% LWBS rate and 16.8-minute median door-to-provider rate during the current fiscal year; the greeter nurse not only had a significant impact on the timed ED metrics, but also on overall patient satisfaction scores.

The final clarifying point to make is in regard to the stated 75% compliance rate. Screening compliance is a report defined in the electronic medical record. A spot check or routine screening can be automated and monitored over time, and the electronic medical record can analyze data from any location where screening is expected (eg, clinics, immediate care sites, and diagnostics locations). A 75% compliance rate in the emergency department may be best explained in moving some individuals quickly to the emergency department for care or for those unable to be screened who are clinically compromised and arrive by ambulance. No other trends were noted.

We hope we have satisfactorily responded to Dr Chmielewski's letter to the editor. We agree with the author that it is important to assess and understand the impacts of symptom- and travel-screening processes on ED throughput metrics; however, as detailed here, the development and implementation of the described screening process at our hospital improved most ED metrics as well as overall patient satisfaction scores. Moreover, the coronavirus disease pandemic further reinforces the critical importance of rapidly identifying and isolating patients with potential highly hazardous communicable diseases to mitigate hospital-based exposure events.—*Michelle M. Schwedhelm, MSN, RN, Executive Director, Emergency Management & Clinical Operations, Co-Executive Director, Global Center for Health Security, Nebraska Medicine, Omaha, NE; Jocelyn J. Herstein, PhD, MPH, Research Assistant Professor, Global Center for Health Security, Department of Environmental, Agricultural, and Occupational Health, College of Public Health, University of Nebraska Medical Center, Omaha, NE, E-mail: jocelyn.herstein@unmc.edu; Suzanne M. Watson, RN, Nurse Manager, Emergency Services, Nebraska Medicine, Omaha, NE; Amy L. Mead, RN, Associate Nurse Manager, Emergency Services, Nebraska Medicine, Omaha, NE; Leo Maddalena, MS, Applications Sr Analyst, Enterprise Clinic, Nebraska Medicine, Omaha, NE; Devon D. Liston, MPH, Applications Sr Analyst, Enterprise Clinic, Nebraska Medicine, Omaha, NE; and Angela L. Hewlett, MD, Associate Professor,*

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# The Emergency Nurses Association: 50 Years of Advocacy and Advancement

**Gwyneth Milbrath, PhD, RN, CEN, and Audrey Snyder, PhD, RN, CEN, ACNP, FAANP, FAEN, FAAN**


## Abstract

To commemorate the 50th anniversary of the Emergency Nurses Association, this article describes the 3 most enduring and impactful policy initiatives in the organization's history. These initiatives were identified through a comprehensive review of the articles published in the *Journal of Emergency Nursing* as well as in other publications of the Emergency Nurses Association, including position statements and press releases. The top 3 policy issues throughout the Emergency Nurses Association's history were identified as provision of care for vulnerable populations, trauma and injury prevention, and patient quality and safety. The Emergency Nurses Association also worked hard to professionalize emergency nursing within the realms of nursing and emergency services during the first half of its history, and since then the Emergency Nurses Association has promoted issues related to the emergency nursing workforce and to ensuring a safe and sustainable environment in which nurses practice. This article includes critical constructs such as the professionalization of emergency nursing; advocating for vulnerable populations such as children, older adults, and people experiencing sexual violence or human trafficking; improvements in trauma care and injury prevention; promoting quality and safety through nursing certifications, efficient and accurate nurse triage, and disseminating best practices in evidence-based care; and supporting the nursing workforce by championing issues such as workplace violence, ED crowding, and healthy work environments.


**Key words:** Emergency nursing; Health policy; Nursing history


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## Introduction

The year 2020 was a historic year for nursing. This year was globally recognized as the Year of the Nurse and Midwife; it was the year of the historic coronavirus disease 2019 (COVID-19) pandemic; and it also marked the 50th anniversary of the Emergency Nurses Association (ENA). The mission of the ENA is "to advance excellence in emergency nursing," and it does so through a variety of initiatives and organizational beliefs.[1] The ENA is committed to collaborating with other health care partners; promoting compassion in emergency nursing; embracing diversity and inclusivity; promoting excellent, high-quality patient and nursing standards; and fostering a culture of inquiry and lifelong learning among its thousands of members worldwide.[1]

As part of this celebration of the ENA and emergency nurses, the ENA commissioned this review of the *Journal of Emergency Nursing* (*JEN*) to highlight some of ENA's most important contributions to nursing and health care over its 50-year history. The purpose of this article was to identify and analyze the publications that have informed the top 3 policy initiatives of enduring and ongoing impact over the 50-year history of the ENA. The objectives were as follows: (1) to identify the top 3 policy initiatives, (2) to analyze these initiatives using a historical framework within the context of their relative importance at the time of ENA's development, and (3) to discover how these initiatives have shaped emergency nursing and health policy over time.

## Methods

A combination of qualitative and historical methods was used to identify and analyze ENA's top policy initiatives over the past 50 years. Qualitative methods were used to

identify the content areas most frequently published in *JEN* after a comprehensive review of the journal's publications, and historical methods were used to describe and analyze these results within the appropriate historical context over time.[2] The authors of this manuscript were provided with a comprehensive list of every article published in *JEN* since its inception in 1975[3] through articles published in 2019, totaling 4883 articles. The authors were selected because of their extensive experience in historical research and emergency nursing. Together, the authors have more than 40 years of experience in emergency nursing, and both are published nurse historians. One author has been a member of the ENA since 1988 and is a Fellow in the Academy of Emergency Nursing.

Initially, the authors used deductive coding to jointly create a list of codes on the basis of their knowledge of emergency nursing and the ENA. As each article was assessed, the code book evolved with additional codes added as needed during the article review processes. The authors coded collaboratively for 2 hours, covering dozens of articles to develop these codes and establish interrater reliability. The 2 authors discussed each code and how it would be applied to ensure consistency between the reviewers during the coding process. The remaining articles were divided equally between the 2 authors, with 1 author coding articles from 1975 to 1999 and the other coding articles from 2000 to 2019. These codes were organized using a standard electronic spreadsheet containing the title of the article, year published, number of citations, assigned code(s), and any additional notes. During and after the coding process, each author noted articles for full review that would be potentially relevant to the purpose and objectives of this manuscript. Each article was coded with a maximum of 3 codes per article. Codes were applied on the basis of the title of the article. For titles that were ambiguous, abstracts were reviewed to more accurately code the articles. The authors also examined the subject matter of the top 10 most highly cited articles in each decade. This process resulted in 33 codes. The implications for policy of the most frequent and consistent codes were assessed after the coding process. The codes were reorganized, and similar categories were combined into broader themes, resulting in 27 categories reflecting the data. For example, the "Self-Care/Safety" and "ER RN Workforce" codes were collapsed together to form "Nursing Workforce." Once all articles were coded, the total number of codes per category were calculated (Table). The authors identified the top 3 most enduring and impactful policy initiatives from the codes with the highest frequency. In addition, 2 highly impactful initiatives that were relevant during the first and second halves of the 50-year history of the ENA were also included.

The 2009 Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were used when appropriate while refining the sources for inclusion (Supplementary Figure).[4] A total of 354 of the 4883 articles did not fit into any category and were excluded. Articles that were not within the identified top policy areas and articles within the appropriate content area but not relevant to policy or the historical analysis were also excluded. This left 59 articles for the final analysis. An additional 49 sources were included from ENA policy statements, resolutions, practice guidelines, and other publications; ENA archival sources; relevant state and federal legislation; published white papers; ENA General Assembly resolutions; and other relevant documents.

The authors manually reviewed the identified articles and included additional articles that may be relevant given the selected initiatives. Articles from 1970 to 1981 that were not available online or in the authors' libraries were requested from the ENA. The review was somewhat limited, however, owing to archives and libraries being closed because of the COVID-19 pandemic during the research period. The authors reviewed the full texts of these selected articles as primary source information, and additional sources were evaluated to analyze these initiatives within an appropriate historical context. The first 3 boxes of ENA historical archives were accessed during a previous historical review and contributed to this work.

The purpose of this article was to identify and analyze the 3 most enduring and impactful policy initiatives that the ENA has championed in its 50-year history. An initiative was considered to be enduring if it was consistently present within the journal over its 50-year history and has continued to have implications for policy on a national (and sometimes international) level. The impact of an initiative was evaluated on the basis of its ability to influence nursing practice or policy through legislation, position statements, collaboration with other professional organizations, or practice changes. Both of these factors were considered when identifying the top 3 initiatives.

## ETHICAL CONSIDERATIONS

This study used historical research and was a review of publicly available publications and documents. This was not reviewed by an institutional review board because this type of research does not constitute human subjects research.

TABLE
**Reviewed article codes from the *Journal of Emergency Nursing*, 1975 to 2019**

| Category | 1975 to 1979, n = 207 n (%) | 1980 to 1989, n = 785 n (%) | 1990 to 1999, n = 1280 n (%) | 2000 to 2009, n = 1276 n (%) | 2010 to 2019, n = 1335 n (%) | Totals |
|---|---|---|---|---|---|---|
| Special populations | 18 (8.7) | 76 (9.7) | 158 (12.3) | 188 (14.7) | 209 (15.7) | 649 |
| Professional development | 18 (8.7) | 67 (8.5) | 55 (4.3) | 175 (13.7) | 235 (17.6) | 550 |
| Trauma | 36 (17.4) | 133 (16.9) | 120 (9.4) | 145 (11.4) | 97 (7.3) | 531 |
| Case studies | 2 (1.0) | 40 (5.1) | 175 (13.7) | 154 (12.1) | 85 (6.4) | 456 |
| Medical | 40 (19.3) | 102 (13) | 66 (5.2) | 114 (8.9) | 85 (6.4) | 407 |
| Patient quality and safety | 6 (2.9) | 21 (2.7) | 51 (4.0) | 147 (11.5) | 177 (13.3) | 402 |
| Pharmacology and toxicology | 8 (3.9) | 66 (8.4) | 81 (6.3) | 106 (8.3) | 115 (8.6) | 376 |
| Editorial | 5 (2.4) | 38 (4.8) | 123 (9.6) | 75 (5.9) | 121 (9.1) | 362 |
| Nursing workforce | 4 (1.9) | 6 (0.8) | 63 (4.9) | 106 (8.3) | 128 (9.6) | 307 |
| Law and ethics | 25 (12.1) | 81 (10.3) | 61 (4.8) | 62 (4.9) | 12 (0.9) | 241 |
| Education | 4 (1.9) | 25 (3.2) | 81 (6.3) | 55 (4.3) | 67 (5.0) | 232 |
| Triage | 8 (3.9) | 17 (2.2) | 38 (3.0) | 73 (5.7) | 87 (6.5) | 223 |
| Environment of care | 0 | 0 | 61 (4.8) | 70 (5.5) | 82 (6.1) | 213 |
| Injury prevention | 0 | 6 (0.8) | 34 (2.7) | 68 (5.3) | 83 (6.2) | 191 |
| Leadership | 4 (1.9) | 51 (6.5) | 43 (3.4) | 31 (2.4) | 44 (3.3) | 173 |
| International | 0 | 5 (0.6) | 42 (3.3) | 54 (4.2) | 70 (5.2) | 171 |
| Research | 2 (1.0) | 25 (3.2) | 56 (4.4) | 36 (2.8) | 50 (3.7) | 169 |
| Prehospital | 12 (5.8) | 52 (6.6) | 56 (4.4) | 22 (1.7) | 21 (1.6) | 163 |
| Procedures | 10 (4.8) | 24 (3.1) | 52 (4.1) | 34 (2.7) | 37 (2.8) | 157 |
| Policy | 1 (0.5) | 12 (1.5) | 20 (1.6) | 81 (6.3) | 42 (3.1) | 156 |
| Psychiatric | 9 (4.3) | 24 (3.1) | 25 (2.0) | 34 (2.7) | 46 (3.4) | 138 |
| Disaster nursing | 3 (1.4) | 6 (0.8) | 43 (3.4) | 48 (3.8) | 34 (2.5) | 134 |
| Technology | 1 (0.5) | 8 (1.0) | 32 (2.5) | 33 (2.6) | 28 (2.1) | 102 |
| Patient education | 2 (1.0) | 21 (2.7) | 9 (0.7) | 10 (0.8) | 14 (1.0) | 56 |
| End-of-life | 5 (2.4) | 9 (1.1) | 5 (0.4) | 16 (1.3) | 19 (1.4) | 54 |
| Advanced practice nursing | 0 | 5 (0.6) | 16 (1.3) | 15 (1.2) | 16 (1.2) | 52 |
| Rural | 3 (1.4) | 9 (1.1) | 6 (0.5) | 5 (0.4) | 18 (1.3) | 41 |

Each article had the potential to be listed in up to 3 categories.

## Results

The Table shows the results of the review of the articles published in *JEN* since its inception. "Special Populations" articles included content related to pediatrics, geriatrics, and people experiencing intimate partner violence or human trafficking. "Professional Development" included articles such as review questions for the Certified Emergency Nurse (CEN) examination, clinical practice guidelines, practice updates, or other articles with the intention of informing the reader on the assessment, management, or treatment of a particular illness or injury. Articles coded with "Nursing Workforce" had content related to compassion fatigue, burnout, staffing challenges, workplace violence, or nurse safety and well-being. The "Education" category referred to articles describing nurse or health provider training, education, or orientation. "Environment of Care," which was more frequent during the last 20 years, described articles regarding the physical space and issues such as boarding patients, crowding, moving patients through the emergency department, and patient satisfaction. "International" referred to articles written by United States–based nurses providing humanitarian aid abroad or articles written about emergency nursing abroad.

After the review, the top 3 most enduring and impactful policy initiatives were identified as the provision of care for

vulnerable populations, trauma care and injury prevention, and patient quality and safety. These were selected from the top 6 most frequently used codes. The codes "Professional Development," "Case Studies," and "Medical" were excluded because these types of articles did not have any direct relevance to policy. The development and impact of the selected initiatives will be further explored in the following section and are presented in order on the basis of their frequency of appearance in the literature review. In addition to the 3 policy initiatives, 2 additional ENA initiatives were included as highly impactful but not enduring. The ENA led the charge to professionalize emergency nursing within the realms of nursing and emergency services during the first half of its history, and since then the ENA has promoted issues related to the emergency nursing workforce, ensuring a safe and sustainable environment in which nurses practice. Although professionalization and workforce support did not meet the criteria for enduring policy initiatives, these topics were some of the most highly impactful during the first and second halves, respectively, of ENA's history. The professionalization of emergency nursing is discussed first because it lays a foundation on which the other policy initiatives have been founded. This is followed by the discussion of the top 3 policy initiatives identified (the provision of care for vulnerable populations, trauma care and injury prevention, and patient quality and safety). Finally, ENA's recent role in addressing emergency nursing workforce concerns is discussed.

## Discussion

### PROFESSIONALIZATION OF EMERGENCY NURSING

Throughout the mid-20th century, emergency care gained recognition and attention as a necessary part of the US health care system, with hospitals establishing emergency rooms and physicians receiving special training in the care of emergencies. After World War II, physicians began to specialize beyond medicine or surgery, and the supply of general practitioners declined.[5] The 1960s and 1970s were decades of rapid growth toward modern-day emergency services. The 1966 National Highway Safety Act helped to address emergency service improvement and included funding for first responder training courses, spawning modern-day prehospital providers. The American College of Emergency Physicians (ACEP) was formed in 1968 with 2 primary goals: (1) recognize emergency medicine as a specialty, and (2) develop and establish emergency medicine residency programs. The Emergency Department Nurses Association (EDNA) was formed 2 years later as a voice and platform for emergency nursing advocacy and education. When the EDNA was formed in 1970, emergency medical services (EMS) in most communities were lacking or inefficient.[6] To address this need, with the support of the newly formed EDNA, the Emergency Medical Service Systems Act of 1973 provided funding to develop comprehensive EMS systems.[7] Under this act, approximately 4000 nurses were trained, some of them as advanced practice nurses specializing in emergency care.[7]

With the expansion and organization of professional emergency services, demand for these services increased, although patients were seeking nonurgent health care services just as often as emergency services. The 1965 Medicare and Medicaid amendments to the Social Security Act provided health services for older adults and the poor by providing co-payments for their care to hospitals (House Resolution 6675).[8] In the 1970s, approximately half of all patients presenting to emergency departments were using the emergency department as an outpatient care facility[9] because many physicians in private practice did not accept government insurance, and the emergency department was available during off-hours when private practice was closed.[10] However, when Americans went to the emergency department, they often found a nurse rather than a physician as the frontline provider. Finke in 1975 stated, "The demands placed upon emergency departments today as primary care and emergency care facilities mean that to treat the emergency patient as a total person, emergency nurses must be trained as an emergency nurse practitioner, to work in unobstructed cooperation with physicians."[11] It was clear that emergency nurses would need specialized training beyond what hospital nurses typically received owing to the comparative independence and autonomy that nurses experienced in early emergency departments. The first nursing core curriculum skills list included interpretation of laboratory results and x-rays and other skills and decisions normally relegated to physicians, but nurses were performing these skills in the emergency department.[12] Advanced training programs specializing in emergency nursing varied from several months of education in certificate programs to graduate-level programs.[13] Emergency medical technicians functioned as an extension of the emergency department.[5] The 1975 position paper "Roles, Responsibilities and Relationship of EDNA to Emergency Medical Technicians and the System of Prehospital Emergency Care" reflected the EDNA's commitment to the entire emergency health services system.[14] By the early 1980s, emergency medical technicians often supplemented the nursing staff in hospital emergency departments rather than responding to emergency calls in the community.[15]

As the necessity for emergency services continued to grow with more and more nurses and other assistive personnel working in this environment, the ENA further delineated the role of the emergency nurse in the 1994 position statement, "Role of the Emergency Nurse in the Clinical Setting": "Although the primary role of the emergency nurse will continue to be the delivery of direct patient care, increasing emphasis will be placed on coordination and facilitation of care and direction of assistive personnel."[16] In 2011, emergency nursing was formally recognized as a nursing specialty by the American Nurses Association (ANA), and the ANA approved the "Emergency Nursing Scope and Standards of Practice."[17] The formation of the EDNA, later changed to the ENA in 1985, was critical to the establishment and advancement of emergency nursing as a recognized nursing specialty. The EDNA's early commitment to nursing education, political advocacy, and recognition created a firm foundation on which the ENA has been able to expand its reach, relevancy, and impact for nurses and their patients.

## PROVISION OF CARE FOR VULNERABLE POPULATIONS

In this analysis, the most commonly applied code was "Special Populations," reflecting a strong commitment toward improving care for those most requiring unique attention. These vulnerable groups included children, older adults, and people experiencing sexual violence or human trafficking, among others. Although the ENA has focused on addressing concerns for several special populations, it has also stressed that nurses should stay current on best practices to ensure that all patients receive the best care possible.[18]

### *Pediatrics*

Articles related to the care of pediatric patients have featured prominently in *JEN* throughout its history. Pieces such as "The Preschooler in the Emergency Department," "Salicylate Poisoning in Children," and "Transporting High-Risk Infants" provided timely education to emergency nurses caring for children.[19-21] The number of publications related to pediatric emergency nursing increased dramatically in the 1980s, no doubt owing to nursing recognizing the need for special care for this vulnerable group. In 1987, the ENA created several special interest groups, 1 of which was focused on pediatrics. The goal of this group was to promote pediatric emergency nursing through pediatric programming at the scientific assembly and a list of experts who could be consulted.[22] To increase the competence and confidence of emergency nurses in pediatric care, a special course that focused on the assessment, treatment, and management of pediatric patients was created in 1993.[23] The Emergency Nursing Pediatric Course was initially released in the US, but quickly spread internationally to Australia, New Zealand, and beyond.[23]

The ENA has a long history of collaboration with other organizations vested in the safe care of pediatric patients. For example, "Guidelines for Pediatric Equipment and Supplies for Emergency Departments" was copublished with the National Emergency Medical Services for Children Resource Alliance.[24] Since 2001, the ENA has worked alongside the American Academy of Pediatrics and the ACEP on several joint policy statements promoting the health and safety of children. In 2001, the ENA joined the American Academy of Pediatrics and the ACEP as coauthor of a revision to a joint policy statement—"Guidelines for Care of Children in the Emergency Department"—and has been a part of each revision since then.[25,26] These 3 organizations worked together again in 2014 to create the "Death of a Child in the ED" policy statement[27] and in 2015 to coauthor 2 technical reports on "Patient- and Family-Centered Care" and "Best Practices in Patient Flow for Pediatric Patients in the Emergency Department."[28,29] More recent position statements have focused on "Child Passenger Safety in the United States" and "Pediatric Readiness in the ED."[30,31] The ENA adopted the "Weighing Pediatric Patients in Kilograms" position statement in 2012, to improve safety when administering medications to pediatric patients.[32] As ED crowding and boarding of intensive care unit (ICU) patients in the emergency department has increased, a call for action was issued in March 2020 to address best practices for boarding pediatric patients in the emergency department.[33] Through promoting new research, education, practice guidelines, and political advocacy, the ENA has been a strong voice for pediatric emergency care.

### *Older Adults*

As the US population continues to age and seek care in the emergency department, older adults are a population at high risk of morbidity and mortality. In 1981, a team of researchers sampled EDNA members to assess emergency nurse perceptions on the use of the department by the older population and about their preparation to meet the needs of older adults in the department. Emergency nurses felt that their nursing programs did not adequately prepare them to care for older adults in the emergency department.[34] Throughout its history, *JEN* has continued to disseminate best practices for caring for older adults on critical topics such as triage, assessment, medication safety, pain management, appropriate trauma care, disaster planning, and managing aggressive

behavior. A decade after the launch of the Emergency Nursing Pediatric Course, the first Geriatric Emergency Nurse Education program was offered in 2004, addressing the needs of the older population. ENA's activism continued through adopting the "Specialty Nursing Association Global Vision Statement on Care of Older Adults" in 2011.[35,36] When considering trauma care and injury prevention, the ENA created the Thoughtful Adults Keep Enlightened care program. It covered medication interactions, alcohol use, doctor/patient relationships, and highway safety concerns for older adults (alcohol use and driving, safety belts, and pedestrian safety).[37] Through education and injury prevention efforts, the ENA has been an advocate for best practices in the care of older adults in the emergency department.

### *People Experiencing Sexual Assault*

As early as 1978, the ENA was educating nurses on the complexities of caring for people who experienced a sexual assault. The article by Moynihan and Coughlin[38] shared Yale New Haven Hospital's model program developed in 1974 to provide comprehensive care (medical, emotional, and legal) to victims of sexual assault. A 1991 article detailing the roles and responsibilities of a sexual assault nurse examiner (SANE) prompted members to request more information, and the journal started a resource list of sexual assault programs with a description of each.[39] In 2001, the ENA published highlights from the inaugural National Sexual Assault Response Team Training Conference.[40] In 2010, the ENA authored a position statement on "Sexual Assault and Rape Victims" to guide emergency nurses caring for this specialty group.[41] This statement was updated in 2016 to include adolescent victims of sexual assault and continues to advocate for specially trained SANE nurses to provide the highly specialized care needed for this vulnerable population.[42] In 2019, only 20% of the acute care hospitals had SANE programs, and the ENA has continued to advocate for legislation and support of training programs to increase the number of SANE nurses to care for victims of sexual assault.[43] The May 2020 *JEN* issue was themed "Forensic and Interpersonal Violence," highlighting problem solving and improvements to screening for interpersonal violence, treatment of the victim of sexual assault, and evidence collection, demonstrating a continued commitment to educate emergency nurses to care for these victims.[44]

### *People Experiencing Human Trafficking*

Recently, emergency departments across the US started implementing assessment and screening programs to help recognize and rescue people experiencing human trafficking. Peters educated nurses on human trafficking and encouraged them to "become actively involved at the legislative level by joining a state or national organization dedicated to ending (modern) slavery."[45] The ENA continued to inform and educate emergency nurses on this topic. In 2016, the ENA released the position statement "Human Trafficking Patient Awareness in the Emergency Department Setting" to address the emergency nurse's critical role in recognizing, stabilizing, and referring people who are trafficked to appropriate community resources.[46] ENA's publications continue to educate nurses on signs of human trafficking, techniques to approach victims, and resources to help them, providing emergency nurses with the tools to support people experiencing human trafficking, intimate partner violence, and sexual assault.[47] Education and increased awareness programs for emergency nurses include topics such as sex trafficking, labor trafficking, and domestic servitude,[48] and they empower nurses to take a stand for this special population.

## TRAUMA CARE AND INJURY PREVENTION

The prevention and treatment of trauma have always been, and will mostly likely continue to be, top priorities for emergency nursing. It was in the setting of a US nationwide focus on trauma that the precursor to the ENA, the EDNA, was formed with a focus on the education of emergency nurses. In 1966, the National Academy of Sciences published a white paper entitled "Accidental Death and Disability: The Neglected Disease of Modern Society," kickstarting a decades-long movement to prevent and improve morbidity and mortality from traumatic injuries.[49] The EDNA collaborated with multiple organizations, including the American Academy of Orthopedic Surgeons and the American College of Surgeons Committee on Trauma (ACSCT) to develop innovative ways of addressing this public health crisis.[23] The first convention, "Challenge to Change: Chimera or Commitment," in 1972, was in collaboration with the University of the State of New York and the ACSCT.[23] However, trauma continued to be the leading cause of premature death in the first 3 decades of life throughout the 1970s.[50] Early guidance in 1976 by the ACSCT provided a list of essential items required to care for patients with trauma,[50] and in 1978 the American College of Surgeons piloted the first Advanced Trauma Life Support course and launched it nationally in 1980.[51] Although initially concerned with physician education, the American College of Surgeons recognized that nursing was a critical link in the chain of survival for patients with trauma. Emergency nurses were invited to participate in a pilot of a physician-nurse Advanced Trauma Life Support course in Maine in 1982.[50]

Seeing a need for trauma education specific to nursing, the ENA developed the trauma committee with an initial charge to develop a trauma course specifically for nurses. As a result, the first Trauma Nursing Core Course (TNCC) was delivered in 1986.[52] This course, disseminated throughout the US in 1987,[53] prepared all nurses to work with patients with trauma using a systematic approach. By 1992, the ENA was piloting TNCC internationally in Australia and Canada.[23]

The ENA continued to prioritize trauma care throughout the 1990s, revising its guidelines as the science advanced and forming partnerships and interest groups around improving trauma care.[54,55] In 1990, the Trauma Care System Act appropriated $5 million for trauma system development. A new framework, the Model Trauma Care System, was developed to create statewide integrated trauma care systems, with the ENA providing input and reviewing the initial draft.[56] The ENA led emergency nursing education in trauma care through courses, publications, and sessions at each annual conference. After the success of the TNCC, the ENA developed the Course in Advanced Trauma Nursing to teach beyond the basics of trauma care. It debuted in 1995, the same year that the ENA produced the *International Journal of Trauma Nursing*.[23] This journal informed nurses caring for patients with trauma until 2002, when the title changed to *Disaster Management and Response* after the 9/11 terrorist attacks. The journal was retired in December 2007, and its content topics transitioned back to *JEN*.

Although nursing has always been at the forefront of providing quality care to patients who are hospitalized, nursing also recognizes the power of preventing illness and injury. As such, the ENA has always promoted injury prevention as an important aspect of trauma care. Even the 1975 position paper on "Emergency Medical Services Problems, Programs and Policies" discussed the role of emergency nurses and physicians in providing prevention measures to consumers.[57] The ENA's Government Affairs Standing Committee (established in 1988) helped support topics critical to injury prevention, including the Brady Bill and legislation for mandatory use of seat belts and motorcycle helmets, ED violence, firearm safety, domestic and violent crime, and trauma-funding reauthorization.[23] The ENA assumed responsibility for Emergency Nurses Cancel Alcohol Related Emergencies, Inc, in 1995 to further public education for injury prevention. Initially founded to prevent alcohol-related injuries, the ENA rebranded it into Emergency Nurses Care to encompass all aspects of injury prevention.[23] The name was later changed to the ENA Institute for Injury Prevention in 1999, highlighting issues such as firearm safety, car safety, and bicycle safety.[58]

In 2006, the ENA Institute for Injury Prevention released the National Scorecard on State Highway Laws to reach lawmakers on 5 key issues: a primary enforcement seat belt law, a child passenger safety law, graduated driver licensing, a universal/all-rider motorcycle helmet law, and the establishment of statewide trauma systems for injury response.[59] ENA's resources complemented the National Scorecard on State Highway Laws with the "Injury Prevention" position statement, the "Injury Prevention/ENCARE (Emergency Nurses Cancel Alcohol Related Emergencies)" program, the "Choices for Living" safe driving education program, and fact sheets on child passenger safety and car seat use.[60] In 2010, the blueprint was revised to advocate for transformative public policy initiatives alongside complementary resources for members. This included position statements on motor vehicle safety; motor vehicle occupant protection; a new alcohol screening toolkit (Screening, Brief Intervention, and Referral to Treatment [SBIRT]); and *The Washington Update,* ENA's e-newsletter on legislative and regulatory issues of concern.[61] This blueprint provided advocacy guidance for ENA state councils, chapters, and members to create an impact on public policy in their respective states. Starting in 2008, the ENA developed a health care reform platform to evaluate and address congressional health care reform proposals.[62] Two new laws in 2010 supported many of ENA's priorities, including regionalization of trauma care systems and financial support for trauma centers. Eventually, the Institute for Injury Prevention was combined with the Institute for Quality and Patient Safety to form the Institute for Quality, Safety and Injury Prevention.

Most recently, the ENA supported the "Stop the Bleed" national campaign to educate the public on actions to control a bleeding emergency.[63] In 2018, the ENA approved "The Role of the Emergency Nurse in Injury Prevention," followed by "Firearm Safety and Injury Prevention and Trauma Nursing Education" in 2019,[63-65] continuing its tradition as a leader in injury prevention and quality trauma care. The ENA promotes injury prevention through education of the public, media, and state and national legislators. The organization's persistence and progress, measured through its educational programs and legislative successes, have made trauma care and injury prevention 1 of the most enduring and impactful legacies of the organization.

## PATIENT QUALITY AND SAFETY

Since the formation of the EDNA, defining and implementing a high standard of quality emergency care has been foundational to the organization's mission.[66] Over time, however, this goal has changed on the basis of the state of the specialty and needs of the patients. The ENA has

advanced patient quality and safety in 3 major ways throughout its history: professional development of nurses through education and certification, defining and standardizing the role of triage, and supporting and disseminating best practices in emergency nursing.

### *Professional Development and Certification*

ENA's founders, Anita Dorr and Judith Kelleher, recognized emergency nursing practice to be distinct from other types of hospital nursing practice, and as such nurses required specific education and training to be competent. Nurses with specialized training, education, and experience would be crucial to ensure patient quality and safety in the emergency department. The ENA and *JEN* have curated hundreds of different opportunities for nursing professional development through ENA's conferences; continuing education offerings; specialty courses in pediatrics, trauma, and geriatrics; and thousands of journal articles related to emergency nursing practice and proficiency. Kelleher also realized the value of recognizing those nurses who showed competency in emergency nursing through certification.[67] In an article published in the first year of *JEN*, the EDNA identified the need to develop a standard curriculum and certification for emergency nurses to improve knowledge, competency, and health care delivery in the emergency department.[68] The dues were increased by $10 to help raise funds for the certification examination; however, with costs estimated to be nearly half a million dollars, the EDNA was not able to raise enough funds for the examination at that time.[69,70] The certification initiative was revisited in September 1978, with the formation of a separate committee on certification in the summer of 1979. In 1980, the committee established an organization with the sole focus of implementing and maintaining the emergency nursing certification examination. The first CEN examination was given less than 1 year later, in July 1980, to more than 1000 emergency nurses. By September 1983, there were more than 7800 CENs.[70] Although not the first specialty certification in nursing, the CEN examination is the certification for emergency nursing worldwide, with more than 39 000 nurses who hold the specialty certification.[71] In addition, certifications are available for pediatrics, flight nursing, critical care ground transportation, and trauma nursing.[71]

### *Triage*

Nursing has long accepted patient assessment as a foundational aspect of the profession, especially in the emergency care setting. Emergency nurses have always required efficient, accurate assessment skills, especially in those responsible for triage. Appropriate triage is one of the most critical decisions an emergency nurse makes that can influence patient care quality and outcomes. Overtriage can divert necessary resources from more acute patients, and undertriage can result in a dangerous delay of care or underestimation of illness severity. Since the beginning of the ENA, nurses have recognized the importance of a quick, accurate assessment. In 1976, an article described an outline of a rapid (90-second) head-to-toe assessment.[72] Triage nurses were expected to be able to accurately assess a patient's needs as emergent, urgent, and nonemergent, and to refer nonemergent cases to other hospital departments or community resources.[73] By 1979, there were 5 types of triage identified in the literature: nonprofessional, basic, advanced, physician, and team. Triage could be performed by a variety of people, from unlicensed personnel using a book to guide decision-making to physicians or a team of a nurse and a physician.[74] Tips for triage at this time included providing patient privacy and stressed the importance of a focused, nonjudgmental initial interview with the patient about their presenting complaints.[75]

As emergency departments continued to see increasing numbers of patients with both acute and nonacute needs, appropriate triage became a critical piece of an emergency nurse's role; however, processes continued to vary widely. Some emergency departments would refuse to treat or evaluate patients without insurance or even those with insurance who had a contract with a different hospital, often referred to as "patient dumping." In response to this unsafe and highly unethical practice, the federal government implemented the Emergency Medical Treatment and Active Labor Act in 1986, essentially requiring that all hospitals that receive federal dollars provide medical screening and stabilization for all patients seeking care.[76] This legislation created universal access to health care for the first time in the US and a huge win for patient quality and safety. That same year, *JEN* started a column entitled "Triage Decisions" in recognition of the importance of triage in emergency nursing.[77] In early 1989, *JEN* published an article educating nurses on how best to comply with these new standards and condemning "financial triage," where patients would be asked to provide a deposit before seeing a physician.[78]

Triage had become a fundamental and unique piece of emergency nursing. The ENA *Standards of Emergency Nursing Practice, 2nd Edition,* published in 1994, included triage as a standard. Standard VII describes the importance of an emergency nurse triaging all patients to prioritize patient care on the basis of physical, psychological, and social needs.[79] The development, validation, and adaptation of 5-level triage systems such as the Emergency Severity Index

(ESI) or the Canadian Emergency Department Triage and Acuity Scale throughout the early 2000s helped standardize triage assessment across the US and around the world.[80,81] In 2010, and revised in 2011 and 2018, the ENA released the "Triage Qualifications and Competencies" position statement, advising that triage nurses have specific experience, training, and evaluation of their triage skills to ensure triage is performed safely, appropriately, and efficiently.[82] In 2019, the ENA acquired the ESI, the most widely used 5-level triage program, promoting the ESI course and offering free triage resources to emergency nurses.[83]

### *Supporting Evidence-Based Practice*

As nursing research has grown in recent years, so have the number and variety of research and quality improvement projects in emergency nursing. Today, evidence-based practice drives practice changes that improve quality and patient safety; however, this is a relatively new phenomenon for emergency nursing. For the first 30 years of *JEN*, only 2% to 4% of the published articles were related to patient quality and safety; however, this jumped to 12% to 13% in the most recent 20 years, with more nurse researchers, more nurses with bachelor's degrees in the workforce, and a greater national focus on patient safety and quality in health care. From Dorr's invention of the "crash cart" in her garage in 1967[84] to innovating solutions to the challenges of today's complex health care system, emergency nurses have created unique solutions to pressing clinical challenges. In the 1990s, research published in *JEN* paved the way in best practices related to family presence during cardiopulmonary resuscitation,[85,86] leading to the publication of an ENA position statement advocating for family presence during resuscitation[87] and an eventual clinical practice guideline, "Family Presence During Invasive Procedures and Resuscitation."[88] Dozens of other practice guidelines and improvements, including the use of capnography, difficult intravenous access, intimate partner violence screening, orthostatic vital signs, preventing blood culture contamination, and many others were developed.[89,90] These clinical practice guidelines guide emergency nurses and educators to perform nursing duties at the highest standard available. Although the ENA has supported dozens of policy and practice initiatives to improve quality and safety, the authors have chosen to spotlight psychiatric care in the emergency department as 1 example.

Providing quality psychiatric care in emergency departments has been challenging because most emergency departments were designed to provide care for physical emergencies, not necessarily psychiatric emergencies. In the 1970s and '80s, articles published by *JEN* primarily focused on proper psychiatric assessment and tips for providing care for a patient with suicidal ideation, overdoses, and/or substance abuse, often focusing on the medical aspects of their psychiatric crisis. In the 1990s, emergency nursing began exploring different models for providing psychiatric care, including dedicated crisis teams or specially trained psychiatric nurses in the emergency department.[91,92] As community funding for mental health decreased in communities across the US, emergency departments were often the only access point for care, especially for those without private health insurance coverage.[93] As the volume and complexity of patients with psychiatric illness seeking emergency care increased, emergency nurses and the ENA recognized the need for continued improvements in the quality of care for this population. In 2007, the ENA assembled the Psychiatric Patients Work Team to formulate public policy recommendations to improve care of ED patients with mental or psychiatric illness. This group advocated for improvements in standardizing guidelines for practice, emergency nursing education, and workforce development, specifically for patients with psychiatric illness, developing systems of community collaboration, and advocating for improved safety and security for patients and ED staff.[94] The ENA also advocated for implementing SBIRT programs throughout emergency departments in the US and cosponsored a national conference.[95] The ENA developed a joint position paper with the International Nurses Society on Addictions, supporting SBIRT programs in emergency departments in 2013 and advocating for nurses to deliver SBIRT programs to decrease the prevalence of alcohol use disorders across the lifespan.[96]

## EMERGENCY NURSING WORKFORCE

The ENA has always been dedicated to supporting the emergency nursing workforce; however, in recent decades, this role has shifted from establishing and professionalizing emergency nursing to maintaining an adequate workforce and advocating for safe and sustainable working conditions. For example, most recently, owing to the COVID-19 pandemic, the ENA provided timely educational opportunities and wrote letters to the US Congress advocating for critical personal protective equipment for frontline health care workers, encouraging a substantial public health response to ensure that emergency nurses have the tools they need to protect themselves and their patients.[97] Over the last 25 years, the ENA has advocated for promoting professional resilience, decreasing workplace violence for emergency nurses, and finding creative solutions for crowded emergency departments.

*Workplace Violence*

Workplace violence in the emergency department has been a concern of the ENA since the early 1990s. A highly cited study published in 2002 revealed that 100% and 82.1% of the emergency nurses surveyed reported experiencing verbal or physical assault, respectively, within the last year.[98] The ENA first developed a position statement about violence in the workplace in 1991 and has revised this statement every 3 to 5 years to reflect the current health care environment. In the statement "Violence in the Emergency Care Setting," the ENA stated that health care organizations have a responsibility to provide safe environments, and emergency nurses have the right to protect themselves and their patients from violence.[99] The ENA is not the only nursing organization that has concerns about workplace violence against nurses; it has collaborated with other organizations, including the International Council of Nurses and the ANA, to advocate for safe workplaces for nurses and other health care workers. The ENA and the International Council of Nurses have offered proactive guidelines for the protection of staff within the departments, such as mandatory incident reporting, tracking assaults, reviewing the security team's responsibility, and consistent incident follow-up from leadership.[99]

During the late 2000s, the ENA promoted advocacy for laws to make injuring a health care worker a significant offense.[100] In many cases, these episodes of violence are now considered a felony. A resolution entitled "Supporting Felony Criminal Penalties for Assaults against Emergency Healthcare Workers" was introduced at the 2010 ENA General Assembly, empowering the ENA at the national and state council levels to support felony legislation as a recourse for violence in the emergency department. For example, the Virginia ENA chapter advocated for harsher penalties for people committing violence against health care workers, ultimately resulting in a new law enacted in mid-2011 that "is one of the first workplace violence laws that carries mandatory jail time."[101]

*Professional Resilience*

Emergency nurses are often on the front lines of a community crisis, including potentially traumatic events such as natural disasters, mass shootings, terrorist attacks, mass casualty scenarios, and pandemics, which can cause significant psychological stress.[102] Work stress among emergency nurses is associated with symptoms of posttraumatic stress disorder,[103] burnout, and compassion fatigue.[104] Because of an emergency nurse's high exposure to potentially traumatic events, emergency nurse researchers have paved the way for others in this important workforce issue. At the time of this writing, an article comparing compassion satisfaction, burnout, and compassion fatigue among emergency nurses and other types of nurses had been cited more than 750 times.[104] The ENA supports a healthy work environment for all nurses and advocates for implementing best practices in fostering resilience in staff. This includes supporting a "just culture," condemning bullying, protecting meal times, and debriefing after critical events.[105]

*Crowding*

Crowding has been a policy issue for numerous health care organizations since the early 1990s, including the ENA, the ACEP, and the Institute of Medicine. Crowding in the emergency department is usually a symptom of a larger system-wide problem, resulting from increased ED volumes, nursing shortages, high staff turnover rates, fewer ICU beds, and fewer hospital beds owing to hospital and unit closures.[106] In the 1990s, the ENA developed a position statement related to crowding,[107] which has been regularly updated and revised, indicating the issue's continued importance.[108] In 2003, the General Accountability Office (GAO) completed a landmark study of emergency departments, measuring crowding.[109] In 2005, the ENA made crowding a strategic priority of the organization,[110] and the Institute of Medicine followed soon after, highlighting crowding as a major problem in its 2006 report, "The Future of Emergency Care."[111]

As part of ENA's strategic plan in the 2000s, an ED Crowding Work Team was formed to develop national standards and metrics to measure crowding and develop partnerships with other stakeholders addressing the issue. The work team provided key insights about the emergency nursing perspective to the GAO in its updated report.[111] The new GAO study was published in 2009, and the findings were similar or worse, with ED wait times nationally increasing, often to unsafe levels, on the basis of acuity.[106] Local strategies, including advanced bed requests, improved communication within and outside hospitals and emergency departments, the creation of permanent hall beds, and an increase in staffing[107] were short-term fixes to a national, multifaceted symptom of an overburdened health care system. In 2015, the ENA General Assembly rated improving ED throughput, especially decreasing the time from admission to bed placement, as 1 of the 3 priority issues for the ENA to address.[112] Although hospital and ED crowding continue to plague hospitals across the US, the ENA has consistently leveraged its resources to best inform members and policy makers of best practices and needed reforms to address this issue.

## Limitations

The study limitations include that each article was limited to the 3 most relevant codes; however, the 3 most relevant codes were chosen when categorizing the articles. There is the potential that more codes could have affected the outcome of the leading themes. The articles analyzed were provided by the ENA directly on the basis of a database it maintains of the articles published in *JEN*. It is possible that some articles were not included in this list and, thus, were not included in our review. In addition, historical reviews are not meant to be comprehensive reviews of every available resource, and there were many other potential resources that were not included as sources for our historical analysis. The historical thesis as well as the constraints regarding what is archived, collected, and available dictate what sources are, and are not, used. It is possible that with different sources and a different methodology, someone else may have come to a different conclusion because historical research requires the writer to make a judgment and curate sources to support the chosen argument.

## Conclusion

From its inception, the ENA has advocated for safe emergency nursing practice through education, position papers, publications, and policy initiatives. Building on the foundation laid by founders Dorr and Kelleher to create a professional emergency nursing organization, ENA's leaders have consistently monitored and addressed emergency nursing concerns. The ENA has grown and thrived. The provision of care for vulnerable populations, trauma and injury prevention, and patient quality and safety were the most enduring and impactful policy initiatives in the first 50 years of the ENA. Most recently, the ENA has promoted strategies to maintain the emergency nursing workforce and ensure a safe and sustainable environment for emergency nurses to practice. The success of the ENA is member-driven. During this historic year of the COVID-19 pandemic and Year of the Nurse and Midwife, the ENA has helped showcase emergency nurses to the world, demonstrating extreme resiliency in a world of uncertainty, determining best practices, and maintaining the health care safety net for the most vulnerable populations.

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## Dedication

We dedicate this article to Anita Dorr and Judith Kelleher for their vision for the Emergency Nurses Association and to all the emergency nurses who work tirelessly for their communities, making our founders' dreams a reality.

## Author Disclosures

The authors were commissioned by the *Emergency Nurses Association* to write this article in response to a call for proposals.

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## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.11.007.

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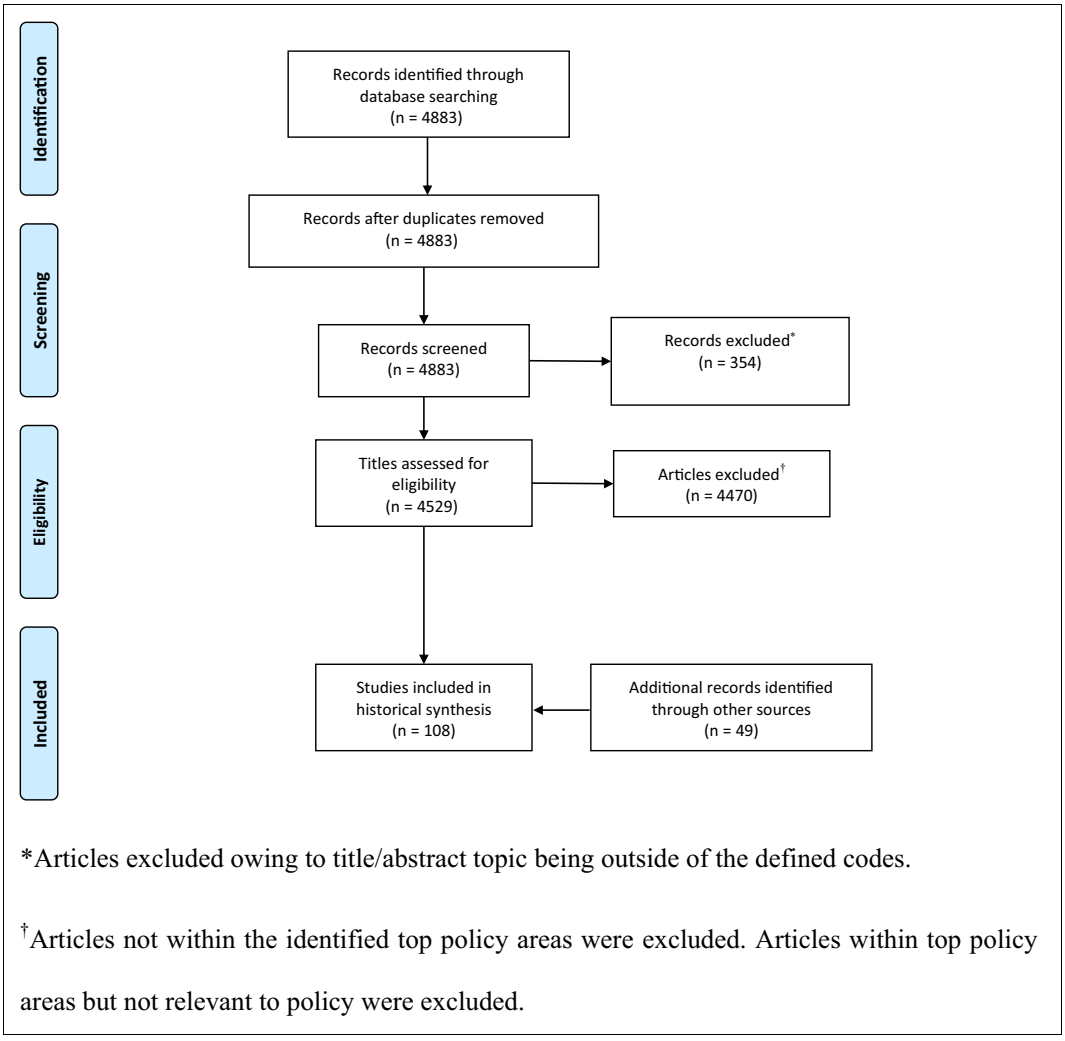
## SUPPLEMENTARY FIGURE




SUPPLEMENTARY FIGURE

Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram. *Articles excluded owing to title/abstract topic being outside of the defined codes. †Articles not within the identified top policy areas were excluded. Articles within top policy areas but not relevant to policy were excluded.

# Use of the Donabedian Model as a Framework for COVID-19 Response at a Hospital in Suburban Westchester County, New York: A Facility-Level Case Report

**Authors:** Cairenn Binder, RN, MS, Rafael E. Torres, MD, FACEP, and Diana Elwell, DNP, FNP-C, White Plains and New York City, NY

**Contribution to Emergency Nursing Practice**

- Current literature on emergency department response to coronavirus disease demonstrates that widespread screening and infection control measures are necessary for controlling viral spread.
- The main finding of this paper is that pandemic response can be structured using a known quality model to seek patient and staff safety outcomes.
- Key measures for emergency department leadership to include in clinical practice are to identify modifiable structure and process measures which can result in improved safety.

## Abstract

The purpose of this facility-level case report was to describe our facility's leadership process of applying the Donabedian model to structure an early response to the coronavirus disease pandemic relative to emergency care. Using the Donabedian model as a guide, both structure and process changes were implemented to maintain high-quality clinical outcomes as well as ED staff safety and engagement. Rapid changes to the model of care, both architecturally and through the expansion of universal precautions through personal protective equipment, created the foundation for what was to follow. Clinical, service quality, and staff safety outcomes were evaluated to demonstrate that the collaborative changes that follow a known process improvement model can be used to address the coronavirus disease pandemic. Further study is needed to compare the outcomes of this facility-level case study with those of others to evaluate the success of the measures outlined.

**Keywords:** Hospitals; Donabedian Model; Pandemics; Emergency Department; COVID-19

## Background

In January 2020, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was identified as the novel coronavirus responsible for the cases of pneumonia in the Hubei province of China earlier reported to the World Health Organization (WHO).[1] In the following weeks, outbreaks of the virus were reported in Iran, Italy, Spain, and finally the United States. New York was among the first states to report a positive case of coronavirus disease (COVID-19) and as of June 2020 remained the US state with the highest number of confirmed cases.[2] In this manuscript, we present a single-facility case report of the leadership's application of the Donabedian model[3] to guide the modifications made to a high-volume nonteaching emergency department in Westchester County, NY, during the first wave of patients seen during the COVID-19 pandemic.

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## Problem Description

Westchester County is home to a diverse population of nearly 1 million residents,[4] including those who work in the county and those who commute to the boroughs of New York City. White Plains Hospital serves a large portion of lower Westchester County, in addition to parts of Bronx, New York City. The hospital's emergency department is the highest-volume emergency department in Westchester County, surpassing 65 000 ED visits in 2019. The nature of the region dictates that public health issues affecting the greater metropolitan area have a direct impact on the county and its inhabitants. Public transportation is commonly used to travel into and out of Manhattan. It is reasonable to assume that the geographic proximity of New York City to Westchester County had a significant impact on the rate and severity of the cases seen.

Westchester County reported its first positive case of COVID-19 on March 2, 2020. Positive cases peaked on March 25, 2020, surged again on April 8, 2020, and began to decline steadily after April 15, 2020.[5] The initial outbreak in Westchester occurred 9 miles from White Plains, in New Rochelle, NY. Hundreds of community members were exposed at a synagogue in New Rochelle, many of whom lived in the neighborhoods adjacent to White Plains that are served by White Plains Hospital.

## Available Knowledge

Peer-reviewed literature was emerging and notably scarce during this facility's initial response to the COVID-19 pandemic. Publications and updates from the Centers for Disease Control and Prevention (CDC) and the WHO were the primary sources of information used by this facility's ED leadership team during the initial outbreak. Available evidence in the literature supported the use of infection control strategies such as the addition of anterooms to care areas for donning and doffing of personal protective equipment (PPE); designated areas for patients at high or low risk for COVID-19; and refresher education for staff on the application and removal of PPE,[6] surface decontamination, and frequent cleaning practices.[7] The successful response strategies employed during the Middle East respiratory syndrome pandemic for routine infection control measures, including the use of PPE, handwashing, and contact tracing for exposed employees, were also considered.[8]

## Rationale

As leaders at the facility, we sought a shared mental model to structure our facility's pandemic response. We evaluated the Donabedian, Systems Engineering Initiative for Patient Safety 2.0, and Plan-Do-Study-Act models. The Plan-Do-Study-Act model[9] demonstrated the ability to test the changes made but was not applied in real time because the changes in the department occurred too rapidly to evaluate the outcomes of each intervention. Although the Systems Engineering Initiative for Patient Safety 2.0 model[10] exhibited the capacity to clearly stratify the factors in the work environment that affected outcomes, the elegant simplicity of the Donabedian model was used here as the best fit for the crisis situation of the pandemic response.

The Donabedian model[3] has been used as a framework for health care quality since 1966.[11] The model describes structure, process, and outcome measures as having synergistic relationships, each important to the evaluation of health care quality. Structural measures are described as characteristics of the space where care occurs, including architecture and availability of equipment; process measures include delivery of care to patients and the workflows encompassed therein; and outcome measures describe the effects of health care on populations.[12] The Donabedian model has been used to evaluate ED triage processes and has successfully validated the relationship between structure and process measures.[13] Another study[14] described the specific structure, process, and outcome measures as either barriers to or enablers of quality of care. Although the body of research surrounding SARS-CoV-2 was not yet established, we postulated that the structure and process measures would provide a framework to enable a comprehensive pandemic response, as well as to further research the demonstrating enablers of positive patient and staff outcomes.

## Specific Aim

The purpose of this facility-level case report was to describe our facility's leadership process to apply the Donabedian model to structure the COVID-19 pandemic response relative to emergency care. The desired outcomes identified by the ED leadership during the initial outbreak at the facility site included the safety of patients and staff, the provision of quality care to all patients presenting to the emergency department, including those solely seeking COVID-19 tests, and the continuous availability of PPE for staff protection.

## Methods

### DESIGN

A facility-level case report of the application of the Donabedian model was used to retrospectively evaluate structure, process, and outcome measures. As a quality improvement

project, this project was not considered human subjects research at this facility.

### CONTEXT

White Plains Hospital is a 292-bed nonprofit medical center located in lower Westchester County, NY. From March 2020 through April 2020, this emergency department was challenged by the nearby threat of increasing illness burden and death being faced by the health systems in nearby New York City as the pandemic surged. As infection rates rose, nearly 30 000 people tested positive for the virus in Westchester County. This resulted in more than 1000 deaths, stretching the health system beyond its capacity and presenting an enormous challenge to hospitals countywide.

### INTERVENTIONS

The creation of innovative systems during the pandemic response was necessary to care for the volume and acuity of patients presenting to the emergency department at the time. The pandemic response interventions implemented at the facility's emergency department are described in detail according to the Donabedian model, classifying the changes as structural, process, or outcome. For clarity, these interventions will be described chronologically, with a further breakdown of the measures using the Donabedian model in supplementary charts. The interventions included initial screening and triage changes, capacity management, expanded screening and capacity interventions, addressing staff safety and morale, testing and surveillance, and telehealth. The team involved in making high-level decisions for the initial response included the physician director and assistant director of the department, the registered nurse (RN) nurse manager, and the RN clinical quality analyst, all of whom are leaders in the department and, in addition, provide direct patient care. Given the rapidly evolving and fluid nature of the pandemic response interventions, we have made our best efforts to describe the risks considered acceptable in the context of this crisis situation and the countermeasures employed to negate them.

### STUDY OF THE INTERVENTIONS

The Donabedian model was used to conceptualize, plan, and evaluate the facility's pandemic response interventions (Figure 1). Extended measures, such as complications, were not included in this evaluation because the field of COVID-19 response measures was in its infancy, and the disease's complications were not yet well documented.

### MEASURES

The measurements that may reflect the staff safety outcomes include the number of staff sick calls, number of staff who contracted COVID-19, and quantity of available PPE. Service quality is reflected in the overall number of patients who received care in the emergency department, the percentage of these patients who received a COVID-19 diagnostic test, and the percentage of patients who left the emergency department without being evaluated.

For this quality evaluation, the measures collected were those able to be analyzed retrospectively from administrative data. Daily sick calls were recorded in real time in the facility's staff scheduling system and were queried later for analysis. ED patient census, patients who left without being evaluated, and the percentage of patients receiving a COVID-19 test were tracked using real-time analytics software. The software used was populated by the electronic medical record system, recording the number of patients registered daily as well as their disposition and the procedures performed. Our department was unable to retrospectively analyze PPE quantity; therefore, this measure was not quantified in this analysis.

### ANALYSIS

Descriptive analytics were applied to the aforementioned data to create the charts in Figures 2, 3, and 4. The data gathered allowed our team to identify and demonstrate when patients and staff were most affected by illness during the initial pandemic surge.

## Results

### PHASE 1: INITIAL SCREENING AND TRIAGE CHANGES

The hospital began screening all patients for exposure to SARS-CoV-2 on February 28, 2020. In early March 2020, the hospital confirmed its first cases of COVID-19. The ED leadership team immediately recognized the potential for infectious spread in the care areas and set about to mitigate the risk to noninfected patients and staff members.

Under normal operations, patients and families were quick-registered and then seated in the waiting room before being triaged. Patients classified as infectious and those classified as noninfectious sitting alongside one another without the opportunity to implement social distancing demonstrated potential danger.

Recognizing that a waiting room nurse could potentially expedite care for patients at clinical risk,[15] a "quick-look"

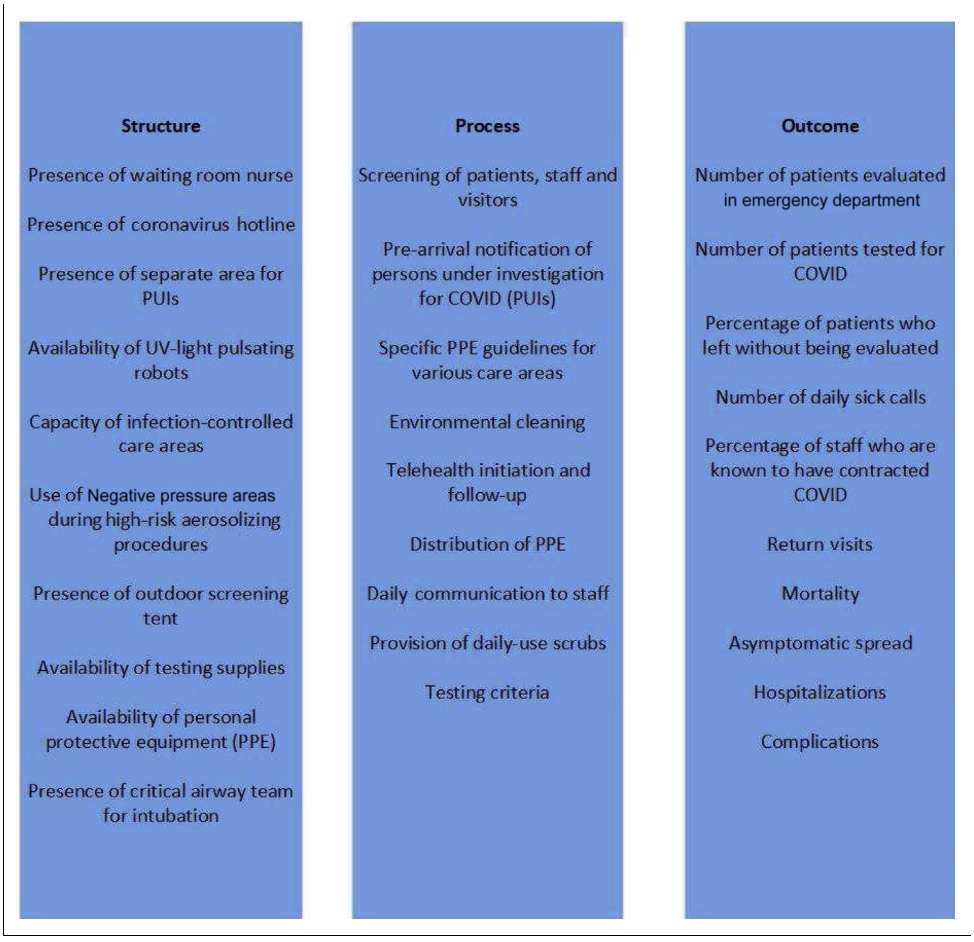



FIGURE 1

Measures as described using the Donabedian model. COVID-19, coronavirus disease; PUI, person under investigation for COVID-19; UV, ultraviolet.

RN was implemented on March 10 to perform the initial screening of patients and visitors. This RN, installed in the waiting room wearing full PPE, was tasked with screening all patients and visitors who presented to the emergency department by measuring oral temperature and asking 2 screening questions. The initial screening questions were an inquiry about travel to affected countries (Figure 5, question 1) and about the presence of fever and cough.

Changes to screening occurred almost daily in the following days. On March 17, community spread in our area was recognized, prompting the CDC as well as local and state health departments to provide guidance for process changes, including suggested screening measures and goals of mitigation strategies.[16] Early in our surveillance of COVID-19 cases in the emergency department, we observed multiple exposures of patients and staff to patients who initially screened negative but later tested positive for COVID-19. The screening of patients at the time of presentation was not always effective. During their visit, many patients with symptoms such as abdominal pain or diarrhea were found to have pneumonia on chest radiographs; these patients then tested positive for COVID-19. For each situation in which the initial screening failed to capture a patient classified as positive, dozens of staff were exposed. Notifying the exposed staff added to the workload of the leadership team as well as contributed to the fear and anxiety expressed by the frontline staff at daily team meetings. Healthy patients and their family members were also exposed to SARS-CoV-2 during the screening in place at the time. The screening questions were progressively pared down to the chief complaint and presence of fever or cough; this made screening more efficient and captured patients requiring investigation for SARS-CoV-2 as well as prevented staff exposures.

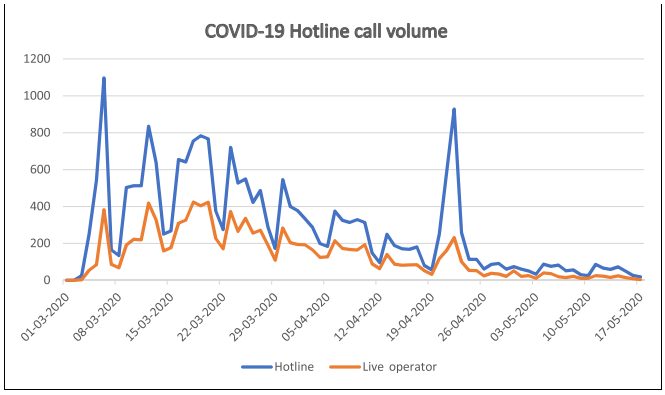



FIGURE 2

Coronavirus disease 2019 hotline call volume. COVID-19, coronavirus disease.

As an additional measure to mitigate staff and patient exposures as well as to provide support to the community, our hospital operated a COVID-19 hotline to provide information about symptoms, exposures, and testing. The phone number for the hotline was publicized in local government communications, and community members calling in were able to be triaged over the phone by ED physicians and redeployed nurses from nonclinical areas. The ED director oversaw the hotline staff and developed the hotline screening and referral procedures in collaboration with the local department of health. This ED prearrival contact helped to provide the earliest possible warning of patients who may present for testing so that the staff could take appropriate precautions when receiving the patient into the facility. From March through May 2020, the hotline received more than 20 000 calls from community members, with nearly half of those speaking with a staff member, whereas the other half heard a recorded message. This service

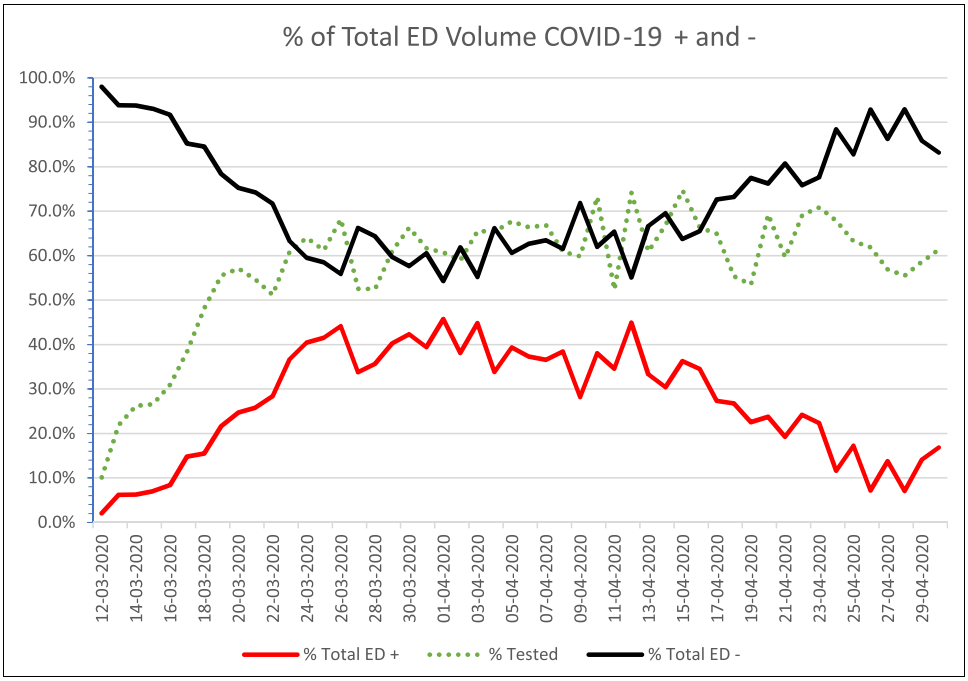



FIGURE 3

Percentage of ED volume tested for coronavirus disease 2019. COVID, coronavirus disease; ED, emergency department.

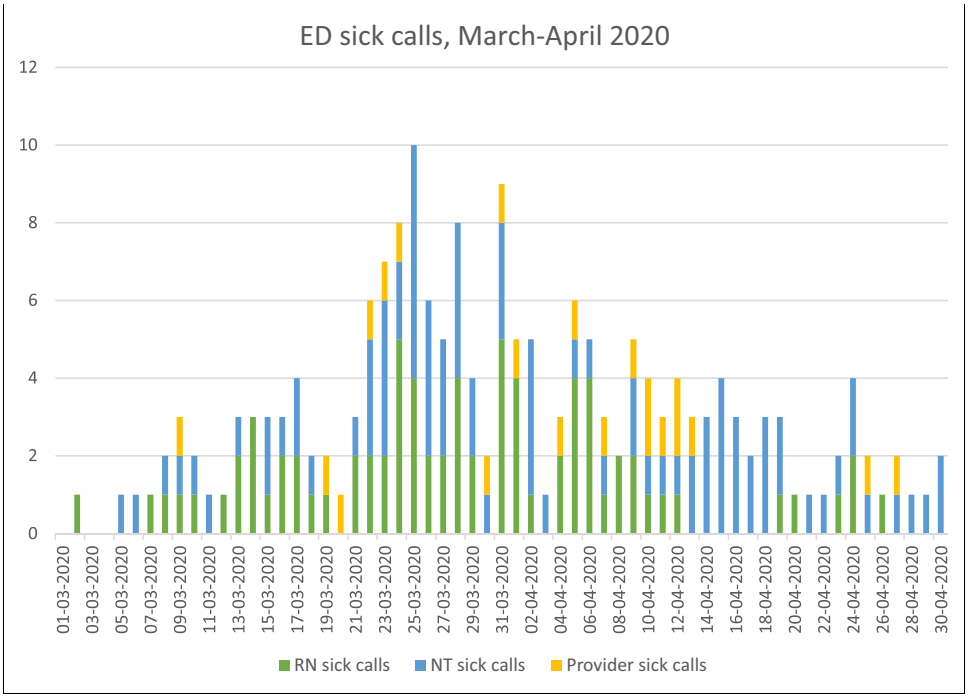



FIGURE 4

ED, emergency department; RN, registered nurse; NT, nursing technician.

provided an educational resource to the community and may have prevented countless ED encounters that threatened to overwhelm the health care system (Figure 2).

In consideration of the risk to visitors, visitation was limited in the emergency department beginning when we first placed patients under investigation for COVID-19 (PUIs). Visitation was limited to 1 person per patient beginning March 9 in the emergency department and throughout the entire facility on March 10. On March 16, visitation was eliminated by the facility except for pediatric patients arriving with a caregiver. These decisions were supported by the CDC[17] and later by the Department of Health; on April 10, the state announced that hospitals were required to suspend visitation.[16]

On March 15, the PPE guidelines were modified to further protect patients and staff. Each patient presenting to the emergency department was given a surgical mask on entry. All employees were required to don N95 particulate respirators for the duration of their shifts to offset the risk of exposure to patients not considered to have initially screened positive.

ED employees' screening on presentation to work was implemented on March 11 and hospital-wide on March 13. After March 13, this intervention was managed by hospital operations, not the emergency department. Employees reporting to work were required to undergo screening each day and were given a colored sticker on their badge to indicate that they had passed a contactless temperature screening on arrival. The alternative entry points to the hospital were closed to ensure that all staff passed a screening checkpoint on arrival each day and were turned away if they had a fever or reported any signs of illness. This screening was an important measure taken by the hospital, which was suggested by the CDC[17] to reduce viral transmission among employees. Communications from occupational health were emailed to all staff, encouraging them to report any signs of illness and to stay home from work if they experienced any symptoms.

## PHASE 2: CAPACITY MANAGEMENT

Capacity management was an obvious challenge to our emergency department because an increasing number of patients with positive risk screenings for COVID-19 presented to the emergency department for care. Under normal operations, the emergency department had 5 negative pressure rooms and 2 high-efficiency particulate air filters, allowing for the care of 7 patients under airborne isolation at a given time. After implementing multiple iterations of structural changes, the capacity increased to care for 46 patients under

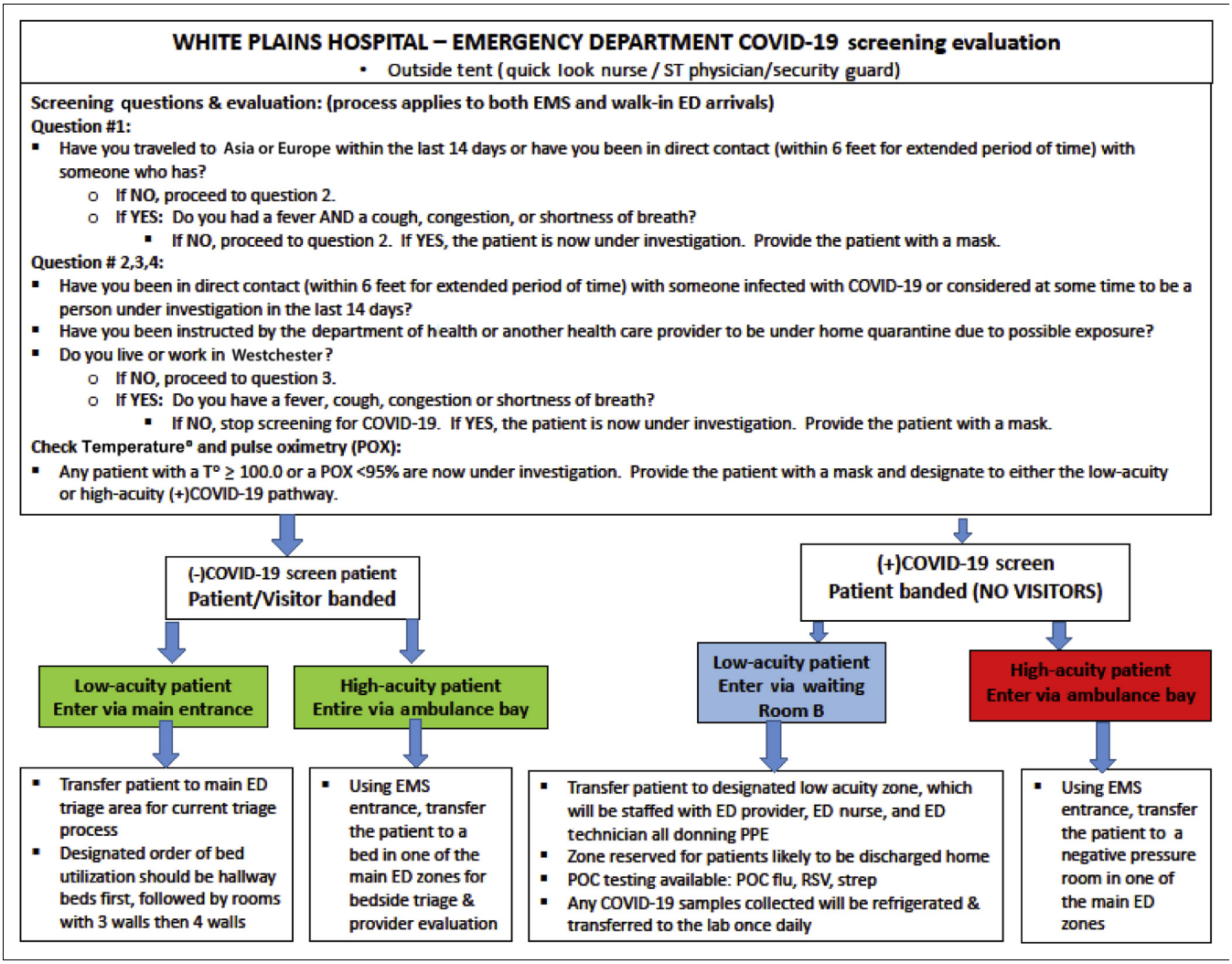



FIGURE 5

Coronavirus disease 2019 screening performed in outdoor screening tent. COVID-19, coronavirus disease; EMS, emergency medical services; PPE, personal protective equipment; POC, point of care; RSV, respiratory syncytial virus; strep, group A streptococcal infection.

isolation for SARS-CoV-2 while maintaining the best possible infection control practices.

Under usual operations, the department was separated into 3 distinct sections over 2 floors, and the negative pressure rooms were evenly spread among them. In addition, there were several rooms with doors that allowed the addition of a high-efficiency particulate air filter; these too were evenly spread among the 3 care areas. Under these conditions, each zone was receiving PUIs, with nurses and providers caring for a mix of patients classified as potentially infectious or noninfectious. As the volume of PUIs increased, the rooms would fill up quickly, causing the care team to use less-than-ideal spaces for these patients. Examples included rooms with a curtain rather than a door, hallway beds while waiting for a negative pressure room, or holding in the triage area. Such conditions contributed to the exposure of other patients and staff, as well as high PPE burn rates and inefficiencies related to infection control measures. Increasing the capacity for patients classified as infectious quickly became a top priority.

The first example of structural change to increase our capacity for PUIs was the development of a low-acuity zone for ambulatory patients whose risk screen was positive and who required assessment and care. This area, colloquially known to staff as the "COVID café," opened on March 13, 2020. It was constructed using half of the ED waiting

room, an area of 1043 square feet. Modular hard wall panels were used to divide the waiting room; half would become the low-acuity zone, whereas the other half would remain an entry point to the main emergency department. A former security booth was converted into a nurses' station with telephones, computers, and handwashing stations installed. A medication box was mounted on the wall, and airflow was modified in the area to make the entire zone negative pressure relative to the adjoining spaces.

Sixteen vertical (chair) care spaces were ultimately created in this area to care for mostly healthy young adults presenting with fever and cough. Patients were given a surgical mask on initial screening and immediately escorted to the low-acuity zone for triage. The chairs were sanitized between each patient visit. Staff working in this area donned full PPE and spent 4- to 6-hour stretches staffing this zone, switching out at break times to prevent burnout and PPE fatigue. Diagnostic tests performed in this area included COVID-19 nasopharyngeal swabs, the rapid group A streptococcal infection test, rapid influenza test, rapid respiratory syncytial virus test, and chest radiographs. Most patients were treated and discharged within 60 minutes. Limitations of the electronic medical record prevented the extraction of all patient data from the COVID-19 low acuity zone. However, a sample of 100 patients seen in this zone by 6 different providers in April 2019 revealed that 69% of patients had an arrival to departure time of less than 60 minutes. Mean arrival to departure time was 55.2 minutes (median 47.5 minutes, standard deviation 27.6 minutes). The common treatments given in this area included oral administration of acetaminophen, ibuprofen, and ondansetron. Rarely, patients required transfer to the central area of the emergency department for further evaluation and admission, which was easily done through a back door leading to the ambulance bay.

The primary risk in this area included patient-to-patient transmission. Although the patients cared for in this area were given surgical masks on initial presentation, we recognized the possibility of droplet transmission among patients in the zone. Whenever possible, patients were placed more than 6 feet apart. The entire area was terminally cleaned each day, and ultraviolet (UV)-light–pulsating robots were used by our environmental services (EVS) department once daily to reduce surface contamination.

## PHASE 3: EXPANDED SCREENING AND CAPACITY MEASURES

The second structural change implemented in the emergency department was the installment of a 594-square-foot outdoor screening tent on March 17. Installed in the parking lot outside the department's ambulance bay, this space became the entry point for all patients entering the emergency department, including those brought in by ambulance. The shelter provided an additional barrier between the main emergency department and patients with potentially infectious conditions. On entering, patients were provided with a surgical mask, and patient screening measures (Figure 5) were performed. Patients who screened positive were then placed on isolation precautions when they entered the emergency department and sorted to the aforementioned low-acuity zone, into a private ED room, or into the high-acuity area that was developed the following week.

When the outdoor screening tent was set up, it was already recognized that there were more patients classified as high acuity with positive COVID-19 screenings than available isolation rooms. Room turnover was a challenge, with terminal cleaning after patient departure taking up to 90 minutes. A COVID-19 high-acuity zone was created to respond to this issue and to add another layer of protection for our staff. In this space, a supply room was converted into a vertical care area, whereas an examination room and an office were converted into supply rooms. This separate and distinct high-acuity zone opened on March 23 with 8 rooms, 12 upright chairs, and 6 hallway beds. On March 29, the area was expanded to include an additional 4 rooms and ED radiology (computed tomography scanner and plain film radiology were included). Colloquially called the "COVID Suites" by our staff, this entire area was made negative pressure to reduce airborne exposures and was designed with designated donning and doffing rooms at the entry and exit points. Employees working in this area remained in full PPE for their time spent in the area, typically 4 to 6 hours, before switching with other staff. The area was considered a contaminated space because each room did not have individual airflow, but the overall space was negative pressure relative to the adjoining areas. The layout of the department after creating this change is illustrated in Figure 6.

Nosocomial spread of the virus in the high-acuity zone was a recognized risk. Nurses and caregivers were instructed to change outer gloves and isolation gowns between patients, patients were masked, and the airflow of the area helped to mitigate the risk of droplet transmission. Many patients were intubated in this area, reaching a peak of 4 intubations in 24 hours on March 26. Intubation was performed with as few participants in the room as possible because aerosolizing procedures were recognized to pose the most significant risk of viral transmission. Those performing and assisting with intubation were instructed to wear a full-body suit and hood in addition to the baseline PPE (Figure 7).

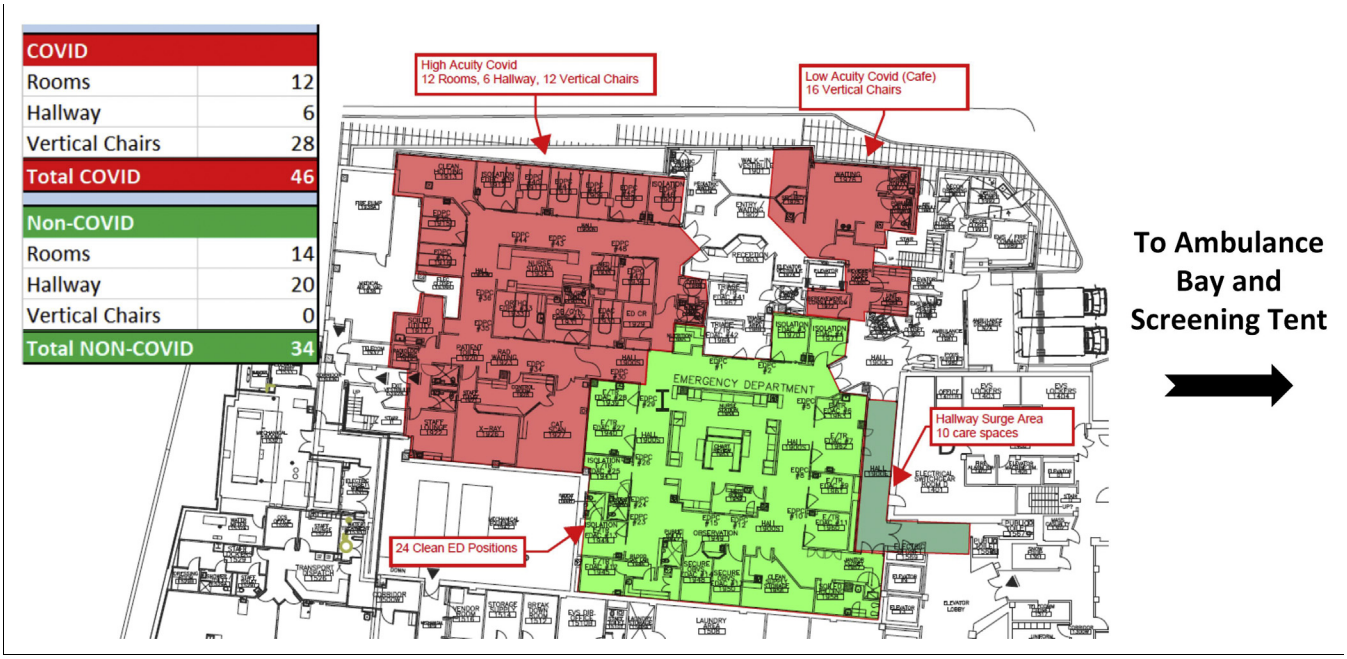



FIGURE 6

Departmental layout after structural changes. COVID-19, coronavirus disease; ED, emergency department.

Room turnover guidelines relaxed as new data emerged regarding the transmission of SARS-CoV-2. Initially, terminal room cleaning, including UV-light pulsation, was required for all PUI rooms after patient departure. Later, the UV light was deemed necessary only if an aerosolizing procedure had occurred in the room. This change, approved by the hospital's infection control department, trimmed the time required for each room cleaning by approximately 30 minutes, creating additional capacity for patients as they arrived.

ED throughput is well known to be dependent on overall hospital capacity and inpatient efficiency. As ED volume rose, there was a concern whether the hospital, despite the cancelation of elective procedures, could manage the surge in volume and acuity. The emergency department partnered with clinical colleagues throughout the organization to make changes to admission criteria on the basis of current epidemiologic patterns. The emerging evidence was evaluated frequently by those involved, and the observations of the patient population were integrated when modifying the admission criteria. Lower oxygen saturation levels and higher respiratory rates were permitted on patients who were discharged home. Patients were referred for admission only if their oxygen saturation level was 93% or less or if they had other symptoms of severe disease (Figure 8). Patients traditionally slated for inpatient care were discharged with home oxygen and the option of telemedicine visits on days 2, 5, and 7 after the index ED encounter to ensure their ongoing safety. These changes were enacted with trepidation from the staff. Maintaining the safety of our patients was a primary concern while conserving hospital capacity, and by extension ED capacity, for the patients who were the sickest at the time and into the future.

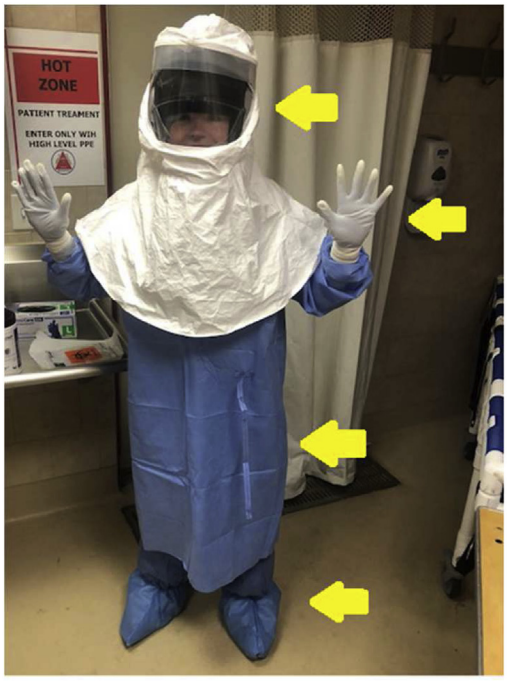
The inpatient census at our facility peaked in early April 2020. As a result of both the hospital's and the emergency department's success in expanding overall capacity, there were no recorded bed shortages. This facility had been so successful in controlling inpatient volume that COVID-19 transfers were received from other regional hospitals. As ED volume dissipated, but the length of stay for hospitalized patients remained extended, the emergency department's upper level was used as an inpatient unit caring for patients classified as COVID-19–negative. This structural change reduced the capacity of the emergency department but did not affect our operations because of the downward trend in ED volume.

## STAFF SAFETY AND MORALE

The threat of insufficient PPE availability owing to the disrupted supply chain and global shortage[18] affected this hospital, with the biggest concern being availability of N95 particulate respirators. Under ideal conditions, all face coverings, including N95 masks, were considered single


**Main ED Emergency Department + Camp COVID-19 Frontline Staff (RN, NT, Provider, Rad tech, Resp Therapist for all patient care)**

- *N95 Mask
- *Goggles
- *Bouffant (if hair longer than shoulder length)
- *Yellow Gown (change between patients in main ED)
- *1 Pair Gloves (change between patients)




**Intubation team (RN, Provider, RT)**

**Base intubation team gear**

- *PAPR (goggles + N95 if no PAPR available)
- *Bouffant cap
- *Double glove - blue gloves + surgical gloves
- *White full body suit
- *Shoe Covers

**(add when intubating)**

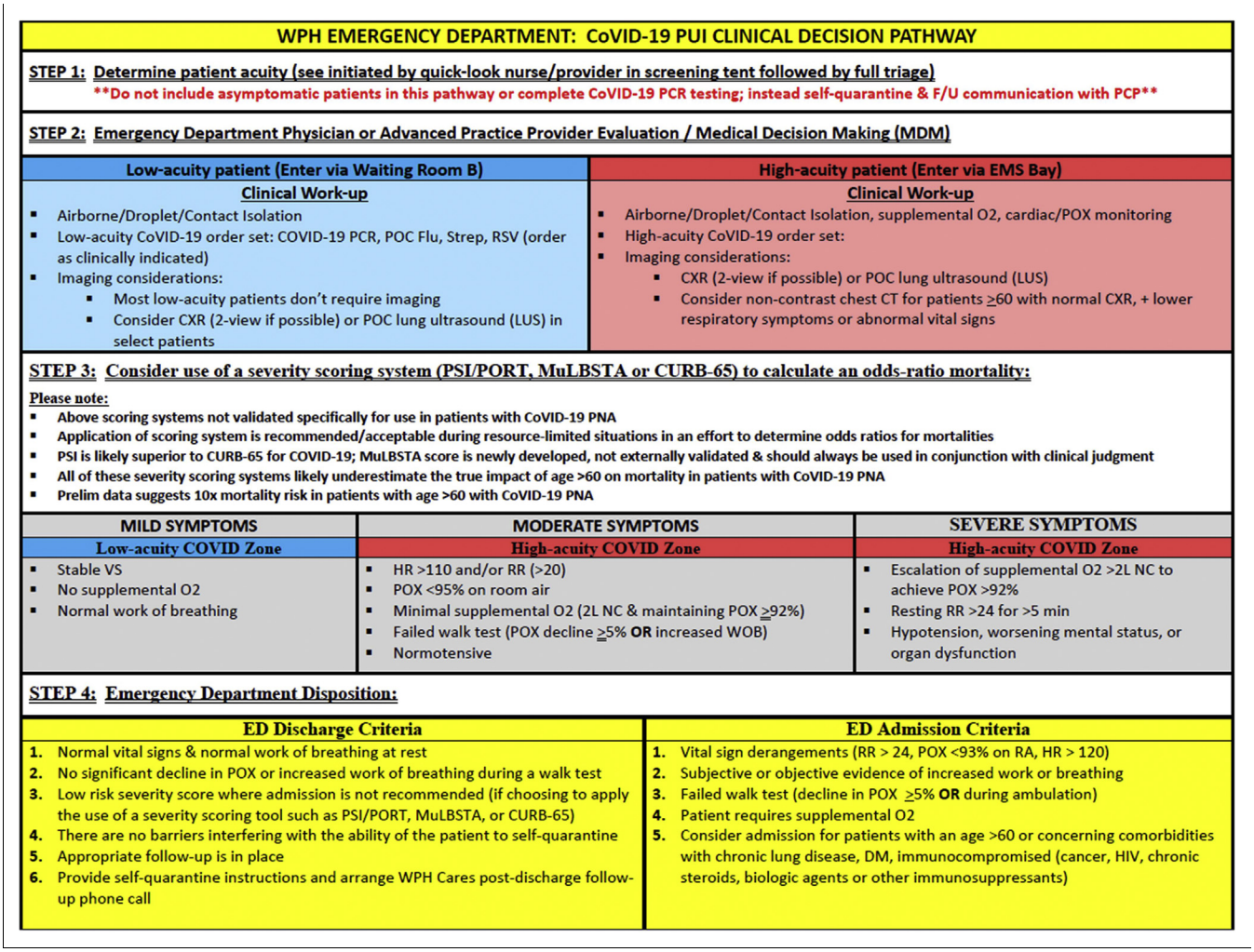
- *Surgical Gown
- *Hood over PAPR

**N95 should be stored in donning room**

** **2 RN & 2 MD** must be wearing base intubation gear at all times in zone 3. In other zones, add when intubating. **

FIGURE 7

Examples of personal protective equipment guidelines provided to staff. PPE, personal protective equipment; RN, registered nurse; NT, nursing technician; Rad, radiology; Resp, respiratory; COVID-19, coronavirus disease; PAPR, powered air-purifying respirators; MD, physician.



**WPH EMERGENCY DEPARTMENT: CoVID-19 PUI CLINICAL DECISION PATHWAY**

**STEP 1: Determine patient acuity (see initiated by quick-look nurse/provider in screening tent followed by full triage)**

****Do not include asymptomatic patients in this pathway or complete CoVID-19 PCR testing; instead self-quarantine & F/U communication with PCP****

**STEP 2: Emergency Department Physician or Advanced Practice Provider Evaluation / Medical Decision Making (MDM)**

| Low-acuity patient (Enter via Waiting Room B) | High-acuity patient (Enter via EMS Bay) |
|---|---|
| **Clinical Work-up** | **Clinical Work-up** |
| ▪ Airborne/Droplet/Contact Isolation<br>▪ Low-acuity CoVID-19 order set: COVID-19 PCR, POC Flu, Strep, RSV (order as clinically indicated)<br>▪ Imaging considerations:<br>  ▪ Most low-acuity patients don't require imaging<br>  ▪ Consider CXR (2-view if possible) or POC lung ultrasound (LUS) in select patients | ▪ Airborne/Droplet/Contact Isolation, supplemental O2, cardiac/POX monitoring<br>▪ High-acuity CoVID-19 order set:<br>▪ Imaging considerations:<br>  ▪ CXR (2-view if possible) or POC lung ultrasound (LUS)<br>  ▪ Consider non-contrast chest CT for patients ≥60 with normal CXR, + lower respiratory symptoms or abnormal vital signs |

**STEP 3: Consider use of a severity scoring system (PSI/PORT, MuLBSTA or CURB-65) to calculate an odds-ratio mortality:**

**Please note:**

- **Above scoring systems not validated specifically for use in patients with CoVID-19 PNA**
- **Application of scoring system is recommended/acceptable during resource-limited situations in an effort to determine odds ratios for mortalities**
- **PSI is likely superior to CURB-65 for COVID-19; MuLBSTA score is newly developed, not externally validated & should always be used in conjunction with clinical judgment**
- **All of these severity scoring systems likely underestimate the true impact of age >60 on mortality in patients with CoVID-19 PNA**
- **Prelim data suggests 10x mortality risk in patients with age >60 with CoVID-19 PNA**

| MILD SYMPTOMS | MODERATE SYMPTOMS | SEVERE SYMPTOMS |
|---|---|---|
| **Low-acuity COVID Zone** | **High-acuity COVID Zone** | **High-acuity COVID Zone** |
| ▪ Stable VS<br>▪ No supplemental O2<br>▪ Normal work of breathing | ▪ HR >110 and/or RR (>20)<br>▪ POX <95% on room air<br>▪ Minimal supplemental O2 (2L NC & maintaining POX ≥92%)<br>▪ Failed walk test (POX decline ≥5% **OR** increased WOB)<br>▪ Normotensive | ▪ Escalation of supplemental O2 >2L NC to achieve POX >92%<br>▪ Resting RR >24 for >5 min<br>▪ Hypotension, worsening mental status, or organ dysfunction |

**STEP 4: Emergency Department Disposition:**

| ED Discharge Criteria | ED Admission Criteria |
|---|---|
| 1. Normal vital signs & normal work of breathing at rest<br>2. No significant decline in POX or increased work of breathing during a walk test<br>3. Low risk severity score where admission is not recommended (if choosing to apply the use of a severity scoring tool such as PSI/PORT, MuLBSTA, or CURB-65)<br>4. There are no barriers interfering with the ability of the patient to self-quarantine<br>5. Appropriate follow-up is in place<br>6. Provide self-quarantine instructions and arrange WPH Cares post-discharge follow-up phone call | 1. Vital sign derangements (RR > 24, POX <93% on RA, HR > 120)<br>2. Subjective or objective evidence of increased work or breathing<br>3. Failed walk test (decline in POX ≥5% **OR** during ambulation)<br>4. Patient requires supplemental O2<br>5. Consider admission for patients with an age >60 or concerning comorbidities with chronic lung disease, DM, immunocompromised (cancer, HIV, chronic steroids, biologic agents or other immunosuppressants) |

FIGURE 8

Admission criteria and clinical workflow. WPH, White Plains Hospital; COVID-19, coronavirus disease-19; ED, emergency department; PUI, Person Under Investigation for COVID-19; PCR, Polymerase Chain Reaction COVID-19 test; F/U, Follow Up; PCP, Primary Care Provider; RSV, Respiratory syncytial virus; CXR, Chest X-Ray; POC, Point-of-care; LUS, lung ultrasound; CT, Computed Tomography Scan; PSI, Pneumonia Severity Index; PORT, Pneumonia Patient Outcomes Research Team; MuLBSTA, (**Score for Viral Pneumonia Mortality**); CURB-65: (**Score for Pneumonia Severity**); PNA, Pneumonia; VS, Vital Signs; O2, oxygen; HR, Heart Rate; RR, Respiratory Rate; POX, Pulse Oximetry; NC, Nasal Cannula; WOB, work of breathing; HIV, human immunodeficiency virus; DM, diabetes mellitus.

use, to be disposed of on exiting a room. Owing to shortage concerns, conservation of masks was required from week 2 of the pandemic response, beginning March 15. Staff were required to use only 2 masks for their shift duration. By March 30, the hospital distributed masks to individual staff members during their daily temperature screening, with those in clinical areas receiving 1 mask per shift. A second mask was to be supplied if a high-risk aerosolizing procedure occurred. The hospital obtained powered air-purifying respirators, to be worn as alternatives to N95 masks in the appropriate care areas. A video demonstrating the PPE doffing process and procedures for cleaning powered air-purifying respirators was sent out to staff to provide a refresher on infection control.

Furthermore, our department provided the staff with guidelines for different PPE levels to be worn, depending on the care area where they were working. These guidelines were disseminated by email as well as by flyers and posters in the donning and doffing areas. ED caregivers received a pair of scrubs daily to be used during their clinical shift and to be returned to be laundered by the hospital at the end of the day. Throughout the emergency department, the universal

precautions included the addition of the N95 mask. In the low- and high-acuity COVID-19 zones, higher levels of PPE were worn, with the highest level being donned by nurses and providers who were expected to intubate patients. Photographs were provided to staff to serve as examples (Figure 7) for staff to select the appropriate PPE for the care area where they would be working for the day.

Early on, the department struggled with the distribution and conservation of PPE. Potential overuse of high-level equipment was observed, and other departments removed PPE from the emergency department to bring to their respective areas of the facility. To combat the waste of PPE, the ED leadership team repurposed supply carts so that the department's unit leader could distribute PPE as designated. This process change effectively promoted conservation and decreased waste. By matching daily demand with what was supplied through the carts, staff members were always provided the necessary PPE without observed gaps in protection. The consistent run rate also made it more efficient for hospital operations to anticipate and address the ED needs daily. We are now able to reliably forecast future PPE requirements in anticipation of the second wave of infections.

The EVS team worked to decrease the bioburden inherent to any patient care area and reduce the likelihood of contact exposures. In response to the aforementioned evidence regarding surface decontamination, the frequency of ED cleaning rounds increased by 4 times the baseline. A member of the EVS team was embedded with the high-acuity COVID-19 zone team to ensure the efficiency of room turnover in that region. The EVS team's efforts were an additional structural and process improvement that fostered the environment of safety outcomes.

Throughout the month of March, the physician leaders used simulation to demonstrate safety measures during the intubation of PUIs. Staff from the emergency department, intensive care, anesthesia, and respiratory therapy collaborated to reduce potential exposures to nurses, nursing technicians, and other staff who may have traditionally been present during intubation. The factors taught included the use of the equipment and procedure modifications to decrease the aerosolization of viral particles, as well as measures to reduce the number of staff in the room during intubation. Those who took the class became part of the COVID-19 Critical Airway Team, a measure that went live on April 2, 2020. This team could be activated to assist with the intubation of PUIs to decrease staff risk during this high-risk procedure (Figure 9). Seventy-three clinicians participated in the class, and 69 intubations were performed by the COVID-19 Critical Airway Team in the month of April.

As care spaces and processes transformed overnight, many staff members expressed frustration that they were uninformed of new changes and often had to "catch up" on arrival to their shift. In response, the leadership sent out daily briefings each evening describing the changes that had occurred throughout the day. The categories of information disseminated in these briefings included patient safety, staff safety, operations, other essential notes, and affirmations. The communications were well received by the

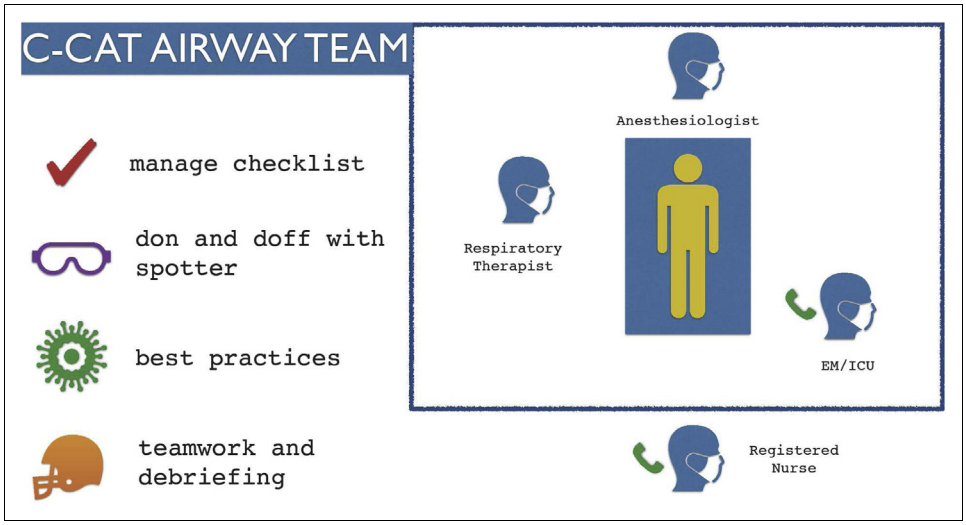



FIGURE 9

COVID-19, coronavirus disease; C-CAT, COVID-19 Critical Airway Team; EM, Emergency Medicine Provider; ICU, intensive care unit.

staff who provided positive feedback. Furthermore, the staff were encouraged to join an online portal, initiated on March 27, which contained copies of the most current processes and procedures and allowed staff to discuss the changes in real time on a secure Web platform.

Our team introduced a weekly happy hour beginning April 10 over a video-conferencing platform. This virtual gathering provided an additional opportunity for staff to decompress, bond, and enjoy the presence of their team members outside of the stressful work environment.

In July 2020, our leadership team held several debriefs with ED staff to identify issues that remained prominent to the staff as our population of patients presenting with COVID-19–related symptoms decreased. The themes that emerged included communication issues, need for supplies, and anticipation of a potential second wave. The leadership is in the process of responding to the concerns of the staff while preparing for future occurrences.

## TESTING AND SURVEILLANCE

The availability of testing for COVID-19 has remained a challenge throughout the pandemic in Westchester County. When our facility sent out the first COVID-19 test on March 7, 2020, the guidelines for testing were strictly controlled by the department of health and required that we received approval from it as well as the staff infectious disease physician. Furthermore, only the department of health was conducting tests at the time, and there were no private laboratories to use. In the first week of testing, 10% of the patients presenting to the emergency department qualified for COVID-19 testing (Figure 3). The testing guidelines were subsequently relaxed in the following weeks so that providers could determine the appropriateness of testing independently, and the capacity for testing also increased. By March 12, a private laboratory began to conduct tests with a faster turnaround time than the state laboratory. On March 15, our hospital's partner facility began to receive our tests as well, further easing the testing bottleneck.

On April 3, in-house point-of-care testing was initiated with a 1-hour turnaround time, and we were able to drastically reduce send-out tests being conducted. This newfound testing capability was especially helpful in terms of managing inpatient capacity and sorting patients to the appropriate inpatient units. On April 6, we began the practice of testing all inpatients to ensure that no patients who had tested positive for COVID-19 were presumed to be negative and sent to inpatient units where they could potentially expose others to the virus. Testing peaked in mid-April 2020, with more than 70% of the patients receiving a COVID-19 test while in the emergency department.

## TELEHEALTH

Telehealth became a vital process measure implemented early in our COVID-19 response, beginning with video follow-ups for those discharged patients deemed clinically high risk on March 20, 2020. Although the ED staff did not directly perform these subsequent visits, they were responsible for the identification and handoff to the outpatient team to ensure clinical quality through maintaining continuity of care. There were more than 1700 attempted video follow-ups, with 727 patients ultimately having 1 scheduled. Given that most medical practices were ill-equipped to safely care for these patients in an office setting, this process provided a patient-centered approach to care that helped maintain the safety of the greater medical staff and the community. A telehealth visit platform was installed in the outdoor screening tent as well, beginning April 6. This visit type allowed ED providers to remain inside the hospital and perform a medical screening examination of patients remotely. After being seen by the provider through a tablet computer, patients in the outdoor screening tent with normal vital signs could be swabbed for COVID-19 and then discharged home without entering the hospital. Ultimately, the emergency department cared for 273 patients in this manner, which assisted in limiting PPE use and potential staff exposures.

## OUTCOMES

Positive identified pandemic response outcomes have mainly been achieved. In March and April 2020, there was never an identified inability to care for a patient because of a capacity constraint. Our internal quality measurements revealed that the patients who were sent home and subsequently returned within 48 hours of their index ED encounter requiring hospitalization remained relatively stable at a rate of 1.1% over the same time frame.

Although these outcome measurements highlighted operational efficiencies, they also served as a marker for clinical quality. What they failed to assess was the perception of care as measured by patients. The service quality measured by Press Ganey (Press Ganey Associates LLC) was noted to be nationally in the upper quartile during our pandemic response. The department ranked in the 92nd and 95th percentiles in the domains of overall assessment and likelihood of recommending, respectively. These outcomes demonstrated that even during an anxiety-provoking and clinically stressful period, the department structure and processes kept the patient at the center of all employed efforts.

Staff sick calls peaked with 10 calls on March 25, 2020, representing 18.5% of the nursing staff scheduled for that

day (Figure 4). A low census in other areas of our hospital system, including radiology and ambulatory surgery, resulted in the redeployment of staff to assist our department during this time. Many of these "floating" staff members were nurses with emergency room experience who were able to fully function as RNs in our department. Others were used in more focused roles such as supply management or infection control; for example, a nurse would be stationed outside a doffing area to provide feedback to staff as they doffed PPE to reduce contamination.

The hospital never ran out of PPE for staff to safely provide care to patients. The New York State Department of Health conducted antibody testing of a sample of health care workers as well as residents of Westchester County; the results were provided to some senior leaders of the hospital demonstrating that 11% of the ED staff tested positive for COVID-19 antibodies. Many variables affect the development of COVID-19 antibodies, including community exposure, home environment, and exposures at work. The leadership at the hospital site interpreted 11% ED staff testing positive for COVID-19 antibodies as providing supporting evidence that this ED team was adequately protected from the virus. Moreover, the antibody rates observed further assured that PPE availability, instruction, and use effectively prevented health care worker infections.

COVID-19–related ED volume peaked on April 1, 2020, and afterward steadily declined. The ability to provide adequate testing increased throughout March and April, starting with the provision of tests to 10% of the ED patients and eventually reaching 75% of the patients by the end of April.

As our ED volume of patients who had tested positive for COVID-19 decreased, structural measures that allowed for a high volume of patients testing positive for COVID-19 were scaled back. The first phase of this was the closure of the low-acuity COVID-19 zone. Even as the department is working toward the resumption of routine operations, it remains prepared for the future, recognizing that the resurgence of SARS-CoV-2 in the community is likely.

Outcomes not measured as part of this case study include inpatient mortality, overall COVID-19 hospitalizations, disease complications, asymptomatic spread, and ED return visits beyond 48 hours.

## Discussion

### LESSONS LEARNED

This hospital's responsiveness in developing key structure and process measures to address the rapidly changing health care environment serves as an example of innovation during such a time of crisis. In the months since the initial outbreak of COVID-19 in New York, the body of literature surrounding the response to this pandemic has grown significantly. The rapid emergence of new literature to review during this facility's initial pandemic response resulted in the need for daily changes to existing structure and process measures. In hindsight, armed with the currently available literature, this emergency department recognizes successes as well as areas of opportunity for a potential second wave of COVID-19.

Perhaps paramount in terms of process measures, the use of face coverings for patients could have been implemented earlier. Early literature regarding mask use included case reports of asymptomatic viral transmission that was reduced with mask use,[19] but the WHO recommended mask use in public only for those with respiratory symptoms. Universal mask use is believed to be a factor in countries that demonstrate lower rates of COVID-19[20] and was mandated by authorities in New York beginning March 17.[21]

Face coverings worn by staff also underwent multiple iterations before it was decided on March 15 that N95 masks should be worn universally by staff in direct contact with patients at the hospital site. As previously noted, the screening of patients early on was inadequate to capture all patients with COVID-19; this problem was not unique, and asymptomatic transmission of the virus has been observed.[22] The universal use of N95 respirators could have potentially been more effective in preventing health care worker infections at this facility, especially during exposure to patients who had screened negative for COVID-19 but were later found to be infected. However, the use of N95 respirators for all staff in direct contact with patients at this facility went beyond what was called for by the WHO, which advised the use of standard medical masks except during aerosol-generating procedures.[18] The emergency department continues to mandate the use of N95 respirators for all health care workers in direct contact with patients.

Another process measure that was important to the facility's ability to provide care spaces for all patients was the ED admission and discharge workflow demonstrated in Figure 8. The 48-hour return rate of 1.1% demonstrates that the criteria were successful in measuring disease severity, although this case study is limited, in that at-home mortality cannot be measured and must be considered as a possibility. Other nearby hospitals used a similar risk-stratification strategy, using oxygen saturation level, respiratory rate, and other criteria to determine care pathways for patients presenting with COVID-19 symptoms.[23]

The transforming space in which care was provided in the emergency department during the pandemic was a key structure measure. Infection control should be a high

priority in the design of emergency departments, with the ability to create large sections of negative pressure space if needed. Multiple points of entry into different sections of the department allowed for reduced contacts between patients classified as infectious and those classified as noninfectious. These lessons will be considered when embarking on a remodeling of the emergency department in the future.

Finally, we consider the ED staff infection rate of 11%. Compared with the 1.1% of the health care workers infected at a hospital in Wuhan, China,[24] and 2.4% in South Korea,[25] this rate seems undesirable or modestly successful. However, the multifactorial challenges that this region faced included population density, supply-chain issues, delays in the closure of schools and public spaces, hesitation of the public to accept universal face coverings, and other factors that may have contributed to COVID-19 exposure at, and outside of, work. This department's success was demonstrated in comparison with that of the general public in Westchester County, which had an infection rate of 13.8%, as well as that of New York City, which demonstrated a rate of 20% among the general public and 12% among health care workers.[26] One hospital in the region experienced a staff COVID-19 antibody seroconversion rate of 46%,[27] further demonstrating the challenge of protecting health care workers in the New York metropolitan area. Structure and process measures that differed among the hospitals in the region may be examined in future studies to determine possible reasons for the disparity.

It should be considered whether the aforementioned lessons learned may have reduced the number of staff who contracted COVID-19. In preparation for the potential second wave of infections, this department considers the protection of staff and patients to be of the utmost importance.

## Limitations

The described interventions were used during the emergence of the COVID-19 epidemic in an institution and emergency department with its own set of challenges and advantages. Information on transmission and the resources that would be required were continually changing, as was the availability of PPE and other supplies. For example, the processes required regular reevaluation as the CDC updated its guidelines regarding the mode of transmission of COVID-19 from droplet to airborne. An institution more equipped with validated information about the virus perhaps would have structured its response differently or according to another timeline.

Furthermore, it is recognized that there are limits to this hospital's response in terms of generalizability. The setting of a private hospital in Westchester County with many available specialists and partnering hospitals for possible transfers needing increased level of care is not applicable to all settings. In addition, the layout of the existing emergency department was such that it lent itself relatively easily to the creation of a larger negative pressure area. A challenge of the setting was that the personnel were perhaps stretched more thinly than those at teaching hospitals or in larger hospital systems that were able to redeploy large numbers of staff.

More information regarding the success of this intervention might also be gleaned from the outcomes not measured, including inpatient mortality, overall COVID-19 hospitalizations, disease complications, asymptomatic spread, and ED return visits beyond 48 hours.

## Implications for Emergency Nurses

The COVID-19 pandemic presented many serious challenges from which there are important implications for emergency nurses. The importance of examining departmental structure and process measures to have a positive impact on outcome measures should not be overlooked when preparing for, or managing, a disaster or crisis.

ED structure measures, including the architecture of the department, may be examined on an ongoing basis to evaluate readiness to respond to crises, including infectious disease, mass casualties, and natural disasters. The addition of a waiting room nurse was a key structure measure in this department's response, serving an important role in infection control, which may be replicated in other departments.

Process measures, including interdisciplinary communication methods, environmental cleaning, and PPE guidelines, were paramount to this facility's success in managing the initial wave of the pandemic. Again, communication methods may be examined on an ongoing basis, ensuring that all staff members have access to communications from management describing rapidly evolving crises. Collaboration between frontline workers and ancillary departments such as EVS to achieve a common goal is reliant on the processes for communication between these departments. Improved communication and transparency from department leaders streamlined the implementation of the outlined interventions. Virtual happy hours and debriefing sessions functioned to keep the lines of communication open with staff and helped to improve morale during an otherwise demoralizing time.

As in many other settings, the use of telehealth was extremely helpful in triaging patients and decreasing exposure to patients and staff. Practical screening tools facilitated

this process and will likely have applications in other disease scenarios once formally validated.

Until this crisis, items of PPE, including N95 respirators were very rarely, if ever, reused. Emerging evidence and effective processes to conserve PPE resources might be required in future pandemics.

## Conclusion

COVID-19, the information surrounding its spread and management, and the response to its prompt advent has made an indelible mark on the way emergency care is delivered. This facility-level case study reflects the response of 1 department at the epicenter of the outbreak in New York. Whereas change is often met with anxiety and resistance, multidisciplinary cooperation and strong leadership allowed for important and necessary structure and process measures to be amended along a tight and tense timeline. It remains to be seen whether these measures demonstrate significant success, and therefore more research is needed to determine whether such measures are associated with causal improvements.

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# Asynchronous Testing of 2 Specimen-Diversion Devices to Reduce Blood Culture Contamination: A Single-Site Product Supply Quality Improvement Project

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CE Earn Up to 10.5 Hours. See page 359.

**Contribution to Emergency Nursing Practice**

- What is already known on blood culture contamination is that it has been a consistent clinical issue in the emergency department site.
- The main finding of this paper is that devices used for initial diversion methods. What is already known on blood culture contamination is that it has been a consistent clinical issue in the emergency department site. reduce blood culture contamination.
- Recommendations for translating the findings of this paper into emergency clinical practice include using initial specimen diversion devices as part of a bundle of interventions for sustained reduction of blood culture contaminations in the emergency departments of hospitals with baseline metrics above national blood culture contamination thresholds.

## Abstract

**Objective:** Blood culture contamination above the national threshold has been a consistent clinical issue in the ED setting. Two commercially available devices were examined that divert an initial small volume of the specimen before the collection of blood culture to reduce skin contamination.

**Methods:** Prospectively, 2 different blood culture–diversion devices were made available in the unit supplies to ED clinicians at a single site during 2 different periods of time as a follow-up strategy to an ongoing quality improvement project. Blood samples were collected in the emergency department over a period of 16 months. A retrospective record review study was conducted comparing the use of the 2 specimen-diversion devices with no device (control group) for blood culture contamination rates. The main outcome of monthly blood culture contamination per device was tested using a Bayesian Poisson multilevel regression model.

**Results:** A total of 4030 blood samples were collected and analyzed from November 2017 to February 2019. The model estimated that the mean incidence of contaminated blood draws in the device A group was 0.29 (0.14-0.55) times the incidence of contaminated draws in the control group. The mean incidence of contaminated blood draws in the device B group was 0.23 (0.13-0.37) times the incidence of contaminated draws in the control group, suggesting that initial-diversion methods reduced blood culture contamination.

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**Conclusion:** Initial specimen–diversion devices supplement present standard phlebotomy protocols to bring down the blood culture contamination rate.

**Key words:** Blood culture; Collection; Contamination; False positive

## Introduction

### AVAILABLE KNOWLEDGE

Blood cultures (BCs) are the gold standard for diagnosing sepsis, one of the leading causes of death and readmissions in United States hospitals.[1] False-positive cultures, owing to the contamination of blood samples by the growth of organisms that are not supposed to be present, can jeopardize the usefulness of this important tool. Moreover, it is estimated that the national BC contamination rate (BCCR) ranges from 0.6% to 12.5%.[2] Hospitals are continually struggling to keep the false-positive BC rates below the national benchmark of less than 3%.[3] False-positive results have adverse consequences for patients, such as inappropriate antibiotic use, extended length of stay, and increased diagnostic and consultation expenditures.[4] In addition, false-positive cultures may have an impact on the interpretation of central line–associated bloodstream infections events that are mandatory reportable conditions.[5]

Whereas the national benchmark for the BCCR is less than 3%, many emergency departments have reported rates as high as 11%.[2,3] Up to 50% of all BCs drawn in hospitals originate in the emergency department.[5] This high volume poses a unique challenge because emergency departments have been noted to have higher BCCRs than the intensive care unit and acute care settings.[2] Multiple interventions have been tried and tested in the emergency department to reduce BCCRs, including the use of specific skin antisepsis solutions,[6,7] prepackaged kits,[8] sterile gloves,[9] samples from percutaneous sites,[10] education,[11] and phlebotomy teams.[12] The bundling of these interventions has been shown to reduce BCCRs significantly when obtained by venipuncture or from an intravascular catheter.[13]

### PROBLEM DESCRIPTION

A retrospective analysis showed that for the past 10 years, the Central Texas Veterans Health Care System has kept the average hospital BCCR below the national benchmark of 3% and the Veterans Affairs (VA) threshold of 2.5%. However, in our routine quality improvement (QI) process records (Figure 1), we noted that the contamination rates for BCs obtained in the emergency department had a BCCR >3%, whereas non–emergency department–obtained BCs were below the benchmark (2.5%).

This facility's emergency department averaged 250 BC collections per month, with BCCR rates at 3% to 4.7%. A multidisciplinary process improvement (PI) team composed of microbiology staff, ED staff, and infection prevention staff were assembled to address this issue by using QI methods, particularly by using a previously reported model improvement framework[14] to reduce the ED BCCRs to below 2.5%. These have included education on best practices for BC collection, use of a transfer device, discarding the first 2 mL to 3 mL of blood by aspiration with a 5-mL syringe, and cleaning the site with a chlorhexidine solution. A discussion with ED staff indicated that the factors contributing to higher BCCRs in the emergency department include time pressures, phlebotomy during emergent procedures, and high staff turnover.[15]

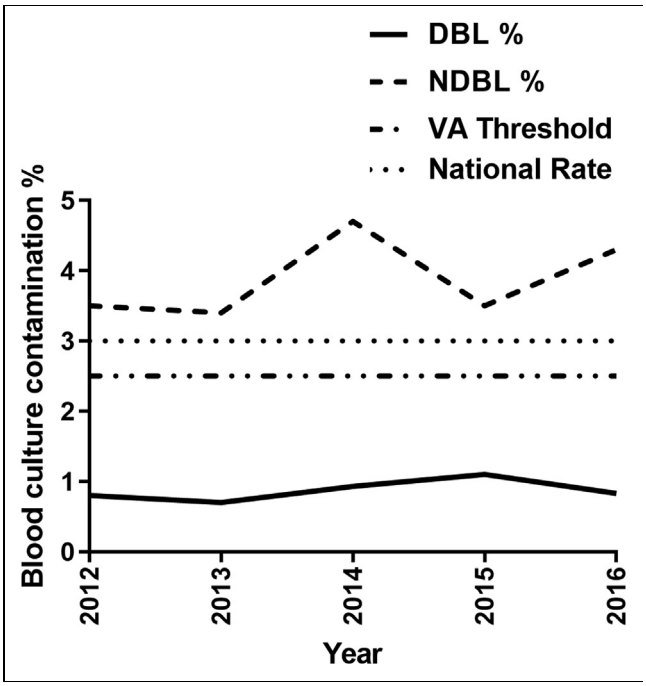


FIGURE 1

Baseline, preproject BCCRs from 2012 to 2016, stratified by DBL and NDBL. DBL shown in a solid line, NDBL depicted in a broken single line. The VA threshold is shown in a dotted line, the national threshold is shown in a line composed of alternate dots and dashes. BCCR, blood culture contamination rate; DBL, blood drawn by laboratory staff; NDBL, blood not drawn by laboratory staff (drawn by ED staff); VA, Veterans Affairs.

TABLE
**Retrospective blood culture contamination data for 16 months with or without an initial specimen–diversion device**

| Month | Drawn without a device, n | Contaminant, without a device, n | Drawn with device A, n | Drawn with device B, n | Contaminant, with a device, n |
|---|---|---|---|---|---|
| 1 | 110 | 3 | 106 | 0 | 0 |
| 2 | 98 | 2 | 180 | 0 | 0 |
| 3 | 108 | 6 | 210 | 0 | 0 |
| 4 | 211 | 2 | 89 | 0 | 0 |
| 5 | 234 | 4 | 79 | 32 | 0 |
| 6 | 85 | 2 | 0 | 149 | 1 |
| 7 | 79 | 2 | 0 | 199 | 1 |
| 8 | 74 | 3 | 0 | 176 | 1 |
| 9 | 79 | 1 | 0 | 150 | 0 |
| 10 | 165 | 11 | 0 | 92 | 0 |
| 11 | 182 | 8 | 0 | 107 | 1 |
| 12 | 129 | 9 | 0 | 86 | 0 |
| 13 | 133 | 7 | 0 | 64 | 0 |
| 14 | 28 | 4 | 0 | 192 | 0 |
| 15 | 169 | 9 | 0 | 40 | 0 |
| 16 | 170 | 11 | 0 | 25 | 0 |

### RATIONALE

The QI strategies—using a transfer device, discarding initial blood by aspiration, and cleaning the site—were unsuccessful. Repeated attempts to reduce our BCCR in the emergency department using the existing PI procedures failed to reach VA standards.

Our facility's QI team then decided to use an initial specimen–diversion (ISD) technique adopted by Rupp et al[16] This technique was successfully innovated and adapted by Patton and Schmitt.[17] Because the emergency department had previously tested an open diversion system—in which the health care worker was required to manually switch the intravenous line from a sterile diversion tube to a collection tube or culture bottle—that had not been effective, the hospital QI team opted to examine 2 commercially available closed system devices manufactured on the basis of on an invention reported by Patton and Schmitt.[17]

### PURPOSE

The purpose of this project was to replicate the Patton and Schmitt[17] study protocol and intervention at our site, comparing the BCCR when a closed BC diversion device was used with that when such a device was not used.

## Methods

### DESIGN

This QI project was designed to test 2 commercially available devices to reduce the BCCR in our emergency department, replicating the technique described by Rupp et al[16] and Patton and Scmitt,[17] device A and device B. We neither endorse nor oppose either of these products and hence do not identify which one is A and which is B. Device A was available on the unit from November 2017 to March 2018. During this time, 664 samples were drawn with device A, and 761 samples were drawn without a device. Device B was available on the unit from April 2018 to February 2019. During this time, 1312 samples were drawn with device B, and 1293 samples were drawn without a device (Table). Blood samples drawn without a device were used as controls to compare the contamination rates.

### CONTEXT

The site location is a single-center emergency department in an urban 146-bed teaching hospital, with an emergency department that averaged nearly 30 000 visits per year.

## DIFFERENT DEVICES IN UNIT PRODUCT SUPPLIES AS INTERVENTION

Product information on the devices was reviewed by the multidisciplinary team and presented to the clinical product review committee, which granted approval for the trial.

One device (Magnolia Medical Technologies, Seattle, WA) is a manually triggered vein-to-bottle closed system that isolates the first 1 mL to 2 mL of blood from the rest of the sample into a sequestration chamber and then flows through a sterile pathway into the BC collection bottles. The preassembled device kits come with a culture bottle transfer adapter with either an attached butterfly needle or a Luer lock for use with freshly inserted peripheral intravenous catheters, both of which were used in the emergency department.[4] Recently the same company launched Steripath Gen2, which received 510(k) clearance from the Food and Drug Administration on February 28, 2020. However, we used their first product marketed, which was available in 2017.[18]

The other diversion device, Kurin, which received 510(k) clearance from the Food and Drug Administration on December 23, 2016, passively diverts less than 0.15 mL of blood into a U-shaped flash chamber in which the initial sequestered volume of blood is locked. As the BC bottle is attached, the specimen is collected in the bottle through a separate channel. This device, which is also a closed system, consists of a winged needle with flexible tubing and an attached vial adapter.[19]

## DATA SOURCE

Data were collected from the pathology and laboratory medicine department's microbiology laboratory blood sample records of all adult patients in the hospital emergency department who required BCs for clinical suspicion of infection. Protected health information and VA sensitive information were not collected, and all data were deidentified. Decisions made by the clinical product review committee and the PI team were mutually exclusive, and no author in this project took part in that decision-making body. Monthly feedback was provided by the ED staff during the review process.

## PROCEDURES

Training representatives from the manufacturers were on site to provide education and demonstration on the use of the products during the first 2 weeks of implementation. To measure and record whether a diversion device was used, the ED staff were instructed to insert the package label of the device along with the BC specimens sent to the laboratory. Nurse managers monitored this practice. The laboratory quality manual (QM) kept records of the monthly reports, which were used to report on the QI project. BCs received with no package label were considered collected without a device and categorized as a control in this project. The laboratory QM routinely verified any suspected positive samples to identify whether a device was used with it or not. As previously described in the design section, the availability of BC diversion devices in the unit supplies changed by time period.

During the evaluation period, BC collections were completed per facility protocol, with the change being the use of the diversion devices. Venipuncture sites were disinfected with ChloraPrep (BD, Franklin Lakes, NJ); BC bottle tops were disinfected with alcohol pads. The BC set consisted of 20 mL venous blood split evenly between the aerobic bottle and the anaerobic bottle.

## BC CONTAMINATION VARIABLE

BCs were monitored using the BacTAlert 3D system (bioMérieux, Marcy-l'Étoile, France), with positive bottles being further characterized by Vitek MS MALDI-TOF (bioMérieux, Marcy-l'Étoile, France) and automated susceptibility testing (Vitek 2). The American Society for Microbiology recently released an updated review of BC contamination on the basis of the College of American Pathologists' Q-Probes QI studies, which was used as a guideline to classify contamination: contamination was present if 1 or more of the following organisms was found in only 1 bottle in a series of BC sets: coagulase-negative staphylococci, *Micrococcus,* α-hemolytic viridans group streptococci, *Corynebacterium sp, Propionibacterium acnes,* and *Bacillus sp*.[20] Our QI project changed the use of diversion devices, but no contamination assessment criteria changed during the project period. Our hospital maintains monthly statistics on BCCRs and reports these to the pathology and laboratory QM committee as well as the infection prevention committee. The microbiology laboratory QM collects BC statistics on the basis of accession number and drawing personnel/phlebotomist. They are recorded by subgroup on the basis of who conducted the draw, the laboratory phlebotomist or ED staff. During the trial periods, a record was kept of how the emergency department conducted BC draws, with or without a diversion device. At the end of every month, the microbiology laboratory QM compiles a report on the basis of individual data to provide the monthly total BC contamination numbers of true positives, the number of contaminants, and the contaminant rate/percentage.

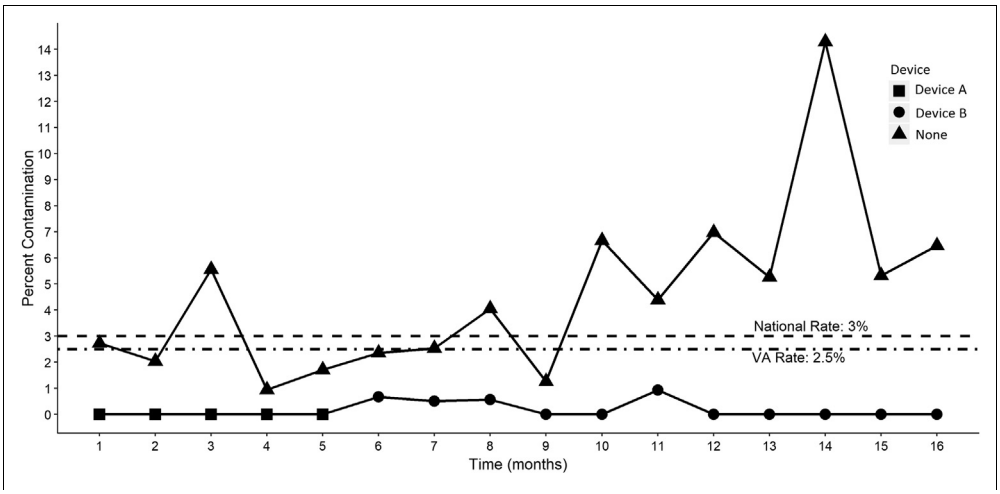


FIGURE 2

Percentage of contamination of blood draws: comparison of ISD devices with standard procedure. Line with solid triangles shows contamination percentage when using standard procedure in the emergency department throughout the study period. Line with solid squares up to 5 months shows zero contamination during device A trial, whereas line with solid circles shows contamination percentage when using device B. The thresholds of the national and VA rates are shown in a discontinuous solid line and a line composed of alternate dots and dashes, respectively. ISD, initial specimen–diversion; VA, Veterans Affairs.

### DEVICE VARIABLE

As previously stated, the ISD package label was included with the BCs and recorded by the laboratory. BCs received with no package label were considered collected without a device and categorized as a control in this project. Although the ED staff were educated about the use of the devices, there were instances when the devices were not available on the unit owing to periodic automatic replenishment–level issues in the supply chain and when the ED staff chose not to use the device. The reasons for why the ED staff chose not to use the device included the inconvenient location (storage room in the back of the emergency department) with reference to the point of care.

### STATISTICAL METHODS

The number of contaminated draws per total monthly draws was modeled as a function of the type of device (control, A, or B), the log of the total draws per month as an offset, and a varying intercept for the month in a Bayesian Poisson multilevel regression model. Prior predictive checks were used to check that the priors specified made clinical sense.[21] A normal (–2, 1) prior was used on the intercept parameter, a normal (0, 0.5) prior on the coefficient parameters, and a half-normal (0, 1) prior on the group-level standard deviation parameter. The results were expressed in incident rate ratios (IRRs) comparing the incident rate of a contaminated sample in a treatment device group with that of the control, and 95% uncertainty intervals for the IRR expressed the uncertainty associated with the estimated IRR in terms of probability. An IRR of 1 indicated the same rate for the control as that for the device, an IRR less than 1 indicated lower rates of a contaminated sample for the device than those for the control, and an IRR greater than 1 indicated increased rates of a contaminated sample for the device compared with those for the control. Details of the model specifications and sensitivity analysis are included in the Supplementary Appendix.

## Results

### EMERGENCY DEPARTMENT WITH HIGHER BCCRS

Data from 2012 to 2016 were analyzed by dichotomizing the BCCRs between those drawn by laboratory staff (DBL) and those not drawn by laboratory staff (NDBL; ED staff) as shown in Figure 1. Although the facility met its BCCR goal at 0.8%, the ED BCCR was at 3.5%. BC collections in the emergency department were performed by nurses and emergency technician nurse assistants.

### INTRODUCING ISD DEVICES REDUCED THE BCCR IN THE EMERGENCY DEPARTMENT

There were 4030 total BCs drawn by registered nurses and emergency technician nurse assistants from November 2017 to March 2018 (device A) and from April 2018 to February

2019 (device B). Blood samples collected from the comparison group (standard method of venipuncture without a device), device A, and device B were analyzed from November 2017 to February 2019 (Table and Figure 2). During the first 5 months, 761 samples were collected by ED staff without the device (control), of which 17 (2.2%) were contaminated, and 664 samples (Table) were collected using device A, of which 0 (0%) were contaminated. During the next 11 months, 1293 samples were collected without the device (comparison group), of which 67 (5.2%) were contaminated, and 1312 samples (Table) were collected using device B, of which 4 (0.3%) were contaminated.

The model estimated that the mean incidence of contaminated draws per month in the device A group was 0.29 (0.14-0.55) times the incidence of contaminated draws in the control group. The estimated mean incidence of contaminated draws in the device B group was 0.23 (0.13-0.37) times the incidence of contaminated draws in the control group. Thus, conditional on the data in this study and the model and prior specified here, there was a 95% probability that the mean rate of contamination for device A was 45% to 86% lower than that for the control and that the mean rate of contamination for device B was 63% to 87% lower than that for the control. The results of the sensitivity analysis and guidance for determining a sample size for replication are contained in the Supplementary Appendix.

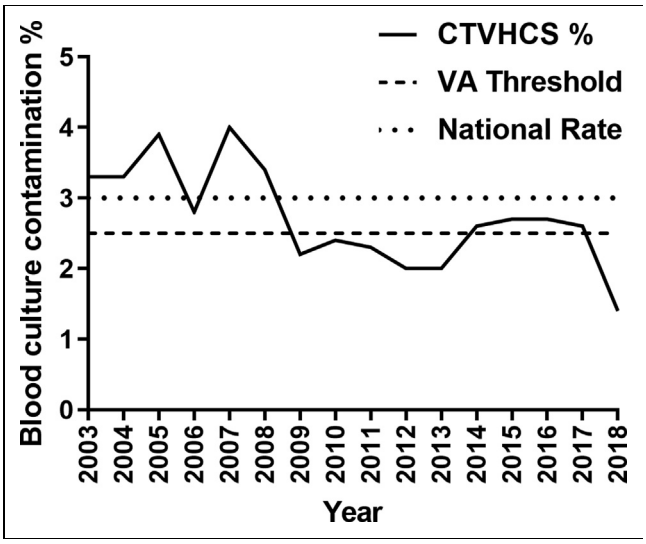


FIGURE 3

Blood culture contamination history of Central Texas Veterans Health Care System for the past 15 years until 2018. The combined initiative was fruitful in reducing the BCCR since 2009 to keep it below the national threshold. BCCR, blood culture contamination rate.

## Discussion

Sepsis is one of the oldest and most pressing problems in emergency care. BC is one of the main tools used to confirm an early diagnosis of sepsis.[22] The accurate identification of causative infectious agents, excluding contamination, is therefore of prime importance. BC contamination has been linked to cross-contamination from the patient's skin, supplies used in BC draws, and the immediate environment of the patient, including the hands of the individual collecting the sample.[5] Novel ISD technology reduces the likelihood of contamination from the external environment and is a feasible and effective approach in reducing the BCCR in the emergency department.

In our study, for the first time in the literature, we examined successful applications of 2 main commercial devices used to reduce BC contamination. Here we show that including diversion devices in the unit product supplies drastically reduced the BCCR, irrespective of the volume of initial diversion. These findings would be of immediate use at the management levels of practice among nurse managers/executives in emergency departments where BC contamination is an ongoing issue.

In agreement with previous studies,[16,17] our data showed that our hospital managed to reduce the BCCR by using a closed-system device using an ISD technique. Both devices reduced the BCCR in our hospital emergency department, irrespective of the different initial volume of sequestration by the device. ISD devices would be an effective solution for sustained reduction of BCCRs in the emergency department. The most common sources of contaminants are the skin flora. However, approximately 20% of the skin microbes are colonized deep in the dermis layer, and they are unaffected by skin antisepsis.[5] Several studies have shown that ISD has significantly reduced false-positive BCs by bypassing deep skin–colonized microbes.[17,20] Most of these studies supported the sequestration of 1 mL to 2 mL of blood before collecting for culture. For the first time, our study examined both closed devices with different volumes of initial sequestration. Our findings also corroborate the results of the recent publication by O'Sullivan and Steere,[23] who reported that an ISD device significantly lowered the BCCR compared with the standard method. In the O'Sullivan and Steere[23] study, 50% of the BCs were collected in the ED setting, emphasizing the importance of the emergency specialty in BCCR QI. It is estimated that the cost of a false-positive BC ranges from $4500 to $10 000.[5]

Figure 3 contextualizes our findings with our site's annual BCCR rates from 2003 to 2018. As we relayed in the problem description section of this paper, the site was previously unsuccessful in targeting the VA 2.5% BCCR threshold goal. In December 2008, a skin disinfectant (ChloraPrep) and the use of a transfer device for BC collections were implemented throughout the facility. In addition, this change in practice was an opportunity to reinforce education on the proper technique for BC collections. This combined strategy decreased the facility's BCCRs from 4% to 2.2% by the end of 2009 (Figure 3). As part of an ongoing QI project, the microbiology laboratory continued to monitor the BCCR rates and communicated the progress to the stakeholders. However, the progress was unsustainable (the BCCR was above the VA threshold from 2014 to 2017), requiring us to investigate the successful diversion device strategy presented in this manuscript.

False-positive BCs incur harmful downstream effects: increased risk for nosocomial infection, improper antibiotic use, prolonged hospital stay, hidden laboratory expenses for unnecessary culture identification, and antibiotic-sensitivity assays with other overheads.[4,5] Because false-positive BCs and downstream effects add to indirect costs, the hospital leadership often emphasizes reducing BC contaminations in the emergency department where most of the BCs are drawn. In our system, gram-positive and gram-negative culture and sensitivity tests cost approximately $20.00 and $40.00 each, respectively, and rapid BC identification costing $136 per sample adds to the cost. We recommend more comparative studies to further our investigation enabling the end clinical users who are involved in device-purchasing decisions in the emergency department to base the decisions on their preference. In addition, more studies comparing the efficacy of both devices side by side would be beneficial in understanding if the ED setting is suitable for the use of each device. Additional study or project replication should be completed in participant samples that include both children and adults.

## LESSONS LEARNED

Here, the intent of the QI project was not to compare devices but to explore strategy for reducing the BCCR using ISD technology. The results show that ISD technology greatly reduced (clinically significant) the BCCR in the facility's emergency department. Testing both devices was also intended to increase awareness of, and attention paid to, the issue of the BCCR in the emergency department as well as increase buy-in to the solution. The trending decline of the BCCRs was reported monthly to the ED staff, and their efforts were affirmed by the QI project team.

After the first few days into the study, the QI team noted that product placement and product availability played a key role in use decline. Initially, the diversion devices were stored in an inconvenient location in a supply room at the end of the hall of the emergency department, which required additional time for the staff to obtain BC collection supplies. Once the product was moved closer to the point of care, an increase in use was noted. Although there was a change in ED nursing leadership during the trial period, both nurse managers were supportive of the QI project. Use of the devices did not overlap except in the fifth month of the study (Table). This minimized device misclassification and human error. However, because the QI team monitored the stock of devices and checked with the QM of the microbiology laboratory, we speculate that this error would have been kept to a minimum. For QI teams considering replicating this project, we also recommend paying attention to maintaining the device stocks for 24/7 availability.

## Implications for Emergency Clinical Practice

Our findings can be used to inform future updates to the relevant Emergency Nurses Association Clinical Practice Guidelines on BC contamination.[24] Our study provides evidence of a successful QI strategy through adding blood diversion devices to the BC collection supplies for hospitals with quality data above the benchmarked thresholds for BC contamination.

For sites considering adding ISD-technique devices, we wish to reiterate the importance of best-practice phlebotomy techniques to draw blood, irrespective of the use of such devices to eliminate BC contamination. It has already been reported nationwide that nonphlebotomists report higher contamination than phlebotomists.[25] However, not all hospitals have phlebotomists servicing the emergency department. In fast-paced, heavy-workload settings such as the emergency department, the ISD technique coupled with the proper aseptic technique is a feasible QI bundle that can result in sustained reduction of BCCRs.

## Limitations

The research design may have been limited by a maturity bias. The 2 diversion devices were introduced to the supply chain sequentially, which meant that the staff had

familiarity, training, comfort, and experience with the second device that they may not have experienced when the first device was introduced. Another limitation of the study could be misclassification of the device use variable, although the ED leadership conveyed to the staff that the use of the product was required for BC draws. The potential for human error should be taken into consideration for circumstances when the collector failed to include the package insert on the specimen sent to the laboratory even if the device was used. In addition, in an unstable patient or 1 in an active sepsis alert, the timely care the patient required would preclude the extra time needed to gather supplies. Thus, the acuity and timeliness of care interventions may have biased the results. Therefore, selection bias is a key limitation because the clinician may have used the device in more stable patients during which time was less constrained or pressured.

In addition to the aforementioned limitations, causation cannot be inferred from the study design because there was no randomization or blinding. Finally, because patient-level data were not collected, confounders and covariates were not tested that may have increased the risk for BC contamination. Despite these limitations, our findings support the need for further studies in using specimen-diversion methods as an option to address BC contamination.

## Conclusion

High incidence rates of false-positive BCs in the emergency department are common. Our QI project using ISD devices was successful in decreasing the BCCRs in our emergency department. We recommend use of the ISD devices as a QI bundle, along with best-practice site preparation and phlebotomy and specimen collection considerations. Our QI project should be replicated in future prospective studies to test the efficacy of each device in the emergency department and in QI studies at sites with both child and adult participants.

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## 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.2020.11.008.

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## Supplementary Appendix

### MODEL CHOICE

A Bayesian multilevel Poisson model was used in the reported analysis. Poisson models are commonly used for count data. Our data were counts of contaminated blood draws for each month. We modeled this outcome as a rate of contaminated draws per total draws each month by including the log of total draws as a predictor in the model. This is possible because the equation $\log u_x/t_x = B_0 + B_1x$, is equivalent to $\log u_x = \log t_x + B_0 + B_1x$. Thus, Poisson regression is a common method used to model counts that are the numerator in a rate.

As in any analysis, there are many choices that can be made as to how to specify the model. For example, a Poisson model assumes that the mean and the variance of the distribution are the same. What about overdispersion?

Overdispersion is often addressed by using the Poisson model. The worse the posterior predictive fits and the higher the Watanabe-Akaike Information Criteria, the poorer the fit, suggesting that the overdispersion parameter is not needed. The summary model results of both the Poisson and negative binomial models are shown in Supplementary Tables 1 and 2.

### HOW WELL DOES OUR MODEL FIT?

Bayesian models are generative models. If the model is good, then it should be able to generate data from the posterior predictive distribution that look like the real observed data. This is the reasoning behind graphical posterior predictive checks. We show some plots below that demonstrate that our model generates data that look similar to the real observed data. For a full discussion of the posterior predictive checks, see Chapter 6 of *Bayesian Data Analysis* by Gelman et al. Supplementary Figure 1 is a density plot of data from 100 simulations from the Poisson model. The dark blue line shows the actual observed data for the study, and the light blue lines show each simulation. The model generates data that are reasonably close to the observed data. Supplementary Figures 2 and 3 show density plots of the mean and standard deviation of simulation data generated from the Poisson model. As can be seen from the plots, the model generates data with means that are very close to the mean of the observed data. The model-generated data also have similar standard deviations as the observed data, although most of the generated datasets from the model slightly underestimate the standard deviation compared with the observed data.

### DO OUR PRIORS INFLUENCE THE ESTIMATES?

A non-Bayesian generalized linear mixed Poisson model was also run. The results are shown in Supplementary Table 3. It should be noted that this model did not converge. For our analysis, a normal (0, 0.5) prior was used for the coefficients for the effect of the devices. This prior is centered around zero effect, with tails that have approximately 95% of the probability between −1 and 1. Thus, it is conservative when estimating the effect of the intervention. The result for device A is a much more conservative estimate but with a reasonable standard error. The prior was chosen using the following reasoning: let's say as an example that the intercept (baseline contamination rate in the control) is $\exp(-2) = 0.14$, which is plausible but pretty high given that the baseline rate without any intervention is pretty low anyway (the national rate is only 0.03). If the parameter estimate for the coefficient for the device was −1.0, this would mean that the rate for the device group would be $\exp(-2 + -1) = 0.05$ or almost a third of the baseline rate of 0.14, which would be quite a large effect for the device.

However, these priors do influence the estimates toward being more conservative (ie, smaller effect size). We ran the same model as in the Results section with more diffuse priors: normal (0, 20) for the intercept, normal (0, 10) for the coefficients for the 2 devices, and a half-normal (0, 5) for the standard deviation of group-level effects. The results are given in Supplementary Table 4.

### SUMMARY

When the dataset is small, it is important not to overstate large effects. Our dataset was very small, and device A had only 5 months (5 observation points) of data. This particular device also had zero contaminations for all 5 months. However, device B also had a run of 5 months without contamination, but because it included 12 data points there were also some months with contaminants. It thus would not be correct to conclude that device A would have near zero contaminations per month simply on the basis of 5 datapoints. Thus, we believe that conservative estimates are better in this case. Our use of a normal (0, 0.5) prior, which has 95% of the probability between −1 and 1, is a conservative and regularizing choice of prior for the effect of the device. The resulting estimate is conservative with regard to the effect size. To estimate the effect more precisely, more data and larger studies are needed.

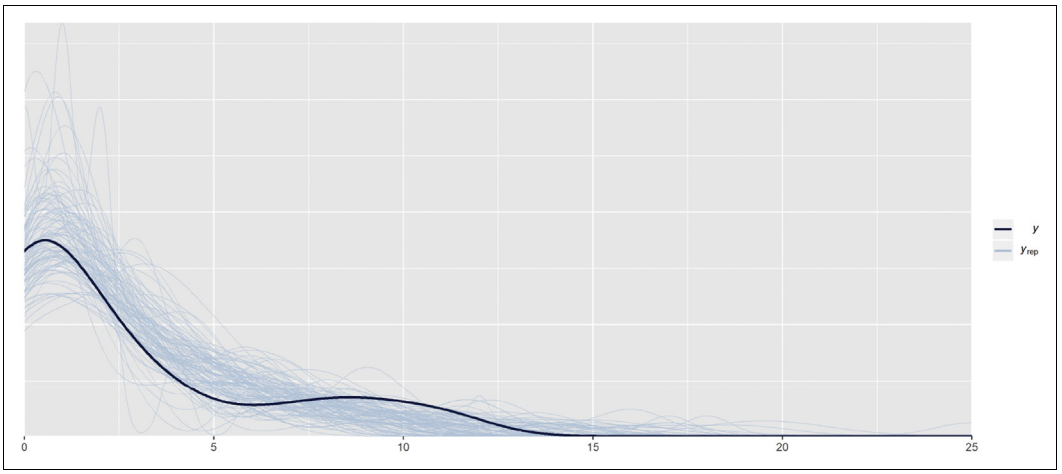
## GUIDANCE ON CALCULATING A SAMPLE SIZE FOR REPLICATION

Our retrospective findings can pave the way for prospective studies to evaluate the use of specimen-diversion devices to reduce blood culture contamination. In this study, we compared 4030 samples over a 16-month period to evaluate the impact of the use of such devices in mitigating blood culture contamination. A prospective well-funded study in a multicenter setting with a double blinded sample collection strategy and larger sample size would solidify our findings.

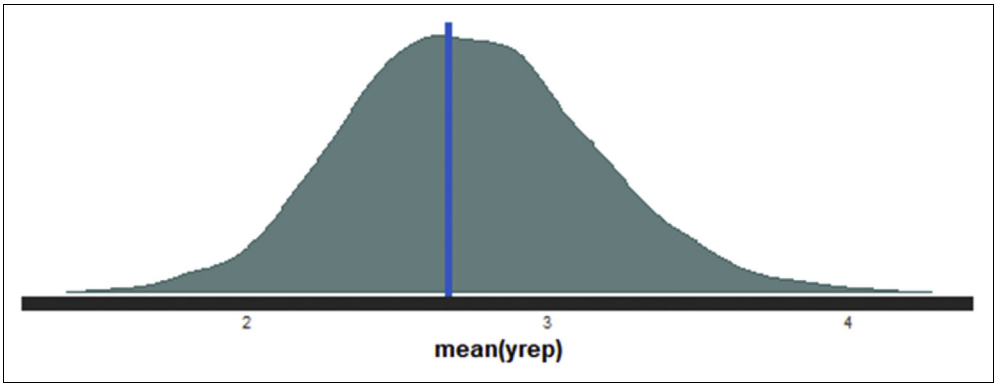
We recommend using a simulation for sample size analysis, where the investigator programs a generative model that simulates data, given the parameters, and then runs the analysis model on the simulated data to obtain effect sizes and standard errors. This program would run iteratively a few thousand times to obtain the average effect and standard error, given the parameters. The investigators in such a scenario should determine the rates of contamination over the last several years at each of their planned study sites, the total number of draws taken during each month, and the variability in the number of draws taken each month. If the investigators wished to use the same analysis model that we did, we recommend using the numbers they found above a range of effect sizes from our study to program a simulation that varies both in sample size and in effect size. Using conservative priors for the treatment effect in the model, our study found the estimated effect of device A to be –1.29, with an estimated standard error of 0.36, and that of device B to be –1.51, with an estimated standard error of 0.28, on the log scale. We would recommend running simulations using effect sizes that range from +2 to –2 standard deviations from these estimates to get a good grasp on the variability of sample size when the effect size varies. The results of the simulations would give the investigators an idea of the range of sample sizes needed for a given effect size. These simulation results would inform the investigators regarding the number of total draws needed per month given their analysis model, the baseline rate of contamination, the variability in draws per month, the chosen effect size, and the prechosen error in the estimated effect that they deemed acceptable. In our opinion, this would provide more useful information than a strict power analysis, and we recommend running a power analysis using the same methods of data simulation and analysis to obtain the sample size, given preplanned power and alpha levels.

## NOTES

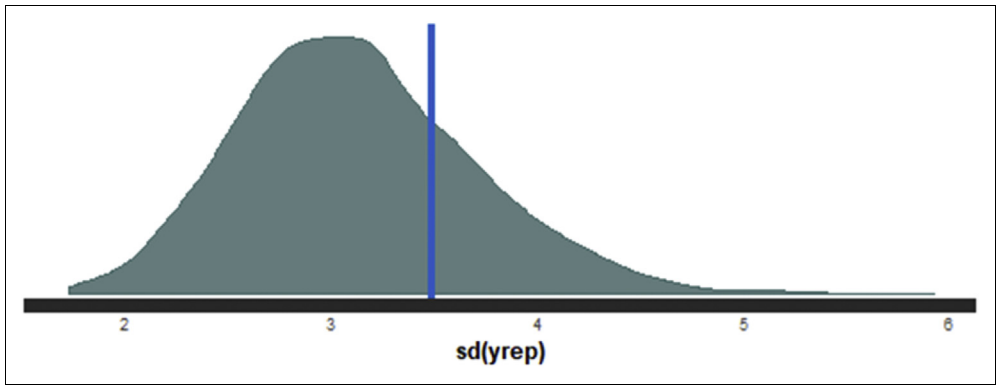
All analyses were conducted in R version 3.5.3 (The R Foundation for Statistical Computing, Vienna, Austria). The 'brms' package was used for all Bayesian models. For Bayesian models, 4 chains were run with 2000 iterations per chain (half warm-up). The mixed model in the Supplementary Appendix was run in the 'lme4' package. Posterior predictive checks were visualized in the package 'shinystan.'




SUPPLEMENTARY FIGURE 1
Density plot.




SUPPLEMENTARY FIGURE 2
Density plot of the mean.




SUPPLEMENTARY FIGURE 3
Density plot of the standard deviation.

SUPPLEMENTARY TABLE 1
**Poisson model**

| **Group-level effects** | **Estimate** | **Est. error** | **l-95% UI** | **u-95% UI** |
|---|---|---|---|---|
| SD (intercept) | 0.43 | 0.19 | 0.07 | 0.84 |
| **Population-level effects** | **Estimate** | **Est. error** | **l-95% UI** | **u-95% UI** |
| Intercept | –3.38 | 0.17 | –3.73 | –3.07 |
| Device B | –1.51 | 0.28 | –2.07 | –0.99 |
| Device A | –1.29 | 0.36 | –2.00 | –0.59 |

Watanabe-Akaike Information Criteria for the Poisson model was 121.9 (12.5). Values in the table were rounded.
UI, uncertainty interval.

SUPPLEMENTARY TABLE 2
**Summary results of negative binomial model**

| **Group-level effects** | **Estimate** | **Est. error** | **l-95% UI** | **u-95% UI** |
|---|---|---|---|---|
| SD (intercept) | 0.27 | 0.20 | 0.01 | 0.72 |
| **Population-level effects** | **Estimate** | **Est. error** | **l-95% UI** | **u-95% UI** |
| Intercept | –3.45 | 0.21 | –3.89 | –3.06 |
| Device B | –1.23 | 0.40 | –1.95 | –0.37 |
| Device A | –1.00 | 0.47 | –1.88 | –0.004 |
| **Family-specific parameters** | **Estimate** | **Est. error** | **l-95% UI** | **u-95% UI** |
| Shape | 8.92 | 22.88 | 0.59 | 63.89 |

Watanabe-Akaike Information Criteria for the negative binomial model it was 117.4 (12.6) (lower Watanabe-Akaike Information Criteria is better). Values in the table were rounded.
UI, uncertainty interval.

SUPPLEMENTARY TABLE 3
**Summary results of Poisson mixed model**

| **Random effects** | | **Variance** | | **SD** |
|---|---|---|---|---|
| Month (intercept) | | 0.10 | | 0.32 |
| **Fixed effects** | **Estimate** | **SE** | ***z* value** | **Pr( > \|z\|)** |
| (Intercept) | –3.23 | 0.14 | –23.17 | <2e-16 |
| Device B | –2.64 | 0.52 | –5.05 | 4.54E-07 |
| Device A | –20.85 | 6861.80 | –0.00 | 0.998 |

Note the very high standard error for the estimate for device A owing to nonconvergence of the model. The excessively high standard error and nonconvergence of the model happened because all months for device A had zero contaminations. In situations where maximum likelihood fails, the Bayesian model allows estimation. Values in this table have been rounded.

SUPPLEMENTARY TABLE 4
**Poisson model with less informative priors**

| **Group-level effects** | **Estimate** | **Est. error** | **l-95% UI** | **u-95% UI** |
|---|---|---|---|---|
| SD (intercept) | 0.39 | 0.2 | 0.04 | 0.82 |
| **Population-level effects** | **Estimate** | **Est. error** | **l-95% UI** | **u-95% UI** |
| Intercept | –3.26 | 0.16 | –3.61 | –2.95 |
| Device B | –2.76 | 0.54 | –3.94 | –1.85 |
| Device A | –10.18 | 5.26 | –23.22 | –3.22 |

Note the larger effects size (larger negative numbers) for the estimates of the effect of the devices. The estimated error for device A is also much larger owing to the more diffuse prior. Thus, the prior has some influence on the estimate because the number of observations is small. Values in this table have been rounded.

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# Improving ED Emergency Severity Index Acuity Assignment Using Machine Learning and Clinical Natural Language Processing

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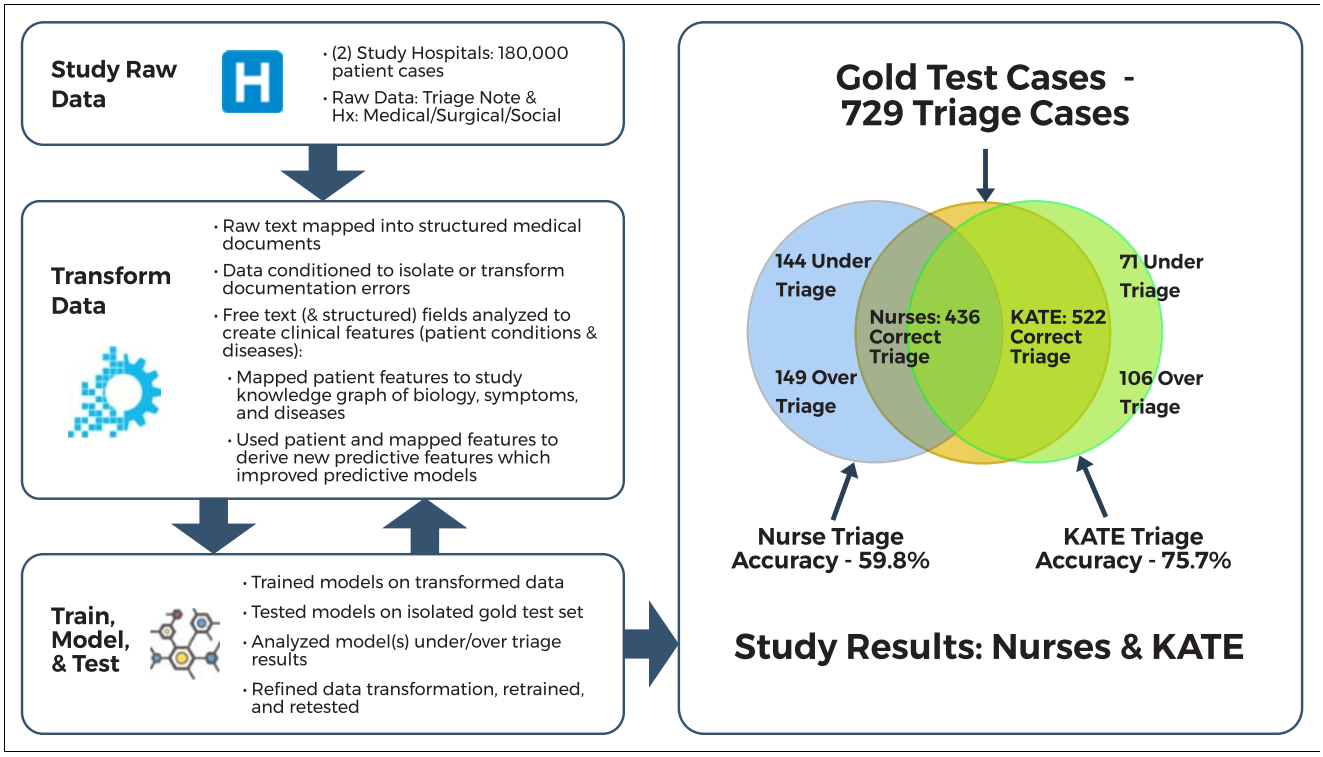



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# Improving ED Emergency Severity Index Acuity Assignment Using Machine Learning and Clinical Natural Language Processing

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### Contribution to Emergency Nursing Practice

- What is already known: triage is a critical process in the initial identification of patients classified as high risk and in the appropriate allocation of resources to ensure safe and effective care. Combined written case scenarios and retrospective reviews for multicenter studies reported nurse triage accuracy of approximately 60%.
- The main finding of this paper is that KATE, a clinical decision support aid using machine learning and natural language processing, was more accurate in assigning acuity on the basis of the criteria set forward in the Emergency Severity Index Handbook than triage nurses and as effective as expert clinicians, especially in the identification of patients classified as high risk presenting for emergency care.
- Recommendations for translating the findings of this paper into emergency clinical practice include that machine-guided support for triage decision-making may improve triage accuracy. Future research should focus on the impact of KATE's feedback to triage nurses in real time and on KATE's impact on mortality and morbidity, ED throughput, resource optimization, and nursing outcomes.

### Abstract

**Introduction:** Triage is critical to mitigating the effect of increased volume by determining patient acuity, need for resources, and establishing acuity-based patient prioritization. The purpose of this retrospective study was to determine whether historical EHR data can be used with clinical natural language processing and machine learning algorithms (KATE) to produce accurate ESI predictive models.

**Methods:** The KATE triage model was developed using 166,175 patient encounters from two participating hospitals. The model was tested against a random sample of encounters that were correctly assigned an acuity by study clinicians using the Emergency Severity Index (ESI) standard as a guide.

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**Results:** At the study sites, KATE predicted accurate ESI acuity assignments 75.7% of the time compared with nurses (59.8%) and the average of individual study clinicians (75.3%). KATE's accuracy was 26.9% higher than the average nurse accuracy ($P < .001$). On the boundary between ESI 2 and ESI 3 acuity assignments, which relates to the risk of decompensation, KATE's accuracy was 93.2% higher, with 80% accuracy compared with triage nurses 41.4% accuracy ($P < .001$).

**Discussion:** KATE provides a triage acuity assignment more accurate than the triage nurses in this study sample. KATE operates independently of contextual factors, unaffected by the external pressures that can cause under triage and may mitigate biases that can negatively affect triage accuracy. Future research should focus on the impact of KATE providing feedback to triage nurses in real time, on mortality and morbidity, ED throughput, resource optimization, and nursing outcomes.

**Key words:** Emergency Severity Index; Triage; Acuity; Machine learning

## Introduction

ED use has increased by 35% in the past 20 years, whereas the number of operating emergency departments has gone down by 11%, affecting approximately 145 million visits in 2016.[1,2] Effective triage is critical to mitigating patients' safety and throughput challenges by accurately determining their acuity and resource needs to ensure that they are placed on an optimal clinical workflow path to deliver safe and high-quality care at the lowest possible cost to ultimately improve overall outcomes.

In the United States, the most widely used triage tool is the Emergency Severity Index (ESI), a 5-point scale—with 1 being "emergent" and 5 being "nonurgent"—assigned by a triage nurse and based on the risk of decompensation and anticipated resource use.[3] In a report in 2012, 70% of the large hospitals and teaching hospitals reported using ESI, whereas a 3-tiered system was still common in community and small hospitals.[4]

Although the ESI classification system uses clear guidelines for acuity assignments (patient vital signs, a unique classification methodology, and expected resource needs), it implicitly leaves room for clinician interpretation. Therefore, accuracy relies heavily on individual triage clinician judgment and experience. It is well documented in medical literature that cognitive biases can impede clinical decision-making.[5-8] These biases include overconfidence, premature closure, the anchoring effect, information and availability bias, and tolerance to risk. Environmental challenges that affect accurate acuity assignment include crowding and boarding, making it difficult to bring patients to a treatment space.[9] Fry and Burr[10] and Chung[11] note that accuracy was affected by interruptions in care delivery, lack of knowledge, and time constraints; it was also reported that triage clinicians manipulated the triage system to speed up or delay care. In other words, triage clinicians respond not just to the patient before them, but also to the environment around them to the potential detriment of the patient.[9] Furthermore, race and gender bias contributed to incorrect acuity assignment, even with dangerous presentations and abnormal vital signs,[12-18] which can lead to suboptimal outcomes.[19]

Nurse triage accuracy measured against that of expert clinicians in various settings was reviewed by Tam et al.[20] In written case scenarios at multiple emergency departments, the nurse average accuracies were 56.2% in Taiwan, 59.2% in Brazil, and 59.6% in Switzerland. In retrospective reviews at multiple emergency departments, the average nurse accuracies were 58.7% in Pennsylvania and 68.3% in South Africa. Some single-center studies demonstrated higher nurse accuracy, which might be attributed to the advancement of technology to assist decision-making in triage.[20] Combined written case scenarios and retrospective reviews for all multicenter studies revealed a triage accuracy of approximately 60%.[20] Challenges to assigning ESI 1 or ESI 2 (resuscitation or emergent, respectively) and ESI 5 (nonurgent) are common, with specific difficulties reported in differentiating between ESI 2 (unstable) and ESI 3 (stable).[21]

Given these challenges, machine learning (ML) approaches have been proposed to aid clinicians in various patient risk assessments. ML has been used to predict in-hospital mortality, critical care (admission to an intensive care unit and/or in-hospital death), and hospitalization (direct hospital admission or transfer) in adults[22-25] and children.[26] ML has also been used to predict hospitalization outcomes[27-29] as well as predict composite risk outcome,[30] defined as an occurrence of mortality, admission to the intensive care unit, or direct transport to the cardiovascular catheterization suite. Rajkomar et al[23] used ML to predict in-hospital mortality, readmission rates, prolonged length of stay, and discharge diagnoses. Other applications of statistical forecasting in emergency departments have been reviewed by Gul and Celic.[31]

Algorithms based on the results of ML predictions of hospitalization, critical care, and mortality have also been developed to predict triage acuity. Dugas et al[30] applied thresholds to predicted probabilities of composite outcome to predict triage acuity. Similarly, Levin et al[32] developed an e-triage algorithm with 3 ML models to predict critical

TABLE 1
**Study site demographic and Emergency Severity Index acuity distributions**

| Demographics/ distribution | Site A | Site B |
|---|---|---|
| Total number of records | 88 237 | 77 938 |
| Number of men | 38 159 | 33 482 |
| Number of women | 49 420 | 44 455 |
| Number of pediatric records (patients aged below 18 years) | 26 772 | 14 027 |
| Number of adult records (patients aged 18 years or older) | 60 815 | 63 911 |
| ESI 1, n (%) | 191 (0.22) | 502 (0.64) |
| ESI 2, n (%) | 8486 (9.62) | 10 877 (13.96) |
| ESI 3, n (%) | 37 730 (42.76) | 44 565 (57.18) |
| ESI 4, n (%) | 35 531 (40.27) | 19 065 (24.46) |
| ESI 5, n (%) | 5715 (6.48) | 2929 (3.76) |
| Missing ESI, n (%) | 584 (0.66) | — |
| Formal education in triage | Yes | Yes |

ESI 1 to 5 distribution: Nurse-assigned ESI acuity in triage.
ESI, Emergency Severity Index.

care outcomes, emergent procedures, and hospitalizations and then applied thresholds on these predictions to determine triage acuity.

To the best of our knowledge, no ML model has used ESI triage acuity scores as labels to predict ESI triage acuity and measure model performance. Therefore, it is not known if an ML model can accurately predict ESI triage acuity using only the information available to the triage nurse at the time of triage.

The purpose of this retrospective study was to determine whether historical electronic health record (EHR) data can be extracted and synthesized with clinical natural language processing (C-NLP) and the latest ML algorithms (KATE) to produce highly accurate ESI predictive models.

## Methods

### STUDY SITES

Site A is a community emergency department in an urban setting in the Western US, with 65 000 annual visits. Site B is a level 1 trauma center in an urban setting in the Midwestern US, with approximately 110 000 ED annual visits. Nurses at both sites performing triage had received training on ESI and triage processes as part of their employment. The study dataset included 88 237 triage records from site A (visits between February 2015 and November 2016) and 77 938 from site B (visits between October 2015 and October 2016). Demographics for the triage records are presented in Table 1.

TABLE 2
**Performance and 95% confidence intervals of clinical natural language processing for 800 randomly sampled medical records**

| Score | Value |
|---|---|
| Number of clinical terms | 9506 |
| Accuracy (95% CI) | 0.9847 (0.9822-0.9871) |
| F1 score (95% CI) | 0.9923 (0.991-0.9935) |
| Sensitivity (95% CI) | 0.997 (0.9957-0.9981) |
| Precision (95% CI) | 0.9877 (0.9853-0.9897) |

CI, confidence interval; C-NLP, clinical natural language processing; F1, harmonic mean of precision and recall.

### ETHICAL CONSIDERATIONS

#### *Ethics Approval and Consent to Participate*

This study was approved as exempted by the Western Institutional Review Board (Office for Human Research Protections/Food and Drug Administration parent organization number: IORG0000432; institutional review board registration number: IRB00000533).

#### *Availability of Data and Material*

The datasets generated and/or analyzed during the current study are not publicly available because they contain protected health information from the medical records of the study.

### DATA COLLECTION AND CONDITIONING

Before data collection, institutional review board exemption was obtained for both sites. All protected health information was redacted from the datasets in accordance with the Code of Federal Regulations (title 45, section 164.514) for deidentifying protected health information to safe harbor standards. Deidentified raw text files were mapped and

TABLE 3
**Statistics of features used in training and validation of machine learning models**

| **C-NLP features overview** | | **Count** | |
|---|---|---|---|
| Total patient encounters used for model training and validation | | 147 052 | |
| Total free text words processed | | 12 158 342 | |
| Total clinical features extracted from free text | | 1 880 841 | |
| Average free text clinical features per triage encounter | | 12.79 | |
| **KATE features overview** | | | |
| Category | Description | Number of unique features | Total count of feature values |
| Total extracted features | All EHR study data, including C-NLP–extracted free-text features as input to feature engineering | 45 928 | approximately 10.1 billion |
| Total features after feature engineering | Processing, consolidation, and enhancement of raw data, input to KATE | 26 332 | approximately 9.9 billion |
| Total features selected by model | Features selected by model with positive predictive power (eg, nonzero gain) | 7 679 | approximately 9.1 billion |
| KATE engineered features | Subset of model features with positive predictive power added through feature engineering | 3 554 | approximately 3.5 billion |
| **Study feature predictive power (gain) overview** | | | |
| Item | Description | Total gain, % | Average gain per feature, % |
| All features | Total model-selected features | 100 | 0.0013 |
| Study EHR features | Model features found in raw EHR data | 53.7 | 0.0012 |
| KATE-engineered features | Study team feature-engineered features | 46.3 | 0.0014 |

C-NLP, clinical natural language processing; EHR, electronic health record.

TABLE 4
**Accuracy against study expert consensus Emergency Severity Index assignment and 95% confidence intervals of KATE, nurses, and 3 study clinicians for the gold set and 2 study sites individually**

| Group | Number of triage records | KATE accuracy (95% CI) | Nurse triage accuracy (95% CI) | Clinician 1 accuracy (95% CI) | Clinician 2 accuracy (95% CI) | Clinician 3 accuracy (95% CI) |
|---|---|---|---|---|---|---|
| All records | 729 | 0.76 (0.72-0.79) | 0.60 (0.56-0.63) | 0.78 (0.74-0.8) | 0.77 (0.74-0.79) | 0.72 (0.68-0.75) |
| Site A | 368 | 0.80 (0.76-0.83) | 0.65 (0.60-0.70) | 0.75 (0.70-0.79) | 0.73 (0.68-0.77) | 0.72 (0.67-0.76) |
| Site B | 361 | 0.72 (0.67-0.76) | 0.55 (0.49-0.59) | 0.81 (0.77-0.85) | 0.81 (0.77-0.85) | 0.71 (0.66-0.75) |
| All ESI 1 | 5 | 0.6 (0.2-1.0) | 0.0 (0.0-0.0) | 0.6 (0.2-1.0) | 0.6 (0.2-1.0) | 0.4 (0.0-0.8) |
| All ESI 2 | 145 | 0.8 (0.72-0.87) | 0.41 (0.33-0.49) | 0.77 (0.70-0.84) | 0.78 (0.71-0.84) | 0.76 (0.68-0.82) |
| All ESI 3 | 277 | 0.83 (0.78-0.87) | 0.77 (0.72-0.82) | 0.83 (0.78-0.87) | 0.85 (0.80-0.88) | 0.8 (0.75-0.84) |
| All ESI 4 | 210 | 0.76 (0.70-0.81) | 0.68 (0.61-0.73) | 0.81 (0.76-0.87) | 0.80 (0.74-0.85) | 0.68 (0.61-0.73) |
| All ESI 5 | 92 | 0.5 (0.39-0.60) | 0.23 (0.14-0.32) | 0.57 (0.46-0.66) | 0.47 (0.36-0.57) | 0.49 (0.39-0.60) |

Group description:
All records: validation records in the gold set from site A and site B.
All ESI 1 to 5: ESI triage acuity from site A and site B.
ESI, Emergency Severity Index; CI, confidence interval.

consolidated to a multihospital hierarchical data model, preserving the differences between the sites. From the initial 166 175 triage records, 19 123 records were removed for patients aged below 1 year and/or if the following items were missing from the record: ESI acuity, reason for visit, or 4 or more vital signs. This data filtering produced the final dataset of 147 052 usable encounters.

## MACHINE LEARNING

### *Clinical Natural Language Processing*

The extraction of clinical terms from patient record free text is a prerequisite to form a complete understanding of each patient and can enhance ML-based clinical decision models.[27] This has been a primary challenge in building ML-based clinical decision support tools for clinicians that leverage clinical raw text evidence. The challenge is to accurately understand the individual's information as documented and then aggregate that understanding across the research dataset. We developed C-NLP technology to accurately extract medical terms from free text.

In C-NLP, we use the following steps to process raw text:

(1) Sentence tokenization
(2) Word tokenization
(3) Text normalization
(4) Part-of-speech tagging
(5) Chunking
(6) Extraction of clinical terms

Steps 1 to 5 are done using the OpenNLP Java library (The Apache Software Foundation). Extraction of clinical terms in step 6 is done using the following steps:

(1) Noun phrases are extracted from the chunker (step 5).
(2) Text in each noun phrase is permuted in all combinations for all phrases.
(3) All text combinations are matched against a Unified Medical Language System (UMLS) dictionary,[33] and clinical terms are extracted on the basis of their matching UMLS terms.
(4) For each medical term, a unique UMLS code (concept unique identifier) is extracted and used as a feature.

To evaluate C-NLP technology, we randomly sampled 800 medical records. For each medical record, 2 independent trained reviewers evaluated the relevance and accuracy of each tag predicted by C-NLP. The performance of C-NLP is

TABLE 5

**Undertriage and overtriage rates against study expert consensus Emergency Severity Index assignment with 95% confidence intervals of KATE, nurses, and 3 study clinicians for the gold set and 2 study sites individually**

| Group | Number of triage records | KATE undertriage (95% CI) | Nurse undertriage (95% CI) | Average of study clinicians undertriage | KATE overtriage (95% CI) | Nurse overtriage (95% CI) | Average of study clinicians overtriage |
|---|---|---|---|---|---|---|---|
| All records | 729 | 0.097 (0.077-0.119) | 0.198 (0.169-0.228) | 0.118 | 0.144 (0.117-0.17) | 0.204 (0.174-0.233) | 0.129 |
| Site A | 368 | 0.098 (0.065-0.128) | 0.193 (0.149-0.234) | 0.093 | 0.103 (0.073-0.133) | 0.16 (0.12-0.198) | 0.178 |
| Site B | 361 | 0.097 (0.067-0.125) | 0.202 (0.161-0.244) | 0.144 | 0.186 (0.147-0.224) | 0.249 (0.202-0.296) | 0.079 |
| All ESI 1 | 5 | 0.4 (0.0-0.8) | 1.0 (1.0-1.0) | 0.467 | — | — | — |
| All ESI 2 | 145 | 0.2 (0.131-0.262) | 0.579 (0.49-0.655) | 0.233 | 0.0 (0.0-0.0) | 0.007 (0.0-0.021) | 0.000 |
| All ESI 3 | 277 | 0.105 (0.065-0.141) | 0.152 (0.105-0.195) | 0.124 | 0.069 (0.04-0.098) | 0.079 (0.047-0.112) | 0.051 |
| All ESI 4 | 210 | 0.052 (0.024-0.086) | 0.062 (0.029-0.095) | 0.073 | 0.19 (0.138-0.243) | 0.262 (0.205-0.319) | 0.167 |
| All ESI 5 | 92 | — | — | — | 0.5 (0.391-0.598) | 0.772 (0.674-0.848) | 0.491 |

Group description:
All records: validation records in the gold set from site A and site B.
All ESI 1 to 5: ESI triage acuity from site A and site B.
ESI, Emergency Severity Index; CI, confidence interval.

TABLE 6
**Accuracy against study expert consensus Emergency Severity Index assignment and 95% confidence intervals of KATE and nurses for a selection of high-risk presentations**

| ESI Handbook: ESI 2 criteria | Count in gold set (n = 729) | KATE gold accuracy (95% CI) | Nurse gold accuracy (95% CI) |
|---|---|---|---|
| Significant tachycardia | 35 | 0.97 (0.91-1.0) | 0.37 (0.2-0.54) |
| Altered level of consciousness | 25 | 0.84 (0.68-0.96) | 0.36 (0.16-0.56) |
| Systemic inflammatory response syndrome | 24 | 0.75 (0.58-0.92) | 0.42 (0.21-0.63) |
| Hypotension | 10 | 1 (1.0-1.0) | 0.2 (0.0-0.5) |
| Symptomatic hypertension | 10 | 0.9 (0.7-1.0) | 0.8 (0.5-1.0) |
| Recent seizure | 8 | 0.88 (0.63-1.0) | 0.13 (0.0-0.38) |
| Active chest pain | 6 | 0.83 (0.5-1.0) | 0.5 (0.17-0.83) |
| Suicidal ideation | 6 | 1 (1.0-1.0) | 0.83 (0.5-1.0) |

ESI, Emergency Severity Index; CI, confidence interval.

presented in Table 2. A more detailed analysis of C-NLP performance is presented in Supplementary Table 1.

The features extracted for this study from free text using C-NLP are summarized in Table 3.

### *Feature Engineering*

In this study, numeric, categorical, and free text data were used. Numeric data were represented by age, vital signs, blood glucose, pain scores (Primary, Faces, FLACC [face, legs, activity, crying, and consolability], NIPS [Neonatal Infant Pain Scale], PIPP [Premature Infant Pain Profile], and PAINAD [Pain Assessment in Advanced Dementia]), Glasgow coma scale score, and Morse fall scale score. Numeric data were transformed into features after removing implausible values. Categorical data were represented by sex, arrival mode, arrived from, family history, social history, and risk factors such as alcohol and drug abuse. Overall, information that was available at triage was used as a data source. Post-triage data such as laboratory test values or vital signs after triage were not used as a data source. Clinical terms were extracted from the chief complaints and patient histories (medical, social, surgical, and medication data) using C-NLP.

Clinical feature engineering was undertaken to derive new composite features from the existing EHR data and public datasets, which improved the predictive value for ESI triage acuity assignment. The following feature engineering algorithms were applied:

(1) UMLS dictionaries of clinical terms were used to derive consolidated features on the basis of features extracted from reason for visit using C-NLP. The UMLS is a collection of dictionaries, many of which have a primary term for medical terms.[33] For example, "radiating chest pain" is related to "chest pain." For each clinical term extracted from reason for visit using C-NLP, relationships were used to derive new features.[33]
(2) ESI 1 and ESI 2 features were created on the basis of the presence of high-risk presentations referenced in the ESI Handbook.[3]
(3) Social and environmental risk factors were binned into risk and nonrisk categories.
(4) Duration of symptoms features was created on the basis of time references in reason for visit (eg, hours, days, and weeks).
(5) Count of number of features extracted from reason of visit using C-NLP.
(6) Pain above acceptable level for each patient.
(7) Count of number of missing values in vital signs.
(8) Count of number of vital signs in the risk zone.

Features with low frequency were removed from the feature set.

A summary of the feature engineering used to improve the modeling and subsequent clinical accuracy of KATE triage prediction is presented in Table 3. A model feature is equivalent to a clinical data point. For reference, "chest pain," "denies chest pain," and "history of myocardial infarction" would represent 3 unique features in KATE.

The concept of time was extracted using regexes, or regular expressions, and binned into the following categories: seconds, minutes, hours, days, weeks, months, and years. For example, "a few days," "3 days," or "three days" were all binned into the "days" category. Duration categories were used as features.

*ML Algorithms*

The open source library, XGBoost, was selected as the ML algorithm used for this study. XGBoost is a method from the gradient tree boosting family. Gradient boosting is a method of sequential building of decision trees in which each subsequent tree is built on the subset of data where previous trees made the most mistakes in classification.[34] XGBoost was designed to have an efficient model training performance for large sparse datasets.[34]

*Software*

Java 8.0 (Oracle Corporation) and the OpenNLP Java library were used to develop C-NLP. Python 2.7 (Python Software Foundation) was used for pipeline development and ML. XGBoost 0.8 library was used to build KATE. Open source libraries Sklearn and SciPy were used for model evaluation and statistical analysis.

### CLINICALLY VERIFIED TRAINING RECORDS

Given the high nurse triage error rate reported in the literature[20,35] and found in this study (see "Results" section below), the triage records were reviewed by 7 study clinicians, all practitioners in emergency health care, to correct potential nurse errors in ESI assignment. The study clinicians were blinded to nurse ESI assignment. Disagreements about ESI acuity levels were resolved using the ESI Handbook. A total of 19 652 records were reviewed and relabeled by 1 or more clinicians. Triage records for clinician review were chosen on the basis of disagreement of KATE ESI predictions with nurse ESI assignment from the results of 5-fold cross-validation. Triage records reviewed by the study clinicians were considered verified, whereas the remaining records were considered unverified. For 7970 (40.54%) verified records, the study clinicians agreed with nurse-assigned ESI acuity, and for 11 682 verified records, the clinicians changed ESI acuity (59.44%). A confusion matrix for nurse ESI assignment against verified ESI acuity is presented in Supplementary Table 2. Both verified and unverified records were used as a training set for the KATE model.

To validate the trained model, 3 expert clinicians were chosen from the study clinical team to review an independent gold test set (described in the "Results Validation" section below). The expert clinicians included a doctorally prepared emergency nurse with nationally recognized expertise in ED triage and 2 emergency physicians with an average of 10 years' experience in emergency health care. We used both physicians and nurses in this process for interdisciplinary expertise and also because accuracy in ESI triage was not substantially different between the 2 groups.[36] The physicians received education about the clinical decision-making process of nurses performing triage and training on the ESI algorithm. Gold records were used as a test set because they have the highest certainty in ESI labels for the evaluation of nurses, the KATE model, and expert clinicians. The results of KATE's performance on the gold set with and without verified ESI acuity labels are presented in Supplementary Table 3. The use of verified ESI acuity labels significantly improved KATE's performance on the gold set. Specifically, accuracy on all gold set records improved by 6.75%, and ESI 2 accuracy improved by 17.13%.

### RESULTS VALIDATION

To validate the model performance a test set (gold set) was created using random sampling from the overall dataset of 147 052 usable encounters. A random sample of 800 records was drawn, with 3.62% margin of error at a 95% confidence level. Hospital-assigned acuities were redacted from the gold set during this review. Each gold set record was reviewed independently by the 3 expert clinicians trained in ESI methodology. ESI acuity assignments were made prospectively using triage information only. If all 3 clinicians agreed in their acuity assignment, such acuity was determined to be correct for that individual record. For records with disagreements, each case was discussed in a team clinical review, referenced against the ESI Handbook, and a final correct acuity was recorded, or the record was removed from the study gold set (deleted). Of the initial random sample of 800 records, 71 triage records (8.9%) were deleted owing to insufficient triage documentation (missing vital signs, lack of reason for visit, or basic patient assessment), or the study clinical team could not reach consensus (Supplementary Table 4). Triage acuity labels in the remaining 729 triage records from the gold set were isolated from the study's ML training and only used for model testing. The acuity assignment accuracy of KATE, site nurses, and study clinicians were tested against the gold set.

## Results

### OVERALL RESULTS

KATE demonstrated significantly higher ESI accuracy, measured against the consensus of the expert clinicians supported by the ESI Handbook, than the nurses for all

gold records from each study site and for each triage acuity level. The results for KATE, the nurses, and individual study clinicians are presented for the study sites in Tables 4 and 5. Specifically, for across the study sites, KATE's accuracy was 75.7%, which was 26.9% higher than the average nurse accuracy of 59.8% ($P < .001$). For study site A, KATE's accuracy was 23.5% higher than the average nurse accuracy ($P < .001$), and for study site B, KATE's accuracy was 30.8% higher than the accuracy ($P < .001$). Combined, KATE's accuracy for the study sites was not significantly different than that of each of the 3 study clinicians (the respective *P*-values were 0.40, 0.63, and 0.06). Importantly, KATE demonstrated 80% accuracy for the ESI 2/3 triage acuity boundary, whereas the ED triage nurses demonstrated 41.4% accuracy (93.2% improvement over the nurses). This significant improvement in performance did not come at the cost of a high false positive rate on the ESI 2/3 boundary because KATE's ESI 3 overtriage was 6.9% vs the nurses' 7.9% (Table 4). The distributions of triage acuity assignment by the nurses, KATE, and the 3 study clinicians for triage records from the gold set are presented in Supplementary Table 5.

KATE demonstrated significantly higher area under the curve (0.85 vs 0.75, Supplementary Table 6), harmonic mean of precision and recall scores (0.74 vs 0.43, Supplementary Table 7), sensitivity (0.70 vs 0.42, Supplementary Table 8), and precision (0.81 vs 0.49, Supplementary Table 9) than the nurses for all gold records. KATE demonstrated both significantly lower undertriage (9.7%) and overtriage (14.4%) than the nurses (19.8% and 20.4%, respectively, Table 4). Furthermore, the nurses demonstrated a 104% higher rate of undertriage and a 41% higher overtriage rate than KATE. Interestingly, KATE was not significantly different from the study clinical team with respect to undertriage and overtriage (11.8% and 12.9%, respectively). The nurses demonstrated a very high level of undertriage for acuity level ESI 2 (57.9%), whereas KATE and the study clinicians demonstrated a 20% and 23.3% undertriage rate, respectively. Compared with the nurses (77.2%), KATE and the study clinical team demonstrated a lower overtriage rate for acuity level ESI 5 (50% and 49.1%, respectively).

KATE, the nurses, and the study clinicians were evaluated for adult (aged 18 years or older) and pediatric (aged 1 year to 17 years) patients separately. For adult patients, KATE's accuracy was 78.5%, the nurses' accuracy was 61.6%, and the accuracy of the 3 study clinicians was 81%, 78.3%, and 74.8%, respectively (Supplementary Table 10). For pediatric patients, KATE's accuracy was 67.1%, the nurses' accuracy was 53.9%, and the accuracy of the study clinicians was 66.5%, 71.9%, and 60.4%, respectively (Table 5 and Supplementary Table 11).

### HIGH-RISK PRESENTATION RESULTS

The performances of KATE and the nurses were also evaluated on high-risk presentations, which may be associated with ESI 1 or ESI 2 presentations (referenced in the ESI Handbook[3]). The results for high-risk presentations that appeared 5 or more times in the gold set are presented in Table 6. KATE demonstrated significantly higher accuracy than the nurses for these selected high-risk presentations.

## Discussion

The purpose of this retrospective study was to determine whether historical EHR data could be extracted and synthesized using C-NLP and the latest ML algorithms (KATE) to produce highly accurate ESI predictive models. Accuracy in the initial assignment of ED patient acuity is a critical dependent function that may affect clinical trajectory and resource deployment. Undertriage has been associated with a significantly higher rate of admission and critical outcome, whereas overtriage has been associated with a lower rate of both.[37] Although overtriage can result in the overuse of resources, extending lengths of stay, the pervasiveness of undertriage, seen both in our sample and in other studies, has potentially serious consequences in patient situations owing to delays in care.[19]

This study has demonstrated that using retrospective data to develop highly accurate predictions are feasible. We found that KATE predicted accurate ESI acuities using only the information available to the triage clinician at the time of triage (eg, no final disposition or diagnosis was used) 75.9% of the time in comparison with the nurses (59.8%) and study clinicians (75.3%). KATE outperformed the nurses on all acuity levels for both study sites. KATE also demonstrated superior performance in accuracy compared with nurses for pediatric patients (67.1% and 53.9%, respectively) and adult patients (78.5% and 61.6%, respectively). Further research is required to improve KATE's performance for pediatric patients.

Importantly, KATE's accuracy on the border of ESI 2 and 3 (greater risk of decompensation) was 80% across both sites vs 41.38% for the emergency nurses. Besides high accuracy overall for each acuity level, KATE also demonstrated high accuracy for common high-risk presentations used as examples in the ESI Handbook (Table 6). Not only do the emergency nurses in this study demonstrate a 40% error rate on average, but the errors are also clustered for specific presentations, including those that would be high risk.

Individual and environmental factors can influence the perception or accuracy of acuity assignment in triage. Individual factors include knowledge deficits and implicit bias.[14-16,18,37] Ethnicity, socioeconomic status, and geographic data were not used as model features in the design and training of KATE, potentially mitigating these biases. We specifically excluded race and socioeconomic status as factors, both because reliance on these as predictors has been shown to decrease accuracy[14-18] and there is no biological or clinical basis on which to weight these factors.[38]

External or environmental factors such as crowding, chaos, cognitive bias, and time pressure can also affect the ability of the triage nurse to accurately perceive acuity.[3,9,39,40] KATE evaluated each patient individually, and thus ED conditions did not affect the perception of acuity; in a chaotic emergency department, the clinical support provided by KATE may mitigate errors due to interruptions of the triage process.

In addition, there are potential real-time benefits to a clinical decision support aid; researchers report that undertriage by nurses fell from 26.3% to 9.3% after an ESI refresher course was provided.[41] Because KATE could provide real-time feedback on clinical decision-making at triage, the program itself may also be useful as a self-directed educational process, improving nursing accuracy.

To the best of our knowledge, KATE is the first ML model that was trained on patient triage records and uses ESI acuity score as labels to predict ESI. Other approaches that use ML to predict triage acuity, such as Dugas et al[30] and Levin et al,[32] focus on an ML model to predict mortality, admission, or critical care outcome and then apply ad hoc thresholds to determine ESI acuity score. The limitation of these approaches is that although predicted outcomes are correlated with high acuity, there are specific clinical presentations such as a hypoglycemic event, anaphylaxis, or opioid overdose for which this may not be the case; nor do the algorithms evaluate resources explicitly or implicitly, which is important for the distinction among ESI 3, ESI 4, and ESI 5. In addition, cutoff thresholds are not known beforehand, and their optimization is not as efficient and hospital-independent as the ML approach, which was used in KATE.

Valuable information about patient presentation, for example, reason for visit, comes in the form of free text. Extracting relevant clinical information from reason for visit is crucial for any ML predictive model in the emergency department. Several approaches have been applied to extract information from reason for visit. Zhang et al[27] extracted significant words for disposition using the chi-square test. Rajkomar et al[23] used individual words. Hong et al[28] extracted 200 most frequent reasons for visit and used them as categories. Raita et al[25] classified reason for visit according to Reason for Visit Classification of Diseases. Sterling et al[29] used all individual words, paragraph vectors, and topic extraction. KATE extracts medical terms from free text using developed C-NLP technology and exploits them in predictive modeling. C-NLP demonstrates accuracy of 98.47% (F1 score 0.992, sensitivity 0.997, and precision 0.9877) in extracting medical terms from free text (Table 2 and Supplementary Table 1). Extracting medical terms using C-NLP provides a more accurate description of patient presentations and medical history than categorization or simple use of individual words.

Because nurse error rate in triage reaches 40%, it is not possible to accurately validate the performance of ML models on the basis of nurse labels. In contrast to previous studies, KATE was validated on a gold set in which all ESI labels were independently verified by ESI-trained clinicians, providing confidence in KATE's performance results.

Given the importance of accurate triage acuity assignment regarding the patient's clinical trajectory, improvement in triage accuracy has the potential to translate into better allocation of resources, more appropriate patient flow, and, most important, more rapid identification of patients needing immediate care.

Although the main aim of this study was to evaluate the performance of nurses, expert clinicians, and KATE in ESI triage, we also analyzed the distribution of disposition per ESI for the gold set (Supplementary Table 12). Among patients who were admitted to hospital, 36.05% were assigned ESI 1 or ESI 2 by the nurses, 61.63% by the expert clinicians, and 60.47% by KATE. This indicates the promise of KATE in improving patient outcomes by accurately assigning ESI levels for patients classified as high acuity. In addition to model improvements for pediatric patients, further prospective research will focus on the impact of KATE on patient and operational outcomes.

## Limitations

This was a retrospective study; thus, the contextual aspects of the triage process were not available for consideration. Another limitation of this study is that individual nurse demographics, in terms of years of nursing and triage experience, were not available. Although formal triage education was standard practice at both sites, records of nurse training, hours of the training, and frequency were not available for analysis. The accuracy of the triage acuity assignments from study sites A and B (64.7% and 54.8%, respectively) are congruent with an average 60% reported in the literature.[20] Other studies report conflicting results on the influence of nurses' number of years since graduation, years of work experience, or years of experience.[22,42-44] The

influence of individual nurse personal characteristics and experience on triage accuracy is a subject for future study.

For each individual high-risk presentation, a larger random sample gold set would need to be created to fully analyze KATE's performance on each of these presentations. For the pediatric population, records for children aged below 1 year were not used, and there were not enough records for critically ill children to adequately assess the model performance.

## Implications for Emergency Nurses

Triage accuracy is critical to the process of getting patients to resources in a timely manner to ensure safe patient care. Our findings that the triage acuity scores assigned by nurses were often inaccurate suggest that multiple factors impede accuracy in triage. The use of KATE, a clinical decision support aid, may facilitate this process and improve the initial clinical decision regarding acuity.

## Conclusion

In this study, the KATE model provided a triage acuity assignment substantially more accurate than that of triage nurses. Importantly, KATE operated independently of contextual factors, potentially mitigating the effects of implicit bias. KATE's acuity score is based on many pieces of information drawn from the patient's medical history, medication history, and documented risk factors, along with vital signs and physiological or psychological complaints. KATE is unaffected by the external pressures that can lead to undertriage and mitigates the racial and social biases that can negatively affect the accuracy of triage assignment.

Future research should focus on the implementation of KATE's providing real-time feedback to nurses in the emergency department. During the real-time implementation, the KATE model needs to be assessed with respect to its impact on mortality and morbidity; ED throughput; resource optimization; and nursing outcomes, including competence, satisfaction, and retention. Another important avenue of further research is the evaluation and improvement of KATE's performance for critically ill children.

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## Author Disclosures

Conflicts of interest: All authors who are with the Mednition organization are employees. All non-Mednition authors are contract employees of Mednition, with the exception of Robert Dunne. Mednition has submitted a provisional patent for the work related to the study.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.11.001.

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## Supplementary Data

SUPPLEMENTARY TABLE 1

**Performance and 95% confidence intervals (in parentheses) of clinical natural language processing for 800 randomly sampled medical records by clinical-term type**

| Clinical-term type | Number of clinical terms | Accuracy | F1 score | Sensitivity | Precision |
|---|---|---|---|---|---|
| Orientation | 392 | 1 | 1 | 1 | 1 |
| Primary pain onset | 52 | 1 | 1 | 1 | 1 |
| Reason for visit | 4391 | 0.9909 (0.9879-0.9936) | 0.9954 (0.9939-0.9968) | 0.9991 (0.9982-0.9998) | 0.9918 (0.9891-0.9943) |
| Previous illness | 687 | 0.9869 (0.9767-0.9942) | 0.9934 (0.9882-0.9971) | 0.9883 (0.9782-0.9956) | 0.9985 (0.9942-1.0) |
| Surgeries | 1063 | 0.9454 (0.9304-0.9586) | 0.972 (0.9639-0.9789) | 0.996 (0.992-0.999) | 0.949 (0.9346-0.9613) |
| Primary pain quality | 39 | 1 | 1 | 1 | 1 |
| Primary pain location | 436 | 0.9954 (0.9885-1.0) | 0.9977 (0.9942-1.0) | 0.9954 (0.9885-1.0) | 1 |
| Level of consciousness | 789 | 1 | 1 | 1 | 1 |
| Affect behavior | 33 | 1 | 1 | 1 | 1 |
| Primary pain location detail | 69 | 1 | 1 | 1 | 1 |
| Before arrival | 109 | 0.9817 (0.9541-1.0) | 0.9907 (0.9765-1.0) | 1.0 (1.0-1.0) | 0.9817 (0.9541-1.0) |
| Respiratory status | 26 | 1 | 1 | 1 | 1 |
| Triage treatment | 370 | 0.9838 (0.9703-0.9946) | 0.9918 (0.9849-0.9973) | 0.9838 (0.9703-0.9946) | 1 |
| Family history | 63 | 1 | 1 | 1 | 1 |
| Problems | 928 | 0.9698 (0.9569-0.9795) | 0.9847 (0.978-0.9897) | 0.9956 (0.9901-0.9989) | 0.974 (0.9623-0.9838) |
| Menstrual | 47 | 1 | 1 | 1 | 1 |
| Primary pain radiation location | 5 | 1 | 1 | 1 | 1 |
| Primary pain radiation location detail | 2 | 1 | 1 | 1 | 1 |
| Primary pain aggravating factors | 1 | 1 | 1 | 1 | 1 |
| Primary pain–associated symptoms | 1 | 1 | 1 | 1 | 1 |
| Medical devices | 3 | 1 | 1 | 1 | 1 |

C-NLP, clinical natural language processing; F1, harmonic mean of precision and recall.

SUPPLEMENTARY TABLE 2

**Confusion matrix of nurse ESI against verified ESI for study sites A and B**

| ESI label | Verified ESI 1 | Verified ESI 2 | Verified ESI 3 | Verified ESI 4 | Verified ESI 5 | Total count |
|---|---|---|---|---|---|---|
| Nurse ESI 1 | 117 | 68 | 16 | 9 | 2 | 212 |
| Nurse ESI 2 | 553 | 1484 | 484 | 73 | 30 | 2624 |
| Nurse ESI 3 | 122 | 4991 | 4124 | 700 | 573 | 10 510 |
| Nurse ESI 4 | 8 | 412 | 715 | 1856 | 2705 | 5696 |
| Nurse ESI 5 | 0 | 30 | 28 | 163 | 389 | 610 |
| Total count | 800 | 6985 | 5367 | 2801 | 3699 | 19 652 |

ESI, Emergency Severity Index.

SUPPLEMENTARY TABLE 3

**Comparison of accuracy against study expert consensus Emergency Severity Index assignment with 95% confidence intervals for KATE with and without verified Emergency Severity Index labels**

| Group | Number of triage records | KATE accuracy without verified ESI labels (95% CI) | KATE accuracy with verified ESI labels (95% CI) |
|---|---|---|---|
| All records | 729 | 0.711 (0.676-0.739) | 0.759 (0.724-0.787) |
| Site A | 368 | 0.755 (0.709-0.796) | 0.799 (0.758-0.834) |
| Site B | 361 | 0.665 (0.615-0.707) | 0.717 (0.665-0.759) |
| All ESI 1 | 5 | 0.2 (0.0-0.6) | 0.6 (0.2-1.0) |
| All ESI 2 | 145 | 0.683 (0.6-0.752) | 0.8 (0.724-0.869) |
| All ESI 3 | 277 | 0.823 (0.773-0.866) | 0.827 (0.776-0.87) |
| All ESI 4 | 210 | 0.757 (0.7-0.809) | 0.757 (0.695-0.814) |
| All ESI 5 | 92 | 0.337 (0.239-0.424) | 0.5 (0.391-0.598) |

ESI, Emergency Severity Index; CI, confidence interval.

SUPPLEMENTARY TABLE 4

**Distribution of reasoning for record removal from the study gold set. Of the initial 800-record sample, 71 records were removed**

| Removal Reason | Count (%) |
|---|---|
| Conflicting documentation | 7 (9.86) |
| Clinical team could not reach consensus | 19 (26.76) |
| Impossible vital signs | 2 (2.82) |
| Insufficient information | 31 (43.66) |
| Missing 4 or more vital signs | 7 (9.86) |
| No reason for visit | 5 (7.04) |

SUPPLEMENTARY TABLE 5

**Emergency Severity Index acuity distribution for each group in the gold set (n = 729)**

| ESI label | Nurse, n (%) | Gold, n (%) | Clinician 1, n (%) | Clinician 2, n (%) | Clinician 3, n (%) | KATE, n (%) |
|---|---|---|---|---|---|---|
| ESI 1 | 1 (0.14) | 5 (0.69) | 3 (0.41) | 3 (0.41) | 2 (0.27) | 3 (0.41) |
| ESI 2 | 88 (12.07) | 145 (19.89) | 129 (17.70) | 134 (18.38) | 134 (18.38) | 144 (19.75) |
| ESI 3 | 363 (49.79) | 277 (38.00) | 293 (40.19) | 295 (40.47) | 295 (40.47) | 308 (42.25) |
| ESI 4 | 241 (33.06) | 210 (28.81) | 238 (32.65) | 242 (33.20) | 214 (29.36) | 213 (29.22) |
| ESI 5 | 36 (4.94) | 92 (12.62) | 66 (9.05) | 55 (7.54) | 78 (10.70) | 61 (8.37) |
| No ESI label | — | — | — | — | 6 (0.82) | — |

Group descriptions:
Nurse: ESI acuity assigned by nurse in study dataset.
Gold: Consensus ESI acuity by clinicians 1, 2, and 3.
Clinician 1, 2, and 3: Each individual study clinician's initial ESI acuity, before consensus agreement.
KATE: ML model acuity prediction.
ESI, Emergency Severity Index; ML, machine learning.

SUPPLEMENTARY TABLE 6

**Micro-average AUC against study expert consensus Emergency Severity Index assignment with 95% confidence intervals (in parentheses) for all age groups (pediatric & adult patients) in the gold set**

| Group | Number of triage records | KATE AUC (95% CI) | Nurse AUC (95% CI) | Clinician AUC (95% CI) | Clinician 2 AUC (95% CI) | Clinician 3 AUC (95% CI) |
|---|---|---|---|---|---|---|
| All records | 729 | 0.849 (0.828-0.867) | 0.749 (0.725-0.769) | 0.86 (0.84-0.877) | 0.855 (0.835-0.871) | 0.822 (0.802-0.841) |
| Site A | 368 | 0.866 (0.839-0.889) | 0.764 (0.73-0.797) | 0.83 (0.797-0.857) | 0.817 (0.784-0.846) | 0.812 (0.778-0.842) |
| Site B | 361 | 0.823 (0.79-0.849) | 0.718 (0.683-0.746) | 0.881 (0.856-0.905) | 0.882 (0.855-0.906) | 0.82 (0.788-0.846) |

AUC, area under the curve; ESI, Emergency Severity Index; CI, confidence interval.

SUPPLEMENTARY TABLE 7

**Macroaverage F1 score against study expert consensus Emergency Severity Index assignment with 95% confidence intervals for all age groups (pediatric and adult patients) in the gold set**

| Group | Number of triage records | KATE F1 score (95% CI) | Nurse F1 score (95% CI) | Clinician 1 F1 score (95% CI) | Clinician 2 F1 score (95% CI) | Clinician 3 F1 score (95% CI) |
|---|---|---|---|---|---|---|
| All records | 729 | 0.738 (0.585-0.802) | 0.428 (0.394-0.459) | 0.757 (0.606-0.817) | 0.74 (0.588-0.797) | 0.665 (0.538-0.746) |
| Site A | 368 | 0.766 (0.714-0.812) | 0.56 (0.499-0.614) | 0.664 (0.602-0.721) | 0.595 (0.542-0.64) | 0.631 (0.57-0.683) |
| Site B | 361 | 0.705 (0.551-0.77) | 0.397 (0.345-0.439) | 0.799 (0.648-0.863) | 0.796 (0.647-0.861) | 0.68 (0.543-0.764) |

ESI, Emergency Severity Index; CI, confidence interval; F1, harmonic mean of precision and recall.

SUPPLEMENTARY TABLE 8

**Macroaverage sensitivity against study expert consensus Emergency Severity Index assignment with 95% confidence intervals for all age groups (pediatric and adult patients) in the gold set**

| Group | Number of triage records | KATE sensitivity (95% CI) | Nurse sensitivity (95% CI) | Clinician 1 sensitivity (95% CI) | Clinician 2 sensitivity (95% CI) | Clinician 3 sensitivity (95% CI) |
|---|---|---|---|---|---|---|
| All records | 729 | 0.695 (0.573-0.786) | 0.417 (0.389-0.445) | 0.714 (0.593-0.801) | 0.697 (0.577-0.788) | 0.626 (0.532-0.735) |
| Site A | 368 | 0.764 (0.707-0.812) | 0.547 (0.488-0.601) | 0.644 (0.589-0.693) | 0.601 (0.56-0.641) | 0.625 (0.573-0.67) |
| Site B | 361 | 0.657 (0.527-0.752) | 0.392 (0.352-0.429) | 0.771 (0.654-0.862) | 0.768 (0.645-0.858) | 0.655 (0.555-0.758) |

ESI, Emergency Severity Index; CI, confidence interval.

SUPPLEMENTARY TABLE 9

**Macroprecision sensitivity against study expert consensus Emergency Severity Index assignment with 95% confidence intervals for all age groups (pediatric and adult patients) in the gold set**

| Group | Number of triage records | KATE precision (95% CI) | Nurse precision (95% CI) | Clinician 1 precision (95% CI) | Clinician 2 precision (95% CI) | Clinician 3 precision (95% CI) |
|---|---|---|---|---|---|---|
| All records | 729 | 0.809 (0.606-0.836) | 0.488 (0.446-0.528) | 0.83 (0.627-0.854) | 0.822 (0.62-0.85) | 0.757 (0.544-0.785) |
| Site A | 368 | 0.769 (0.712-0.818) | 0.601 (0.527-0.675) | 0.733 (0.65-0.799) | 0.687 (0.543-0.825) | 0.672 (0.594-0.748) |
| Site B | 361 | 0.805 (0.598-0.844) | 0.507 (0.446-0.562) | 0.85 (0.657-0.883) | 0.846 (0.639-0.877) | 0.761 (0.543-0.796) |

ESI, Emergency Severity Index; CI, confidence interval.

SUPPLEMENTARY TABLE 10

**Emergency Severity Index acuity assignment accuracy against study expert consensus Emergency Severity Index assignment with 95% confidence intervals for adult patients in the gold set**

| Group | Number of triage records | KATE model accuracy (95% CI) | Nurse triage accuracy (95% CI) | Clinician 1 accuracy (95% CI) | Clinician 2 accuracy (95% CI) | Clinician 3 accuracy (95% CI) |
|---|---|---|---|---|---|---|
| All records | 562 | 0.785 (0.749-0.817) | 0.616 (0.573-0.653) | 0.81 (0.774-0.838) | 0.783 (0.747-0.815) | 0.748 (0.708-0.783) |
| Site A | 272 | 0.82 (0.772-0.86) | 0.647 (0.588-0.699) | 0.783 (0.728-0.827) | 0.754 (0.702-0.805) | 0.79 (0.739-0.835) |
| Site B | 290 | 0.752 (0.7-0.797) | 0.586 (0.528-0.638) | 0.834 (0.79-0.869) | 0.81 (0.762-0.852) | 0.707 (0.652-0.756) |
| All ESI 1 | 5 | 0.6 (0.2-1.0) | 0.0 (0.0-0.0) | 0.6 (0.2-1.0) | 0.6 (0.2-1.0) | 0.4 (0.0-0.8) |
| All ESI 2 | 131 | 0.855 (0.794-0.916) | 0.427 (0.343-0.511) | 0.786 (0.71-0.855) | 0.786 (0.71-0.855) | 0.746 (0.669-0.815) |
| All ESI 3 | 251 | 0.841 (0.793-0.884) | 0.797 (0.741-0.845) | 0.837 (0.789-0.876) | 0.849 (0.805-0.892) | 0.803 (0.747-0.851) |
| All ESI 4 | 129 | 0.721 (0.643-0.798) | 0.62 (0.527-0.698) | 0.837 (0.767-0.899) | 0.791 (0.713-0.853) | 0.721 (0.643-0.791) |
| All ESI 5 | 46 | 0.478 (0.326-0.609) | 0.217 (0.109-0.348) | 0.674 (0.543-0.804) | 0.413 (0.261-0.565) | 0.565 (0.413-0.696) |

ESI, Emergency Severity Index; CI, confidence interval.

SUPPLEMENTARY TABLE 11

**Emergency Severity Index acuity assignment accuracy against study expert consensus Emergency Severity Index assignment with 95% confidence intervals for pediatric patients in the gold set**

| Group | Number of triage records | KATE accuracy (95% CI) | Nurse triage accuracy (95% CI) | Clinician 1 accuracy (95% CI) | Clinician 2 accuracy (95% CI) | Clinician 3 accuracy (95% CI) |
|---|---|---|---|---|---|---|
| All records | 167 | 0.671 (0.599-0.743) | 0.539 (0.455-0.617) | 0.665 (0.587-0.731) | 0.719 (0.647-0.784) | 0.604 (0.524-0.677) |
| Site A | 96 | 0.74 (0.646-0.823) | 0.646 (0.541-0.729) | 0.635 (0.531-0.729) | 0.646 (0.552-0.729) | 0.511 (0.404-0.606) |
| Site B | 71 | 0.577 (0.465-0.676) | 0.394 (0.268-0.507) | 0.704 (0.592-0.803) | 0.817 (0.718-0.901) | 0.729 (0.614-0.814) |
| All ESI 1 | 0 | — | — | — | — | — |
| All ESI 2 | 14 | 0.286 (0.071-0.5) | 0.286 (0.071-0.5) | 0.571 (0.356-0.786) | 0.714 (0.5-0.929) | 0.857 (0.643-1.0) |
| All ESI 3 | 26 | 0.692 (0.5-0.846) | 0.5 (0.308-0.692) | 0.769 (0.577-0.923) | 0.808 (0.654-0.923) | 0.769 (0.577-0.885) |
| All ESI 4 | 81 | 0.815 (0.716-0.889) | 0.765 (0.667-0.852) | 0.765 (0.667-0.852) | 0.802 (0.716-0.876) | 0.605 (0.506-0.704) |
| All ESI 5 | 46 | 0.522 (0.37-0.652) | 0.239 (0.109-0.348) | 0.457 (0.304-0.587) | 0.522 (0.37-0.652) | 0.419 (0.256-0.558) |

ESI, Emergency Severity Index; CI, confidence interval.

SUPPLEMENTARY TABLE 12

**Distribution of disposition for gold set by assigned Emergency Severity Index by nurses, expert clinicians, and KATE**

| **Nurses** | | | | | |
|---|---|---|---|---|---|
| Disposition | ESI 1, n (%) | ESI 2, n (%) | ESI 3, n (%) | ESI 4, n (%) | ESI 5, n (%) |
| Discharge | 1 (0.16) | 50 (8.16) | 293 (47.80) | 233 (38.01) | 36 (5.87) |
| Admit | 0 (0) | 31 (36.05) | 52 (60.47) | 3 (3.49) | 0 (0) |
| Expert clinicians | | | | | |
| Discharge | 1 (0.16) | 88 (14.36) | 233 (38.01) | 202 (32.95) | 89 (14.52) |
| Admit | 4 (4.65) | 49 (56.98) | 28 (32.56) | 3 (3.49) | 2 (2.33) |
| KATE | | | | | |
| Discharge | 0 (0) | 82 (13.38) | 267 (43.56) | 205 (33.44) | 59 (9.62) |
| Admit | 3 (3.49) | 49 (56.98) | 32 (37.21) | 2 (2.33) | 0 (0) |

ESI, Emergency Severity Index.

# Prone Positioning of Patients With Coronavirus Disease 2019 Who Are Nonintubated in Hypoxic Respiratory Distress: Single-Site Retrospective Health Records Review

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### Contribution to Emergency Nursing Practice

- The practice of prone positioning of patients in adult respiratory distress syndrome who are intubated has been practiced since the 1970s with documented positive clinical outcomes.
- The main finding of this article is a significant improvement in oxygen saturation during prone positioning of patients with coronavirus disease 2019 in hypoxic respiratory distress who are awake, alert, and nonintubated in the emergency department.
- Recommendations for translating the findings of this article into clinical practice include emergency nurse–initiated prone positioning guidelines for patients with coronavirus disease 2019 who are awake, alert, and nonintubated in the emergency department are easily implemented with positive patient impact.

## Abstract

**Introduction:** In March and April 2020 of the coronavirus disease 2019 pandemic, site clinical practice guidelines were implemented for prone positioning of patients with suspected coronavirus disease 2019 in hypoxic respiratory distress who are awake, alert, and spontaneously breathing. The purpose of this pandemic disaster practice improvement project was to measure changes in pulse oximetry associated with prone positioning of patients with coronavirus disease 2019 infection in adult acute respiratory distress or adult respiratory distress syndrome, who are awake, alert, spontaneously breathing, and nonintubated.

**Methods:** A retrospective chart review of patients who were coronavirus disease 2019 positive in the emergency department from March 30, 2020 to April 30, 2020 was conducted for patients with a room air pulse oximetry $<90\%$ and a preprone position pulse oximetry $\leq 94\%$ who tolerated prone positioning for at least 30 minutes. The primary outcome was the change in pulse oximetry associated with prone positioning, measured on room air, with supplemental oxygen, and approximately 30 minutes after initiating prone positioning. Median and mean differences were compared with the Wilcoxon signed-rank test and paired *t*-test.

**Results:** Of the 440 patients with coronavirus disease 2019, 31 met inclusion criteria. Median pulse oximetry increased as 83% (interquartile range, 75%-86%) on room air, 90%

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(interquartile range, 89%-93%) with supplemental oxygen, and 96% (interquartile range, 94%-98%) with prone positioning ($z = -4.48$, $P < .001$). A total of 45% (n = 14) were intubated during their hospital stay, and 26% (n = 8) of the included patients died.

**Discussion:** In patients with coronavirus disease 2019 who are awake, alert, and spontaneously breathing, an initially low pulse oximetry reading improved with prone positioning. Future studies are needed to determine the association of prone positioning with subsequent endotracheal intubation and mortality.

**Key words:** Coronavirus disease 2019; Adult respiratory distress syndrome; prone position

## Introduction

The 2019 novel coronavirus emerged out of the Hubei Provence of China in November 2019. The first United States case of coronavirus disease 2019 (COVID-19) was confirmed on January 20, 2020, in Seattle, WA. In the subsequent weeks, the virus spread globally and was declared a pandemic by the World Health Organization on March 11, 2020. In our emergency department in northern New Jersey, the first patient with COVID-19 arrived on March 11, 2020.

Emergency services worldwide were tasked with responding to a crisis with presentations ranging from patients who were asymptomatic to those in hypoxic respiratory distress. Testing centers appeared across the US in the form of tents and drive-throughs, thus accommodating patients' requests for testing, however this met only the need of the "walking well."

Emergency departments in areas experiencing clustered, high incidences of the spread of COVID-19 were inundated with patients who were symptomatic, many of whom arrived critically ill. As this crisis unfolded, little was known about the epidemiology and clinical course of the virus, although cases of severe pneumonia, adult respiratory distress syndrome (ARDS), and multiple organ failure associated with COVID-19 infection were reported from Wuhan, China, in January 2020.[1]

To lessen aerosolization of the virus, many health care providers avoided the use of continuous positive airway pressure or high-flow nasal cannula (HFNC), leading to the early intubation of patients in severe hypoxic respiratory distress. To forestall intubation, alternative methods of respiratory support were explored. The anatomical and physiological changes attributed to prone positioning (PP) result in a more even tidal volume distribution. These changes include enhanced lung volume in the dorsocaudal regions through the reduction of superimposed pressure of the heart and the abdomen and improvement in alveolar ventilation/perfusion relationship as a result of pulmonary perfusion preferentially distributed to the expanded dorsal regions of the lung.[2] The treatment of patients in ARDS with PP who are intubated and mechanically ventilated has been an accepted practice for decades.[3,4] An early account of the use of PP for patients who were intubated was by Douglas et al[3] in 1977 who reported on 6 patients (5 were intubated) with pneumonia in acute respiratory failure who were proned. After being placed in the prone position, $PaO_2$ increased by a median of 32 mm Hg (interquartile range [IQR], 31-105 mm Hg), but $PCO_2$ and respiratory rate were unchanged. The meta-analysis by Bloomfield et al,[4] published in 2015, included 9 randomized controlled trials of PP in patients with respiratory failure who were intubated (described in later text). However, data regarding the use of PP on patients in acute respiratory failure who were nonintubated and spontaneously breathing are limited.

### AVAILABLE KNOWLEDGE

A search of the literature conducted in OVID MEDLINE at the end of March 2020 using terms "PP" and "non-intubated patients" yielded 3 articles, which guided this study. Published in 2003, Valter et al[5] reported a case series of 4 patients in severe respiratory distress who were nonintubated in whom PP resulted in improved oxygenation and reduced oxygen requirement. After PP, on average, the fraction of inspired oxygen ($FIO_2$) was reduced by 23% (from 68% to 45%), respiratory rate decreased from 31 per minute to 19 per minute, $PaO_2$ increased by 14 mm Hg (from 58 to 72), $PCO_2$ decreased by 1 mm Hg (from 52 to 51), and pH increased by 0.06 (from 7.34 to 7.40). Published in 2015, Scaravilli et al[6] retrospectively reviewed the effectiveness of PP on 15 patients in the intensive care unit (ICU) who were hypoxemic and nonintubated, 13 with pneumonia.[6] The $PaO_2/FIO_2$ significantly improved during prone periods. The mean $PaO_2/FIO_2$ increased from 127 (SD = 49) mm Hg to 186 (SD = 72) mm Hg while prone, decreasing to 141 (SD = 64) mm Hg after resuming the supine position ($P < .05$). The $PaO_2$ increased from 89 (SD = 28) mm Hg to 124 (SD = 53) mm Hg, decreasing to 91 (SD = 42) mm Hg after being placed supine. There was no change in the $PCO_2$, bicarbonate, heart rate (HR), or

blood pressure. In a prospective study, Ding et al[1] proned 19 patients with moderate to severe ARDS who were nonintubated. Etiologies were influenza, other viruses, and other pneumonias in 9 (47%), 2 (11%), and 8 (42%) patients, respectively. All patients received HFNC and/or noninvasive ventilation treatment: 3 HFNC, 8 noninvasive ventilation treatment, and 8 both. The median $PaO_2/FIO_2$ increased from 94 (IQR, 79-115) to 130 (IQR, 95-152) mm Hg after PP. The median difference was 32 (IQR, 6-60) mm Hg ($z = -3.15$, $P < 0.001$). After PP, 9 patients were intubated, of whom 3 required extracorporeal membrane oxygenation; 1 patient died.

There have been 7 meta-analyses on PP in patients who were intubated. In the meta-analysis of 9 randomized controlled trials of PP in patients with respiratory failure who were intubated, Bloomfield et al[4] (2015) found a nonstatistically significant trend in mortality overall (relative risk [RR] of 0.84; 95% confidence interval [CI], 0.69-1.02). However, the subgroup analysis revealed a statistically significant benefit for those recruited within 48 hours of meeting entry criteria (5 trials; 1024 participants showed an RR of 0.75 [95% CI, 0.59-0.94]); those treated with PP for 16 or more hours per day (5 trials; 1005 participants showed an RR of 0.77 [95% CI, 0.61-0.99]); and participants with more severe hypoxemia at trial entry (6 trials; 1108 participants showed an RR of 0.77 [95% CI, 0.65-0.92]). The study also showed an improvement in oxygenation. The mean difference in the $PaO_2/FIO_2$ between PP and supine positioning was 24.6 mm Hg (95% CI, 13.9-35.2). PP reduced ventilator-associated pneumonia and days on the ventilator but appeared to have increased the length of ICU and hospital stays.

### PURPOSE

The primary aim of this pandemic disaster practice improvement project was to measure changes in pulse oximetry associated with PP on adult patients with ARDS with COVID-19 infection who were awake, alert, spontaneously breathing, and nonintubated. The secondary aim was to analyze changes in respiratory rate and HR associated with proning in these patients.

## Methods

### DESIGN

This study was a pandemic disaster practice improvement initiative using retrospective chart review.

### SETTING

The practice site was a suburban hospital emergency department in northern New Jersey with an annual volume of 90 000. The hospital was a level 1 trauma center and had several residencies, including one in emergency medicine.

### PROTOCOL

Site guidelines were implemented for PP of patients suspected to be infected with COVID-19 who were awake, alert, and spontaneously breathing with hypoxic respiratory distress (Supplementary Appendix). Included were positioning recommendations and contraindications consistent with those described in The Proning Severe ARDS Patients (PROSEVA) trial.[7] Beginning March 30, 2020, emergency nurses and physicians were encouraged to prone position this patient population. Guidelines were communicated to nurses staffing the emergency department at the multiple shift change huddles and by e-mail. Staff assisted the patient in assuming a prone position, with the stretcher positioned in mild reverse Trendelenburg. The patient was asked to remain prone for at least 2 hours or as long as tolerated, and no clinical deterioration was noted. Patients were provided with pillows and/or blankets to position comfortably and to cushion bony prominences and were encouraged to move frequently while maintaining PP. Providers were asked to enter a nursing communication "Keep Prone" in the electronic medical record (EMR) for ease of data extraction.

### DATA SOURCE AND INCLUSION CRITERIA

A report was run in the EPIC (Epic Systems Corporation, Verona, WI) EMR system to identify all adult patients with COVID-19 admitted through the emergency department between March 30, 2020, and April 30, 2020. Patients who met the following criteria were included: assuming PP by themselves and tolerating it for at least 30 minutes, documented room air pulse oximetry (peripherhal capillary oxygen saturation [$SpO_2$]) $< 90\%$ and pre-PP $SpO_2 \leq 94\%$ despite supplemental oxygen.

### DATA EXTRACTION AND VARIABLES

The following data from the EMRs of the patients meeting inclusion criteria were extracted: length of time from arrival to PP, $SpO_2$ on room air, HR and respiratory rate, $SpO_2$ before and after PP, and length of time proned. Although these data are repeated measures on the clinical record, only 1 measure for each variable was extracted. The

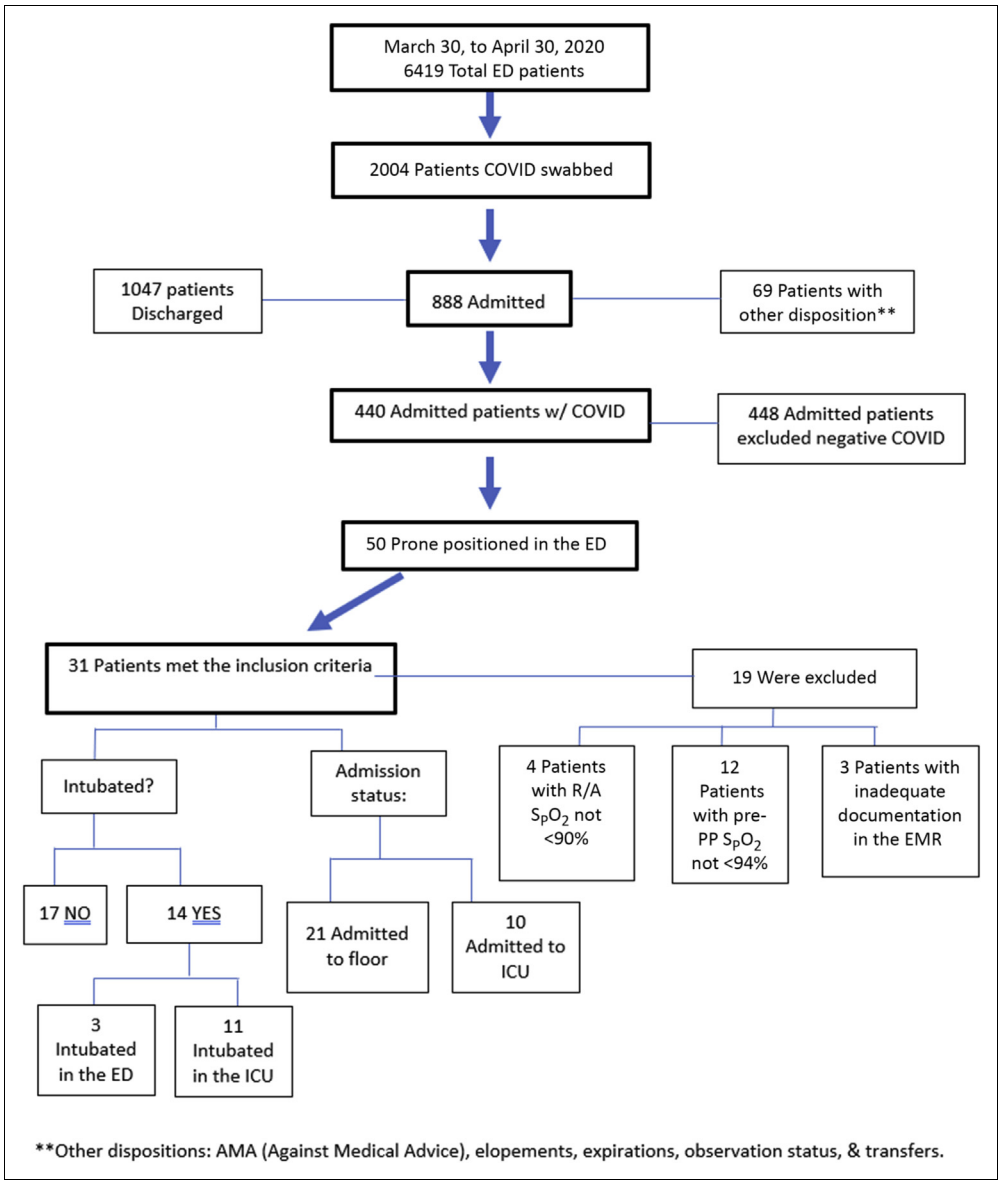


FIGURE 1

Sample description. ED, emergency department; COVID, coronavirus disease; $SpO_2$, peripheral capillary oxygen saturation; PP, prone positioning; R/A, room air; EMR, electronic medical record; ICU, intensive care unit.

post-PP measure closest to 30 minutes after the onset of proning was recorded. Demographic data, level of care on admission, intubation during hospitalization (including the length of time from ED arrival to intubation), the existence of a "do not intubate order," length of hospital stay, and disposition on discharge were collected. The primary outcome was the pre- to postproning change in $SpO_2$. Pre- to postproning changes in respiratory rate and HR were analyzed as secondary measures. Two of the authors abstracted data from the EMR. The 2 data abstracters examined 10 charts together, with excellent agreement. The rare circumstance of uncertainty was resolved by consensus.

## DATA ANALYSIS

Data are presented as means and SDs or medians with IQRs. We compared medians and means with the Wilcoxon signed-rank test and paired *t* test, respectively,

TABLE 1
**Comparison of demographics of patients in 2019 to study group 2020***

| Demographic | 2019 n = 6419 | | 2020 n = 31 | |
|---|---|---|---|---|
| | Mean or n | SD or % | Mean or n | SD or % |
| BMI, kg/m$^2$ | 28 | 6 | 31 | 5 |
| Age, y | 56 | 21 | 62 | 12 |
| Sex, % female | 3466 | 54% | 4 | 13% |
| Race/Ethnicity | | | | |
| Hispanic | 449 | 7% | 17 | 55% |
| White | 4622 | 72% | 7 | 23% |
| Asian | 257 | 4% | 3 | 10% |
| African American | 449 | 7% | 2 | 6% |
| Unspecified | 642 | 10% | 2 | 6% |

BMI, body mass index.
* Demographics of the 6419 patients in the emergency department seen from March 30, 2019 to April 30, 2019 and the 31 study patients in 2020.

using Statistical Package for the Social Sciences version 27 (SSPS Inc, Chicago IL.). Missing data were excluded from each individual analytic test. To replicate this study, to detect a change in pulse ox of 5%, with alpha = 0.05 and power = 0.8, an empirical sample size of 13 is needed.

## Results

### SAMPLE DESCRIPTION

A total of 440 patients with COVID-19 were identified in the EMR retrospective chart review. Of the 50 patients who were prone positioned in the emergency department as part of the pandemic process improvement project, 19 were excluded, leaving 31 patients who met inclusion criteria (Figure 1). For the 19 patients who did not meet the inclusion criteria, the median levels of $SpO_2$ were 87% (IQR, 81%-90%) on room air, 96% (IQR, 94%-98%) before proning, and 96% (IQR, 94%-98%) during proning. Three patients did not have levels of room air $SpO_2$ recorded because they arrived with supplemental oxygen.

For the 31 included patients, the mean age was 62 (SD = 12) years; 13% were female. The average body mass index (weight [kg] ÷ height$^2$ [m]) was 31 (SD = 5). A total of 55% were Hispanic, 23% white, 9% Asian, 6% African American, and 6% unspecified. These demographic parameters were different from the typical patient population in this emergency department (Table 1).

### PROCESS DESCRIPTION AND CLINICAL OUTCOMES

The median time from patient arrival to PP was 85 minutes (IQR, 46-174). For the 13 (42%) patients for whom the times were recorded, the duration of PP was 140 (SD = 47) minutes. For the 31 patients included in the study, the least recorded duration of PP was 51 minutes, and for that individual patient, the $SpO_2$ rose from 93% to 96% during PP. All but 4 (13%) patients were given supplemental oxygen (from 2 to 21 L/min by nasal cannula and/or nonrebreather mask) and then were proned. The median levels of $SpO_2$ were 83% (IQR, 75%-86%) on room air, 90% (IQR, 89%-93%) with supplemental oxygen, and 96% (IQR, 94%-98%) with PP. (Table 2 and Figure 2). The 5% (IQR, 4%-9%) median change from before to with PP was statistically significant (z= -4.48, $P < .001$).

Supplemental oxygen was increased for 7 (23%) patients when placed in the prone position. Considering only the 24 patients for whom supplemental oxygen was not increased, the median levels of $SpO_2$ before and with PP were 92% (IQR, 89%-93%) and 96% (IQR, 94%-98%), respectively. For these 24 patients, the 4% (IQR, 3%-6%) change from before to with PP was statistically significant (z= -3.75, $P < .001$).

For all 31 patients, both HR and respiratory rate showed small decreases after being placed in the prone position. The mean HR and respiratory rate before PP were 93 (SD = 18) and 31 (SD = 9) beats/min, respectively. With PP, the rates were 88 (SD = 15) and 26 (SD = 8) beats/min, respectively. These changes were statistically significant (HR change: 5 [SD = 11] beats/minutes, $t$= 5.21,

TABLE 2
**Change in parameters with prone positioning for patients with coronavirus disease 2019 in the emergency department who were awake, alert, and nonintubated**

| Patients | Parameter | Time period | Values* | SD or IQR | Point estimate | Change* | *P* value |
|---|---|---|---|---|---|---|---|
| All patients | $SpO_2$ | Room air | 83 | 75-86 | | | |
| | | Before PP | 90 | 89-93 | z= -4.48 | 5 (4-9) | < .001 |
| | | With PP | 96 | 94-98 | | | |
| 24 patients (no O2 Δ)† | $SpO_2$ | Before PP | 92 | 89-93 | z= -3.75 | 4 (3-6) | < .001 |
| | | With PP | 96 | 94–98 | | | |
| All patients | pulse | Before PP | 93 | 18 | t= 5.21 | 5 (11) | < .001 |
| | | With PP | 88 | 15 | | | |
| | resp | Before PP | 31 | 9 | t= 2.91 | 5 (17) | .01 |
| | | With PP | 26 | 8 | | | |

resp, respiratory rate; PP, prone positioning; O2, supplemental oxyen; $SpO_2$, peripheral capillary oxygen saturation; IQR, interquartile range.
* Median (IQR) or mean (SD).
† No O2 Δ: 24 patients with no change in supplemental oxygen when proned.

$P < .001$ and respiratory rate change: 5 [SD = 17] breaths/min, t= 2.91, $P = .01$).

### PATIENT DISPOSITION

Patients remained in PP in the emergency department for a median time of 200 minutes (IQR, 134-363). Of the 31 patients, 14 (45%) were intubated (3 and 11 in the emergency department and ICU, respectively) after a median time of 35 hours (IQR, 11-88). A "do not intubate" decision had been made for 2 (6%) of the patients. All patients were admitted to the hospital, 10 (32%) to the ICU. As of writing this manuscript, 18 patients (58%) had been discharged home, 3 (10%) were still in the hospital, 2 (6%) were transferred to another facility, and 8 (26%) died (after a median of 8 [IQR, 5-13] days, range: 4-17 days). The median lengths of hospital stay including and excluding those still in the hospital were 11 (IQR, 7-17) and 11 (IQR, 7-15) days, respectively.

## Discussion

We studied the association of PP and $SpO_2$ on patients with COVID-19 in the emergency department who were nonintubated. This work was a single-site, pragmatic pandemic process implementation in a real-world clinical setting that demonstrated feasibility and initial effectiveness of the intervention for the included patients and should not be interpreted as testing the efficacy of PP as a controlled clinical trial. Only one study on this patient population (ie, non-intubated ED patients) with a total of 50 patients had been previously published when we began this work.[8] Our results confirmed most of the findings of this study, discussed in more detail in later text, which increases confidence in the reproducibility of these findings. Our study is unique for reporting the ethnicity of the patients (most were Hispanic), in-hospital disposition (32% were admitted to the ICU), and mortality (26% died). To contextualize our findings, we found 2 previous reports on the effectiveness of PP on mortality and intubation rate, with conflicting results.[1,6]

In 31 patients who were proned in the emergency department, $SpO_2$ increased by a median of 5% (IQR, 4%-9%) with PP, from a borderline oxygenation level of 90% (IQR, 89%-93%) before PP to a more clinically acceptable median of 96% (IQR, 94%-98%) with PP. There may be other explanations for changes besides assuming PP, such as change in ambient temperature, physical activity, emotional status, or $FIO_2$. However, there were no documented changes in any of these factors for any patients except $FIO_2$. With the changes in $FIO_2$, when 24 of 31 patients with no change in $FIO_2$ while being placed in PP were analyzed separately, the 4% increase in $SpO_2$ was similar to the 5% increase in the patients for whom $FIO_2$ had been increased when placed in PP. Fourteen (45%) were intubated after a median time of 35 hours (IQR, 11-88).

After the completion of our analysis, we searched for cohort studies (each with at least 3 patients) of patients with COVID-19 who were nonintubated, treated with PP to contextualize our results in the rapidly emerging published literature. Our search returned 13 such studies that included 228 (range in each study of 3-56) patients

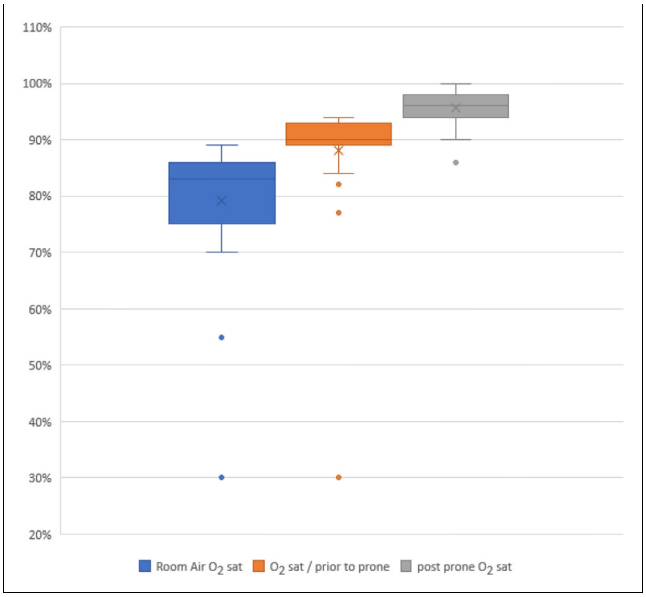


FIGURE 2

Change in $SpO_2$ with prone positioning in patients with coronavirus disease 2019 in the emergency department who were awake, alert, and nonintubated. $SpO_2$, peripheral capillary oxygen saturation; O2, supplemental oxygen; SAT, saturation. Note: Postprone measure approximately 30 minutes after initiation of proning intervention.

with COVID-19 who were nonintubated, but only one was done entirely on patients in the emergency department.[9-18] In this study of 50 patients, the median age of 59 years (IQR, 50-68) was similar to our median age of 62 years, but a larger proportion were female (40%, compared with our 13%).[8] The median $SpO_2$ on ED arrival of 80% (IQR, 69-85) increased to 84% (IQR, 75-90) after supplemental oxygen and then 94% (IQR, 90-95) with PP. This 10% increase from before to with PP was statistically significant ($P = .001$). This change was greater than the 5% change we found, although the $SpO_2$ with PP was similar to our 96% finding. A total of 18 (36%) patients were intubated, with the median time until intubation in the 1- to 24-hour period after ED arrival. This is slightly smaller than our 45% intubation rate, although the median time to intubation was shorter than in our study (35 hours). Mortality statistics were not reported in these other studies. The overall outcomes of the 13 previous studies mentioned previously (including the ED study just described) were reported as $PaO_2$ in 2 studies (33 patients), $PaO_2/FIO_2$ in 5 studies (78 patients), $SpO_2$ in 6 studies (118 patients), and "oxygenation" in 1 study (10 patients). The mean changes in $PaO_2$, $PaO_2/FIO_2$, and $SpO_2$ with PP were 30 (SD = 13) mm Hg, 80 (SD = 87) mm Hg and 8% (SD = 2%), respectively. The latter change was somewhat larger than what we found (5%). In the 13 studies, 59 (26%) patients were intubated. Calculating the median rate for the individual studies yields a median intubation rate of 21% (IQR, 7-33). Only 8 studies (139 patients) reported mortality results, and in those studies, 11 (8%) died. Calculating the median rate for individual studies yields a median mortality rate of 3% (IQR, 0%-10%). Both these intubation and mortality rates are less than what we found. Although not directly comparable with our study, we did find 1 other study on PP in patients with COVID-19 who were intubated. Carsetti et al[19] retrospectively reviewed 10 patients with COVID-19 who were intubated, whose median $PaO_2/FIO_2$ before PP was 126 mm Hg. With PP for either 16- or 36-hour cycles, $PaO_2/FIO_2$ increased significantly to 177 mm Hg and 394 mm Hg, respectively, and remained elevated after subsequent supine repositioning (166 mm Hg and 290 mmHg, respectively).

When our findings are contextualized in the published literature, we interpret that our results corroborate the association of PP with increased pulse oximetry outcomes. The effectiveness of PP on longer term outcomes of mortality and intubation rates are conflicting. Future study is needed to determine the required duration of PP to improve outcomes and the effect of PP on intubation and mortality in patients with COVID-19.

## Limitations

Limitations included a small sample size, demographics that may have limited generalizability (87% male, 55% Hispanic), variations in time the patient remained in the prone position, along with the inability to ascertain if the patient maintained positive effects of PP once returned to supine position. Race and ethnicity were not collected using standard research categories and definitions, and no field was used for patients who were biracial or multiracial. Our results should be interpreted in light of the amount of missing data, particularly for the duration of the PP intervention. Although $SpO_2$ is less accurate than other invasive measures, it is the standard method to monitor oxygenation in the emergency department.

As a retrospective review, there is no assurance that all patients who met the inclusion criteria were placed in PP by the emergency staff nor that all PP intervention was accurately recorded in the EMR for inclusion in the study. Retrospective data abstraction has innate problems and shortcomings.[20] Although the data abstracters were not blinded to the purpose of the study, there were well defined objective data present in the same place in the EMR to limit bias. Despite these limitations, our study design demonstrates an initial feasibility and effectiveness in achieving

the intended clinical results at our site to raise $SpO_2$ by implementing a proning guideline for patients with COVID-19 in the emergency department.

## Implications for Emergency Nurses

Emergency nurses must implement practice changes to meet the needs of patients presenting with ARDS, including those with COVID-19. As COVID-19 cases continue to occur in the US, it is essential to provide early intervention for patients presenting in respiratory failure. Management of this patient population has been challenging from a logistical as well as clinical standpoint. Considering limitations in use of noninvasive respiratory support devices, continuous positive airway pressure and HFNC, the application of PP is a potential alternative to improve patients' $SpO_2$ levels. The currently published evidence supports the early use of PP for patients who are intubated. Implementation of PP guidelines for patients with suspected COVID-19 who are alert arriving to the emergency department is nurse-driven and can be accomplished quickly and with little additional expense. Although some patients did not tolerate PP, this intervention appears to be safe and feasible in this patient population. Emergency nurses are pivotal in expanding the use of PP to patients who are awake, alert, and spontaneously breathing.

## Conclusions

We demonstrated a single-site, pandemic practice guideline implementation of PP was feasible and associated with improved $SpO_2$ approximately 30 minutes after the initiation of PP for the included patients with COVID-19 who were awake, alert, and nonintubated. The PP of patients with COVID-19 who were awake and alert, not receiving noninvasive or invasive respiratory support, presenting to the emergency department with low pulse oximetry, was associated with a 5% improvement in pulse oximetry readings. Future studies are needed to determine the required duration of PP to improve outcomes and the effect of PP on rates of endotracheal intubation and long-term survival.

## Acknowledgments

The authors recognize the devoted staff at Morristown Medical Center emergency department whose dedication to their patients and unfailing teamwork provided outstanding care during the coronavirus disease 2019 pandemic.

## 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.2020.12.006.

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## Supplementary Appendix

Prone positioning guidelines

- Identify awake, alert, non-intubated COVID positive or COVID patients under investigation experiencing respiratory distress and low $SpO_2$ (>90%)
- Patient must be capable of repositioning with or without assistance at least every 2 hours
- Collaborate with ED provider regarding the appropriateness of PP the patient and maximization of non-invasive oxygen delivery
- Provider enters a "keep prone" nursing communication in the EMR (see below)
- Describe the intervention to the patient
- Place patient in prone position with mild reverse Trendelenburg (approximately 20-30 degrees)
- Provide pillows for comfort and pressure injury prevention per National Pressure Injury Advisory Panel (NPIAP) https://cdn.ymaws.com/npiap.com/resource/resmgr/press_releases/npiap_pip_tips_-_proning_202.pdf)
- Document PP in EMR
- Encourage the patient to remain in PP for as long as is tolerated and patient respiratory parameters improve (respiratory rate, effort, $SpO_2$)
- Continually monitor patient and communicate patient tolerance of PP to provider

**Contraindications:**
ABSOLUTE CONTRAINDICATIONS:

1. Shock (eg, persistent mean arterial pressure <65 mmHg)
2. Acute bleeding (eg, hemorrhagic shock, massive hemoptysis)
3. Multiple fractures or trauma (eg, unstable fractures of femur, pelvis, face)
4. Spinal instability
5. Raised intracranial pressure >30 mmHg or cerebral perfusion pressure <60 mmHg
6. Hemicraniectomy
7. Sternotomy within two weeks
8. Life-threatening arrhythmias

RELATIVE CONTRAINDICATIONS:

1. 48 hours or greater of refractory hypoxemia
2. Pregnancy
3. Tracheal surgery
4. Recent DVT treated for <2 days*
5. Anterior chest tube(s) with air leaks*
6. Major abdominal surgery
7. Recent pacemaker*
8. Clinical conditions limiting life expectancy* (eg, oxygen- or ventilator-dependent respiratory failure)
9. Severe burns*
10. Lung transplant recipient*

*Atlantic Health System Patient Care Manual Prone Positioning Guidelines*

* *Based upon exclusion criteria from the Prone Positioning in Severe ARDS trial (PROSEVA)*

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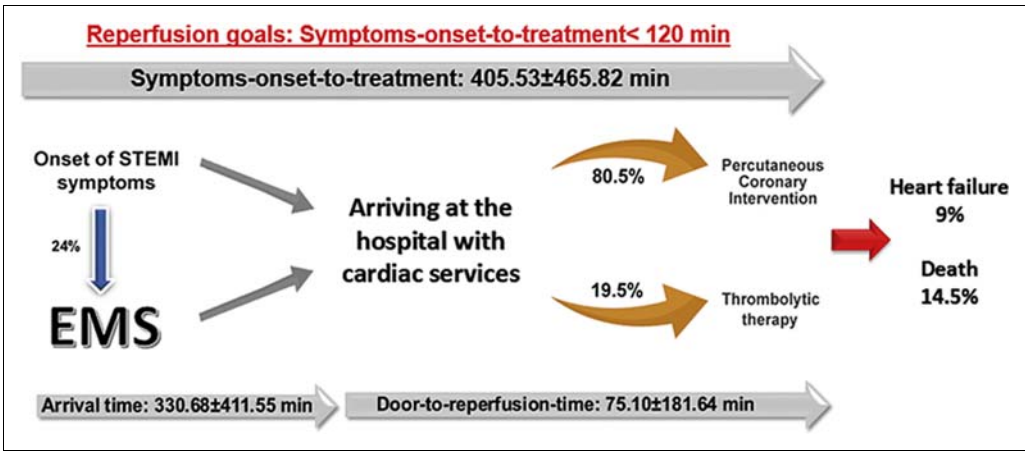
# Time-to-Treatment and Its Association With Complications and Mortality Rate in Patients With Acute Myocardial Infarction: A Prospective Cohort Study

**Authors:** Nasrin Hanifi, PhD, Ensiyeh Rezaee, MSN, and Mahin Rohani, MSN, Zanjan, Iran



# Time-to-Treatment and Its Association With Complications and Mortality Rate in Patients With Acute Myocardial Infarction: A Prospective Cohort Study

**Authors:** Nasrin Hanifi, PhD, Ensiyeh Rezaee, MSN, and Mahin Rohani, MSN, Zanjan, Iran

CE Earn Up to 10.5 Hours. See page 359.

**Contribution to Emergency Nursing Practice**

- The current literature on time-to-treatment and its association with complications and mortality rate in patients with acute myocardial infarction indicates that delay in treatment time was associated with the occurrence of heart failure and mortality.
- The main finding of this research is that smoking history and hypertension were highly associated predictor factors with complications and mortality of myocardial infarction. Both risk factors can be modified through patient and community education.
- Key implications for emergency nursing practice found in this article are the need to raise population-level awareness about leading risk factors for myocardial infarction, symptoms, and access treatment as soon as possible.


## Abstract

**Introduction:** Time-to-treatment is one of the most important factors affecting the complications and mortality rate in patients with acute myocardial infarction. The purpose of this study was to determine time-to-treatment and its association with complications and mortality rates in patients with acute myocardial infarction in selected hospitals in Zanjan, Iran.

**Methods:** This prospective cohort study was performed with 200 patients suffering from acute myocardial infarction in selected educational hospitals of Zanjan from June 2016 to March 2017. Parameters including the interval between pain onset and treatment, myocardial infarction complications, in-hospital mortality, and 30-day mortality after the occurrence of myocardial infarction were collected through a special questionnaire and phone calls. The data were analyzed using descriptive statistics and logistic regression models.

**Results:** The longest time-to-treatment delay is related to prehospital time (mean, 330.68 [SD=411.55] minutes). Based on the results, the increase in the interval time between onset of pain and treatment (odds ratio: 1.001; 95% confidence interval, 1.000–1.002; $P = 0.01$), hypertension (odds ratio: 2.96; 95% confidence interval, 1.14–7.68; $P = 0.02$), and left coronary artery complete occlusion (odds ratio: 2.78; 95% confidence interval, 1.57–4.94; $P < 0.001$) were mortality predictor factors. Furthermore, the increase in the interval time between onset of pain and treatment (odds ratio: 1.001; 95% confidence interval, 1.000–1.002; $P = 0.03$), current smoking (odds ratio: 5.53; 95% confidence interval, 1.75–17.43; $P = 0.004$), and right coronary artery complete occlusion (odds ratio: 5.87; 95% confidence interval, 1.34–25.82; $P = 0.02$) were highly associated with the occurrence of heart failure.

**Discussion:** Hypertension, smoking history, and delay in treatment time were highly associated with the occurrence of heart failure and mortality. Therefore, in Iranian society, education on primary and secondary prevention of myocardial infarction is recommended to reduce patient mortality.


**Key words:** Myocardial infarction; Time-to-treatment; Complication; Mortality

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## Introduction

Myocardial infarction (MI) is one of the leading causes of death, especially in the early hours of occurrence.[1-5] According to the American Heart Association guidelines, the treatment of MI should occur within 120 minutes. Early diagnosis and successful intervention play an important role in reducing mortality related to acute MI. Reducing the time-to-treatment depends on the performance quality of therapeutic systems.[6-9]

Two important factors that affect the performance quality of associated therapeutic systems are door-to-needle time (DTNT) less than or equal to 30 minutes and door-to-balloon time (DTBT) less than or equal to 90 minutes.[10] Each 30-minute delay in thrombolytic therapy leads to 7.5% and 8.7% increases in mortality rate and left ventricular dysfunction, respectively, and in addition, each 30-minute delay between the onset of symptoms and performing percutaneous intervention results in an 8% increase in 1-year mortality.[11] Nallamothu et al[12] reported that every 10-minute reduction in DTBT leads to 92% and 94% decreases in the in-hospital mortality and 6-month mortality, respectively. Sim et al[13] performed a study on patients with MI from 2009 to 2012. In the study, the patients were divided into "non-delay" (DTBT <90 minutes) and "delay" (DTBT >90 minutes) groups. The results indicated a higher rate of mortality in the "delay" group. In 3 other studies, by reducing the average DTBT, no change was observed in in-hospital mortality, 1-month mortality rate, or heart failure.[10,14,15] However, less than 4 hours between onset of pain and treatment was associated with significantly decreased heart failure and mortality rates.[14]

According to the studies performed in Iran and other countries, the average door-to-reperfusion time is more than 2 hours.[4,16-19] One study showed that only 35.7% of patients arrived at the hospital within 1 hour and 7.9% of them attended after 24 hours from starting the symptoms.[18]

The main elements of chest pain-to-reperfusion time delay include lack of timely patient recognition of the severity of symptoms; evaluation, treatment, and transfer to a hospital; the required time for diagnostic evaluations and starting treatment in the hospital; and the onset of treatment until reperfusion.[9,20,21]

Based on previous studies, prehospital delays were more significant than hospital delays.[22,23] The factors affecting prehospital delays included incorrect patient identification of symptoms, patients presenting to primary care centers and general practitioners, patient transit problems, patients residing in rural areas, lack of patient or family history of coronary artery disease, and incorrect provider diagnosis.[16,20,22-26] In 1 study, the most common cause of delay in DTNT was associated with the delay in informing the physician of a patient's symptoms and electrocardiogram (ECG) by ED staff.[27]

Numerous investigations have reported the association of certain factors (eg, males, high education, patient's perception of the severity of symptoms, and residence in urban areas) with a faster onset of treatment.[23,26]

Population health policy is relevant to the treatment of MI. The Ministry of Health of Iran and its affiliated medical universities are responsible for treatment, health, and medical education. In Iran, the Ministry of Health has issued a code of MI or code 247 to improve the treatment of patients with MI since 2015. Therefore, researchers must investigate the status of prehospital and hospital delays in patients with MI after the implementation of this project in angioplasty service centers in Iran.[28]

Despite numerous studies in this field, there is a need to continuously evaluate community awareness of MI symptoms and its need for timely treatment, as well as examine the quality of prehospital and hospital care services. To the best of our knowledge, there is no study in Iran addressing time intervals between the onset of pain of patients with MI and thrombolytic therapy or angioplasty. Most of the studies in this field only evaluated prehospital or hospital delays, with few of them investigating complications and mortality rates.[11,16,18,23,26] This study aimed to determine time-to-treatment and its association with complications and mortality rate in patients with MI in hospitals with heart services in Zanjan, Iran.

## Methods

This hospital-based prospective cohort study was performed with patients with MI in educational hospitals of Zanjan from June 2016 to March 2017.

### STUDY SETTING

The Zanjan province is located in the northwestern part of Iran. The capital of this province is Zanjan. It has a population of 1,057,461 with 8 counties and 978 villages. Because Zanjan province is located on the Iran transit route to Europe, its medical centers also provide medical services to people from other provinces. There are 10 hospitals affiliated with Zanjan University of Medical Sciences and 3 other hospitals in Zanjan province. Of these 3 hospitals, 1

is private, the others are affiliated with law enforcement and social security. However, in Zanjan, 2 ValiAsr and Ayatollah Mousavi hospitals affiliated with the University of Medical Sciences provide services for patients with heart disease. In the province, the treatment process for patients with MI patients is performed with code 247. According to the protocol of code 247 policy, as soon as a patient calls emergency medical services (EMS), the telephone triage unit responds to the call. After the ambulance is dispatched, first-aid treatments are performed, and an ECG is taken immediately from the patient and sent to a specialist. With an initial diagnosis of MI, code 247 is activated, and the target hospital and the hospital supervisor are notified. After the patient is delivered to the hospital, in the case of ST- elevation MI or non-ST– elevation MI, the patient will be referred directly to the angiographic unit or an emergency medicine specialist, respectively. Patients with cardiac arrest or ventricular fibrillation are transferred to the resuscitation room and are monitored by an emergency medicine specialist.

The study setting was the Cardiac Health Centers of Zanjan Province, Valiasr and Ayatollah Mousavi Educational Hospitals.

## SAMPLING

We used a convenience sampling design. A total of 50 participants were considered in a pilot study. Because the participants in the pilot study had the same inclusion and exclusion criteria, the results from the pilot study were also included in this study. Considering the pilot study and based on the time-to-treatment variable and the distance of a SD of $137 < \sim < 365$, the SD was calculated to be 140 minutes. By considering the 20-minute sampling error, 95% confidence interval, and 80% power, the sample size was determined to be 196 people.

## INCLUSION AND EXCLUSION CRITERIA

Patients who were referred to cardiac treatment centers with typical and atypical symptoms of MI at the time of our study were included in the study if an ECG and elevated cardiac enzymes indicated ST-elevation MI. In addition, patients who were admitted to the hospital with ventricular fibrillation or cardiac arrest were included in the study if they had cardiopulmonary resuscitation and survived. Another inclusion criterion was the willingness of patients to participate in the study. Patients who had secondary MI owing to other diseases such as hemorrhage were excluded from the study. We did not include patients who died in the prehospital or emergency department setting without successful resuscitation in the emergency department.

## ETHICAL CONSIDERATION

The present study was conducted after approval of the ethics committee of Zanjan University of Medical Sciences (ZUMS.REC.1395.68). Written informed consent was taken from all patients or, if necessary, from their guardians.

## DATA SOURCES AND INSTRUMENTS

Data were collected by research nurses who recorded direct observations, reviewed the medical record, completed a questionnaire for each patient participant during the hospital stay, and completed telephone follow-up for 30-day mortality with patients or persons who accompanied them to the hospital. Prehospital and hospital delays and their effective factors (sex, age, lack of patient or family history of coronary artery disease, pain intensity and patient identification of symptoms, residence in rural areas, referral source to the hospital with cardiac services, transit problems, and incorrect provider diagnosis), complications, and mortality rates were gathered by direct observation as well as patient records.

The data collection instrument of this study was a questionnaire designed to capture demographic data and factors from time of pain onset until treatment (Supplementary Table 1). Sex, age, risk factors for cardiovascular disease (diabetes, hypertension, hyperlipidemia, smoking, drug use),[29] pain intensity (0-10), referral source to the hospital with cardiac services (EMS, personal vehicle, public vehicle, referral by ambulance from other medical centers), type of MI, percent coronary artery blockage, and type of treatment were included in this questionnaire.

The interval between the onset of pain and the patient's contact with EMS or referral to a treatment center, the onset of pain until the first ECG in an ambulance or noncardiac treatment center, the onset of pain until arrival to the hospital with cardiac services, the interval between the arrival to the hospital with cardiac services and the first physician visit, the arrival to the hospital with cardiac services until the first ECG, the arrival to the hospital until a treatment order, and the arrival to the hospital until treatment implementation were also assessed.

A checklist was also used to investigate any MI complications (Supplementary Table 2).[30] These included cardiac dysrhythmia, cardiogenic shock, heart failure, aortic valve rupture, coronary dissection, pulmonary edema, unstable angina, gastrointestinal bleeding, and brain stroke.

Both tools were developed from information in the published literature.[16,31,32] Moreover, to determine their

validity, the designed tools were submitted to 10 critical care nursing professors, and the necessary corrections were made on the basis of their feedback. Moreover, the reliability of the study was determined using the evaluation of inter-rater agreement. Accordingly, 2 researchers filled the designed questionnaire for 10 patients. The 99% Cohen's kappa coefficient obtained through these questionnaires showed a high agreement between the results of the 2 researchers.

### *Variables*

The variables of this study included demographic variables, risk factors related to atherosclerotic heart disease, factors related to prehospital and hospital time-to-treatment, coronary artery involvement based on angiographic results, complications, and mortality.

In this study, heart failure owing to MI was determined on the basis of the results of the ECG and the ejection fraction (EF) of the patients. The degree of left ventricular dysfunction correlated well with the extent of acute infarction. Hemodynamic compromise becomes evident when impairment involves 20% to 25% of the left ventricle, and cardiogenic shock or death occurs with involvement of the left ventricular muscle of 40% or more.[33] Therefore, in this study, an EF of 35% and less was recognized as heart failure.

In this study, the mortality rate owing to the complications of MI was assessed in the hospital and also 30 days after hospitalization. To find cardiac mortality, all patients were followed up to 30 days after hospitalization. If mortality occurred within 30 days of hospitalization owing to MI, patients' medical records were reviewed to determine the cause of cardiac mortality.

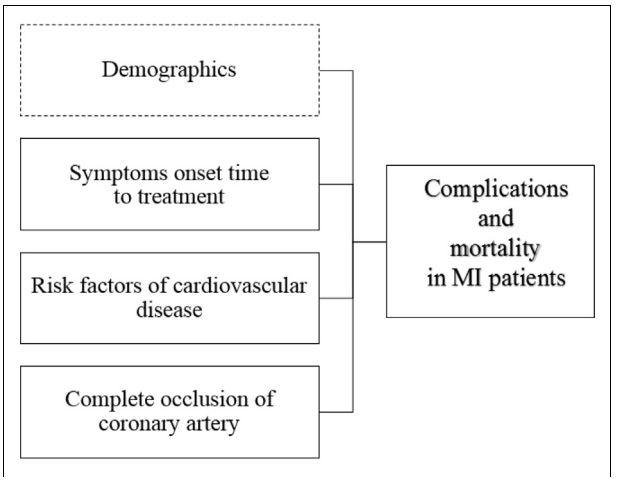
### *Hypothesis*

This study examined the following hypothesis in patients with MI: Demographic variables, delay in treatment, risk factors of cardiovascular disease, and complete occlusion of coronary artery are associated with complications and mortality (Figure).

## DATA COLLECTION PROCEDURES

Data were collected from June 2016 to March 2017 on a 24-hour basis by 2 nurses with bachelor degrees working at the emergency department, cardiac care unit, and cardiology ward.

Attempts were made to collect data at the appropriate time and place by interviewing the patients or, if necessary, the emergency contact support person who accompanied the patient to the hospital. The 30-day mortality rate was obtained through contact with the patients or the emergency contact support person who accompanied them to the hospital.




FIGURE

The hypothesis tested in this study. Dotted box indicates covariate. MI = myocardial infarction.

## DATA ANALYSIS

Statistical analyses were performed using SPSS version 16 software. To analyze the data, quantitative variables were presented in the form of SD and mean, whereas qualitative variables were presented as frequency and percentage. The predictor factors of time, individual and organizational delays associated with the occurrence of complications, and mortality were determined using a logistic regression model.

Backward stepwise logistic regression was performed for 30-day mortality predictor factors in 8 steps and for heart failure (as the most common complication) predictor factors in 9 steps. This analysis started with all variables in step 1; that is sex, age, diabetes, hyperlipidemia, hypertension, smoking, drug use, previous heart disease, time between onset of symptoms and beginning of treatment, 100% left anterior descending (LAD) coronary artery obstruction, 100% right coronary artery (RCA) obstruction, 100% left circumflex artery (LCX) obstruction.

At each step, the variable with the largest $P$ value (the least statistically significant) was removed automatically, and this process was repeated until no further variables could be deleted without a statistically insignificant

TABLE 1
**Demographic characteristics of participants**

| Variables | Number | % |
|---|---|---|
| Sex | | |
| Male | 159 | 79.5 |
| Female | 41 | 20.5 |
| Age | | |
| >60 y | 105 | 52.5 |
| <60 y | 95 | 47.5 |
| Risk factors | | |
| Smoking | 83 | 41.5 |
| Hypertension | 72 | 36 |
| Drug addiction | 41 | 20.5 |
| Hyperlipidemia | 39 | 19.5 |
| Diabetes mellitus | 33 | 16.5 |
| Prior heart disease | 53 | 26.5 |
| Pain severity (0–10) | | |
| >8 | 138 | 69 |
| <8 | 62 | 31 |
| Mode of transport | | |
| Personal vehicle | 94 | 47 |
| Referral from other centers | 78 | 39 |
| Call to the emergency medical services | 24 | 12 |
| Public vehicle | 4 | 2 |
| Myocardial infarction type | | |
| Inferior | 56 | 28 |
| Anterior | 51 | 25.5 |
| Extensive | 34 | 17 |
| 100% obstruction of arteries | | |
| Left anterior descending | 81 | 40.5 |
| Right coronary artery | 43 | 21.5 |
| Left circumflex artery | 12 | 6 |
| Reperfusion therapy | | |
| Angioplasty | 141 | 70.5 |
| Thrombolytic therapy | 31 | 15.5 |
| Complication | | |
| Heart failure | 18 | 9 |
| Ventricular tachycardia | 6 | 3 |
| 30-d mortality | | |
| First wk | 6 | 3 |
| Second k | 6 | 3 |
| Third wk | 7 | 3.5 |
| Fourth wk | 10 | 5 |

loss of fit and finally a reduced model that best explained the data was found. The remaining statistically significant variables for 30-day mortality in step 8 are age, hypertension, drug use, previous heart disease, time between onset of symptoms and beginning of treatment, and 100% LAD obstruction. The remaining statistically significant variables for heart failure in step 9 are smoking, drug use, time between onset of symptoms and beginning of treatment, 100% RCA obstruction, and 100% LCX obstruction. A $P$ value of equal to or less than 0.05 was considered statistically significant.

## Results

Of the eligible participants, 9 patients declined to participate in the study or to continue collaborating by telephone and were excluded from the study. Two participants were admitted to the hospital with cardiac arrest and entered the study after resuscitation.

Of the 200 patients who participated and were eligible, 159 (79.5%) were male. The mean age of the patients was 60.77 (SD = 13.97) years. The most common risk factor for MI was current smoking (41.5%), followed by hypertension (36%) (Table 1). Only 26 of the patients contacted EMS, and their ECG was taken in an ambulance according to code 247.

In this study, the most common type of MI was inferior(28%). Moreover, the LAD (40.5%) and the RCA (20%) were the most common arteries that underwent angioplasty, respectively. Of the 19.5% of the patients who received thrombolytics, in more than half of them drug administration was started in the emergency room (Table 1).

Mean DTNT was 64.83 (SD = 47.66) minutes, and mean DTBT was 89.43 (SD = 213.06) minutes. The total time from pain onset until reperfusion therapy (thrombolytic therapy or angioplasty) was 405.53 (SD = 465.82) minutes (330.68 [SD = 411.55] minutes prehospital time and 75.10 [SD = 181.64] minutes door-to-reperfusion-time) (Table 2). Only 18.5% of patients underwent reperfusion therapy in less than 120 minutes (the golden time for initiating cardiac ischemia treatment).

In total, MI complications were observed in 25% of the patients. The most common complication was heart failure (9%) followed by ventricular tachycardia (3%). Of the 200 patients, death occurred in 14.5%. In regard to death distribution, 5% of the patients died in the fourth week, 3.5% in the third week, 3% in the second week, and 3% in the first week after MI (Table 1). As for the location where the death

TABLE 2
**Evaluation of the mean interval between the onset of pain and treatment in patients with myocardial infarction**

| Variable | Mean (SD) | CI |
|---|---|---|
| Prehospital intervals | | |
| Onset of pain until decision to call EMS or go to a health center | 100.31 (172.06) | 0–1,070 |
| Onset of pain until first ECG in ambulance | 8.6 (15.05) | 6–22 |
| Onset of pain until arrival to hospital with cardiac services | 330.68 (411.55) | 10–4,320 |
| Hospital intervals | | |
| Arrival to the hospital until first visit | 8.36 (9.02) | 0–55 |
| Arrival to the hospital until first ECG | 10.44 (12.35) | 0–95 |
| Arrival to the hospital until the treatment order | 62.54 (180.47) | 0–2,160 |
| Arrival to the hospital until the reperfusion therapy | 75.10 (181.64) | 3–2,160 |
| Onset of pain until treatment | 405.53 (465.82) | 15–4,325 |

Values are given in minutes.
CI, confidence interval; EMS, emergency medical services; ECG, electrocardiogram.

occurred, 11% of the patients died at home, 2.5% in the CCU and 1% in the cardiac ward.

The results of the logistic regression showed that prolonged chest pain-to-reperfusion time, hypertension, and 100% obstruction of LAD were the statistically significant predictors of 30-day mortality (Table 3). It also showed that prolonged chest pain-to-reperfusion time, smoking, and 100% obstruction of RCA were the statistically significant predictors of heart failure (Table 4).

## Discussion

The purpose of this study was to determine time-to-treatment and its association with complications and mortality rates in patients with acute MI. According to the results of this study, delay in time-to-treatment was highly associated with the occurrence of heart failure and mortality. The results of this study demonstrated that prehospital delay was more significant than hospital delay (Table 2). A 30-day mortality was associated with prolonged chest pain-to-reperfusion time, hypertension, and 100% obstruction of LAD (Table 3). Heart failure (with EF 35% or less) was associated with prolonged chest pain-to-reperfusion time, smoking, and 100% obstruction of RCA (Table 4).

In the present study, a large proportion of the delay in the onset of treatment related to the time interval between the onset of pain and the arrival to cardiac hospitals. Although most of the foreign studies mentioned in this article align with the findings of the current study, the prehospital delay in Iran was mostly because of a delay in the recognition of symptoms by patients (61%) and then being away from the hospital (22%) was more than that in other countries.[22-25,27,34] For example, the mean time from pain onset until performing angioplasty or thrombolytic therapy, according to Beig et al[22] and Björklund et al[35] who conducted a study in India (250 minutes) and Sweden (165 minutes), respectively, was much lower than the results obtained in Iran (507 minutes).[23]

In Iranian society, chronic diseases such as atherosclerotic heart disease are on the rise.[36,37] For this purpose, the Ministry of Health of Iran has set the National Document for Prevention of Non-Communicable Diseases from 2016 to 2026. In this document, conditions such as poverty, level of health literacy, and access to service centers in Iran are mentioned as barriers to preventing diseases such as heart disease.[31] One of the goals of this document for preventing noncommunicable diseases such as heart disease is to provide community-based responsive medical science education. Therefore, according to this document, health service managers and health staff should provide necessary training about the risk factors for heart disease, symptoms of heart disease, and how the patient and his or her family deal with these symptoms.[28] Therefore, to assess the achievement of the goal of prevention at the third level and to reduce complications in cardiac patients, the prehospital delays of cardiac patients at 5-year intervals until 2026 should be investigated.

In our results, limiting the provision of treatment services to patients with MI in only 2 health care centers delayed the referral of patients with MI. Because Zanjan has some impassable areas, access to these medical centers

TABLE 3
**Multiple stepwise logistic regression analysis of predictors for 30-day mortality**

| Variables | β | SE | OR (95% CI) | *P* value |
|---|---|---|---|---|
| Age | 0.35 | 0.19 | 1.035 (0.997–1.075) | 0.07 |
| Hypertension | 1.08 | 0.49 | 2.956 (1.137–7.683) | 0.03 |
| Previous heart disease | 0.97 | 0.57 | 0.381 (0.124–1.172) | 0.09 |
| 100% LAD obstruction | 1.02 | 0.29 | 2.781 (1.566–4.938) | < 0.001 |
| Time-to-treatment | 0.001 | < 0.01 | 1.001(1.000–1.002) | 0.01 |

CI, confidence interval; LAD, left anterior descending coronary artery; OR, odds ratio; SE, standard error.

is restricted. Therefore, emergency care leaders should take measures to reduce the prehospital delay time of cardiac patients and facilitate access to health care centers where transportation may be challenging because of the geography.

In our study, an increase in pain onset-to-treatment time was highly associated with 30-day mortality, which was consistent with that of Ho et al[14] in China. The results of studies by Sim et al[13] and Yamada et al,[38] which were conducted in Asia, and those of Nallamothu et al[12] in the United States, indicated an increase in mortality rate by increasing the time from entry to the hospital until treatment. Menees et al[10] performed a study in the US and showed that despite improvement in DTBT from 2005 to 2009, no significant changes were observed in in-hospital and 30-day mortality. Elsewhere, Peng et al[34] conducted a study in China and indicated that an increase in prehospital delay led to an increase in mortality rate. Most studies demonstrated that an increase in pain onset-to-treatment time led to a higher mortality rate.

A limited number of studies showed the relationship between pain onset-to-treatment time and common complications of MI. The results of our present study were consistent with those of Ho et al[14] in China. A delay in treatment increased the infarction area and the possibility of heart failure.[39]

In this study, major risk factors of MI had a greater role in mortality and complications than prehospital delay. In this study, hypertension and smoking were identified as one of the predictors of mortality and heart failure in patients with MI, respectively (Tables 3 and 4). Studies by Lacey et al,[40] Gupta et al,[41] Lewington et al,[42] and Rojas et al[43] showed that hypertension was associated with increased mortality owing to cardiovascular disease. Gopal et al[44] also indicated that smoking was associated with an increase in heart failure, and according to the studies by Shah et al[45] and Ahmed et al,[46] smoking cessation was associated with increased cardiac function. The results of all 3 studies are consistent with the present study. Therefore, the results of this study indicated that in Iranian society, the focus should be on primary prevention rather than secondary prevention with appropriate training to reduce the mortality and complications of MI.

## Limitations

A major limitation of this study was that it relied on the patients to recall times, which was especially challenging for senior patients. Researchers tried to focus on important times such as adhan (this is the call to prayer) and news, as well as

TABLE 4
**Multiple stepwise logistic regression analysis of predictors for heart failure**

| Variables | β | SE | OR (95% CI) | *P* value |
|---|---|---|---|---|
| Smoking | 1.71 | 0.59 | 5.528 (1.753–17.434) | 0.004 |
| 100% RCA obstruction | 1.77 | 0.76 | 5.873 (1.336–25.821) | 0.02 |
| 100% LCX obstruction | −1.38 | 0.71 | 0.252 (0.063–1,003) | 0.05 |
| Time-to-treatment | 0.001 | < 0.01 | 1.001 (1.000–1.002) | 0.03 |

CI, confidence interval; LCX, left circumflex artery OR, odds ratio; RCA, right coronary artery; SE, standard error.

reviewing the events of that day, as far as possible, to accurately record the time and factors affecting the prehospital delays.

Patients who died in the emergency room because of dysrhythmia or other comorbidities were not investigated; it was not possible to obtain information because of their family's mental and emotional status. The results of this study may have changed with the inclusion of these patients. Therefore, it is recommended that future studies use this type of information to obtain more reliable results on prehospital and hospital delays and other risk factors in predicting complications and mortality of patients with MI in Iran. Owing to the descriptive nature of this study and the specific conditions of the Zanjan province, the results of this study may have limited generalizability to other communities. Not all possible complications of MI may have been captured by the methods used. Unlike international studies where government death records or indices can be linked to measure nonhospital mortality, this study relied on communication with family members after discharge, which may not have recorded all postdischarge deaths.

## Implications for Emergency Nurses

Key implications for emergency nursing practice from this research are the need to raise population-level awareness about leading risk factors for MI, symptoms, and access treatment as soon as possible. Emergency clinicians can integrate prevention into patient teaching and discharge education. Adequate prevention and control of hypertension and smoking cessation can be included in patient education and discharge instructions for all at-risk patients to prevent subsequent MI, regardless of the reason for a present ED visit.

## Conclusion

The results of the present study showed that smoking history and hypertension were highly associated with complications and mortality. Both risk factors can be modified through community education. Therefore, the authorities should aim at raising awareness about the leading risk factors for MI, symptoms, and the need for treatment as soon as possible.

Changing people's lifestyles by guiding them to self-care can prevent atherosclerotic heart disease. Conducting training courses for at-risk populations (such as the older people or people with diabetes or hypertension), as well as public education through national media, social networks, and popular publications can be good ways for primary and secondary prevention of heart disease. In contrast, training during the discharge of patients with MI and periodic home visits of patients with MI can reduce the complications of MI.

In addition, the results of our study determined that prehospital delay was more significant than hospital delay, and these delays were identified as the statistically significant predictors for heart failure and mortality. The presence of experienced emergency medical personnel and the rapid and proper performance of emergency physicians and nurses are important factors in timely treatment, which can reduce the complications and mortality of the disease. To enhance the performance quality of the health care team, it is important to regularly evaluate their knowledge and performance and provide them with retraining courses if needed.

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## Author Disclosures

Conflicts of interest: none to report.

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## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.05.013.

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## Supplementary Data

SUPPLEMENTARY TABLE 1
**Demographic and factors related to delay in treatment questionnaire**

Hospital name:
☐ Vali Asr
☐ Ayatollah Mousavi
Sex:
☐ male
☐ female
Age:
Weight:
Education degree:
☐ Analphabetic
☐ Less than diploma
☐ Diploma
☐ College education
Job:
☐ Worker
☐ Employee
☐ Housewife
☐ Retired
☐ Self employed
The number of family members
Monthly income:
Living with:
☐ Alone
☐ Spouse
☐ Children
☐ Family
Insurance status:

*continued*

SUPPLEMENTARY TABLE 1
**Continued**

Medical history:
☐ Diabetes
☐ Hypertension
☐ Hyperlipidemia
☐ Unstable angina
☐ Myocardial infarction
☐ Gastrointestinal disease
☐ Family history of myocardial infarction
☐ Smoking
☐ Drug abuse
Hospital history:
☐ Yes
☐ No
Hospital history due to cardiac disease:
☐ Yes
☐ No
Location during onset of symptoms:
☐ Less than 10 kilometers of cardiac hospitals in the city
☐ more than 10 kilometers of cardiac hospitals in the city
☐ Out of the city
Symptoms type:
☐ Chest pain
☐ Left hand pain
☐ Right hand pain
☐ Shoulder pain
☐ Neck pain
☐ Stomachache
☐ Vomiting
☐ Nausea
☐ Dyspnea
☐ Dizziness
☐ Fainting
☐ Sweating
Your definition of symptoms:
☐ Cardiac disease
☐ Gastrointestinal disease
☐ Common cold
☐ Other definitions

*continued*

SUPPLEMENTARY TABLE 1
**Continued**

Which of the following medications did you take at the onset of symptoms?
☐ Aspirin
☐ TNG Perl
☐ Stomach syrup
☐ Herbal medicine
☐ Drugs
☐ Other medications
☐ None
Have you taken aspirin in the last 7 days?
☐ Yes
☐ No
If your symptoms appeared as pain, how severe was it?
10 9 8 7 6 5 4 3 2 1 0
Which of the following did you visit before going to the cardiac hospital?
☐ Private clinic
☐ General clinic
☐ Private hospital
☐ Other center
☐ None
Why did you visit the above center?
☐ Accessibility of the center
☐ Low center costs
☐ I didn't think my illness was important
Who did you consult first after the onset of symptoms?
☐ Spouse
☐ Children
☐ Friends
☐ EMS
☐ None
Did you call EMS before going to the health centers?
☐ Yes
☐ No
Time of your symptoms onset (exactly)?
Time of your calling EMS (exactly)?
Time of arriving EMS (exactly)?

*continued*

SUPPLEMENTARY TABLE 1
**Continued**

Why did you decide to go to the cardiac hospital?
☐ My symptoms got worse
☐ Based on my background and information, I guessed it was a heart attack
☐ Based on the doctors recommendations
☐ Based on EMS consultation
☐ Based on others' advice
How did you get to the hospital?
☐ By personal vehicle
☐ By public transport
☐ EMS
☐ Referral by ambulance
The degree of the person accompanying you?
☐ Analphabetic
☐ Less than diploma
☐ Diploma
☐ College education (medical field)
☐ College education (non-medical field)
How were your symptoms when you arrived at the hospital?
☐ Reduced
☐ Relieved
☐ Increased
☐ No change
Did you have any new symptoms when you arrived at the hospital?
☐ Yes
☐ No
Were you referred to the triage unit at the beginning of admission?
☐ Yes
☐ No
The exact time of arrival at the hospital?
With whom was your first visit?
☐ General practitioner or non-cardiac resident
☐ Cardiac resident
☐ Specialist
The exact time of first visit?

*continued*

SUPPLEMENTARY TABLE 1
**Continued**

Possible diagnosis on the first visit?
☐ Unstable angina
☐ Myocardial infarction
☐ Ischemic heart disease
☐ Other diagnosis
Blood pressure at the admission time?
Heart rate at the admission time?
The first ECG time?
Was there ST segment elevation in the first ECG?
☐ Yes
☐ No
What was the diagnosis after the first ECG?
☐ Inferior MI
☐ Anterior MI
☐ Posterior MI
☐ Anteroseptal MI
☐ Inferolateral MI
☐ Extensive MI
☐ Right ventricular MI
☐ Left bundle branch block
☐ Other diagnosis
Was there an increase in biomarker enzymes?
☐ Yes
☐ No
The exact time of the reperfusion therapy order?
The exact time of thrombolytic injection?
The exact time of angiography?
What was the result of angiography and coronary artery occlusion percentage?
In which ward was thrombolytic therapy done?
☐ Emergency department
☐ CCU
From which ward were you transferred to the angiography ward?
☐ Emergency department
☐ CCU
How was the thrombolytic provision done?
☐ Available in the ward
☐ From another ward
☐ It was prepared by the patient's companion

*continued*

SUPPLEMENTARY TABLE 1
**Continued**

Prehospital time (arrival time)?
Door to needle time or door to balloon time?
Symptoms onset time to reperfusion therapy (PCI or thrombolytic therapy)

EMS, emergency medical services; ECG, electrocardiogram; CCU, cardiac care unit; MI, myocardial infarction; PCI, percutaneous intervention

SUPPLEMENTARY TABLE 2
**Checklist for complications in patients with myocardial infarction**

| Complications of myocardial infarction | YES | NO |
|---|---|---|
| Post MI angina | | |
| Re-infarction | | |
| Pulmonary edema | | |
| Heart failure | | |
| Cardiogenic shock | | |
| Mitral regurgitation | | |
| Left ventricle aneurism | | |
| Cardiac rupture | | |
| PVC | | |
| VT | | |
| VF | | |
| PSVT | | |
| Sinus Brady arrhythmia | | |
| Junction Brady arrhythmia | | |
| AV block grade 1 | | |
| AV block grade 2 | | |
| Complete AV block | | |
| Brain stroke | | |
| Peripheral emboli | | |
| Pericarditis | | |
| Mortality (if so, please write down the exact time) | | |
| In the emergency department | | |
| In CCU | | |
| In the cardiac ward | | |
| At home after discharge | | |
| In the re-admission | | |

PVC, premature ventricular contraction; VT, ventricular tachycardia; VF, ventricular fibrillation; PVST, paroxysmal supra ventricular tachycardia; AV, atrioventricular; CCU, cardiac care unit.

# Implementing Point-of-Care Troponin Testing in the Emergency Department: Impact on Time to Result

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CE Earn Up to 10.5 Hours. See page 359.

**Contribution to Emergency Nursing Practice**

- The current literature on point-of-care troponin testing indicates that it correlates well with central laboratory values and decreases the time to result. Prior research has been inconclusive on whether it decreases ED length of stay.
- This article contributes the main finding that point-of-care troponin testing has the potential to decrease length of stay in patients classified as low risk being discharged.
- Key implications for emergency nursing practice found in this article are that point-of-care troponin testing can decrease the length of time patients with chest pain stay in the emergency department. However, implementing point-of-care testing adds to the workload of nursing staff and health care technicians. Its exact financial impact is difficult to predict.

## Abstract

**Introduction:** In the emergency department, troponin assays are commonly used and essential in the evaluation of chest pain and diagnosis of acute coronary syndrome. This study was designed to assess the potential impact of implementing point-of-care troponin testing by comparing the time to point-of-care laboratory result and time to conventional laboratory result.

**Methods:** The study enrolled 60 ED patients deemed to need a troponin test in the evaluation of low-risk chest pain (HEART score <4 based on history, electrocardiogram, age, risk factors). Point-of-care troponin testing was performed with the same blood sample obtained for a conventional troponin assay. If the provider determined that the patient required 2 troponin tests, the second laboratory draw was used in the data collection. This was to correlate the time of laboratory result to time of disposition.

**Results:** Of the 60 subjects enrolled, 2 subjects were excluded because of user errors with the point-of-care testing equipment and 2 others for not meeting inclusion criteria on later review. The median times for the point-of-care troponin and conventional troponin assays were 11:00 minutes (interquartile range 10:00-15:30) and 40:00 minutes (interquartile range 31:30-52:30), respectively; $P < 0.001$. There were 3 extreme outliers from the conventional troponin assay that significantly skewed the distribution of the mean, making the median the more accurate assessment of the central tendency.

**Discussion:** Point-of-care troponin testing provided results in a median time 29 minutes quicker than the conventional troponin assay. This result is statistically significant and has

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the potential to greatly improve time to disposition in all patients with chest pain requiring a troponin assay.

**Key words:** Point-of-care testing; Troponin; Chest pain; Acute coronary syndrome

## Introduction

In the emergency department, chest pain and other angina equivalents are common chief complaints. Determining each patient's risk for having acute coronary syndrome (ACS) and dispositioning them appropriately is a core skill for any emergency provider. Prior studies have shown that a low history, electrocardiogram, age, risk factors, and troponin (HEART) score (0-3) can safely identify patients classified as low risk suitable for discharge because they have an approximately 1.0% to 2.5% chance of developing a major adverse cardiac event.[1-3] This involves evaluating the patient's HEART score by assigning 0, 1, or 2 points to each variable (Table 1). Obtaining a troponin assay is often the most time-consuming component of determining a patient's HEART score. In 2017, a quantitative study showed point-of-care (POC) troponin laboratory testing was equally accurate and correlated well with standard troponin samples that were sent to the central laboratory for testing.[3] These results supported previous findings from earlier studies.[4,5] In 2005, a before-and-after trial at an academic medical center showed an approximately 1-hour reduction in time to admission with the introduction of POC troponin testing.[6] In 2013, another before-and-after trial showed a significant decrease in time to result by 19 minutes but not a significant difference in ED length of stay.[7] Related studies suggest that implementing POC testing improves practice efficiency in the ambulatory care setting, leading to improved clinical operation and cost reductions.[8] The 2 similar before-and-after trials looked at either exclusively admitted patients or all ED patients (both admitted and discharged). The ED length of stay of admitted patients involves many factors and likely dilutes the potential impact of POC testing. We sought to determine if implementing POC troponin testing in patients classified as low risk would shorten the time to result and discuss its potential to reduce length of stay in patients likely to be discharged.

This study compared the performance of POC troponin testing to core laboratory troponin testing on the time to result in patients with HEART scores of 0 to 3. If the troponin result is the last piece of information needed for disposition, any difference in timing could mean decreased length of stay. At the time of data collection, POC troponin testing was not approved for clinical use by our laboratory. Not being able to make clinical decisions on the basis of its result made it impossible to look at its direct effects on length of stay. However, a significant reduction in time to result could justify implementing POC troponin testing in this low-risk population for our emergency department.

TABLE 1
**HEART score**[1]

| Component | Grading | Score |
|---|---|---|
| History | Highly suspicious | 2 |
| | Moderately suspicious | 1 |
| | Slightly suspicious | 0 |
| ECG | Significant ST deviation | 2 |
| | Nonspecific repolarization disturbance/left bundle branch block/ pacemaker | 1 |
| | Normal | 0 |
| Age, y | >65 | 2 |
| | 45 to 65 | 1 |
| | <45 | 0 |
| Risk factors | >3 for atherosclerotic disease | 2 |
| | 1 to 2 | 1 |
| | None | 0 |
| Troponin | >3× normal limit | 2 |
| | 1× to 3× normal limit | 1 |
| | <normal limit | 0 |
| | | Total |

ECG, electrocardiogram; HEART, history, ECG, age, risk factors, and troponin.

## Methods

This was a single-centered, convenience sample, quantitative study. It was conducted in the emergency department at Naval Medical Center San Diego, an academic, urban, military treatment facility. The emergency department sees approximately 80,000 annual visits. The study aimed to enroll a sample size of 60 patients. This was based on a power analysis to achieve 80% power with a significance level (alpha) of 0.05. The protocol was approved by the Clinical Investigation Department at the Naval Medical Center San Diego as CIP number NMCSD.2016.0104.

TABLE 2
**Subjects' demographics and risk factors**

| Subjects' characteristics | Mean or N | SD or % | 95% CI |
|---|---|---|---|
| Mean age, y | 45.2 | 14.8 | |
| Female (%) | 34 | 60.7 | 46.8, 73.2 |
| Cardiac risk factors (%) | | | |
| Received 1 point for history | 38 | 67.9 | 53.9, 79.4 |
| Received 1 point for ECG | 3 | 5.4 | 1.4, 15.8 |
| Received 1 point for age >45 y | 26 | 46.4 | 33.2, 60.1 |
| History of hypertension | 19 | 33.9 | 22.2, 47.9 |
| History of hyperlipidemia | 12 | 21.4 | 12.0, 34.8 |
| History of diabetes mellitus | 4 | 7.1 | 2.3, 18.1 |
| History of smoking | 9 | 16.1 | 8.1, 28.8 |
| History of atherosclerotic disease | 2 | 3.6 | 0.6, 13.4 |
| Family history of cardiovascular disease | 9 | 16.1 | 8.1, 28.8 |
| Elevated troponin result | 0 | 0.0 | 0.0, 8.0 |

ECG, electrocardiogram; CI, confidence interval.

Independent emergency providers identified patients presenting to the emergency department and deemed to need a troponin assay to evaluate for ACS. The enrolling researcher would screen for eligibility of and consent from the patient. The inclusion criteria were necessity for troponin testing as determined by an independent provider, no signs of ischemia on electrocardiogram, and a preliminary HEART score of 0 to 3 (Table 1). The exclusion criteria included inability to understand the consent process, pregnancy, age below 18 years or above 65 years, or military recruit in basic training. There were no changes to the methods on trial commencement.

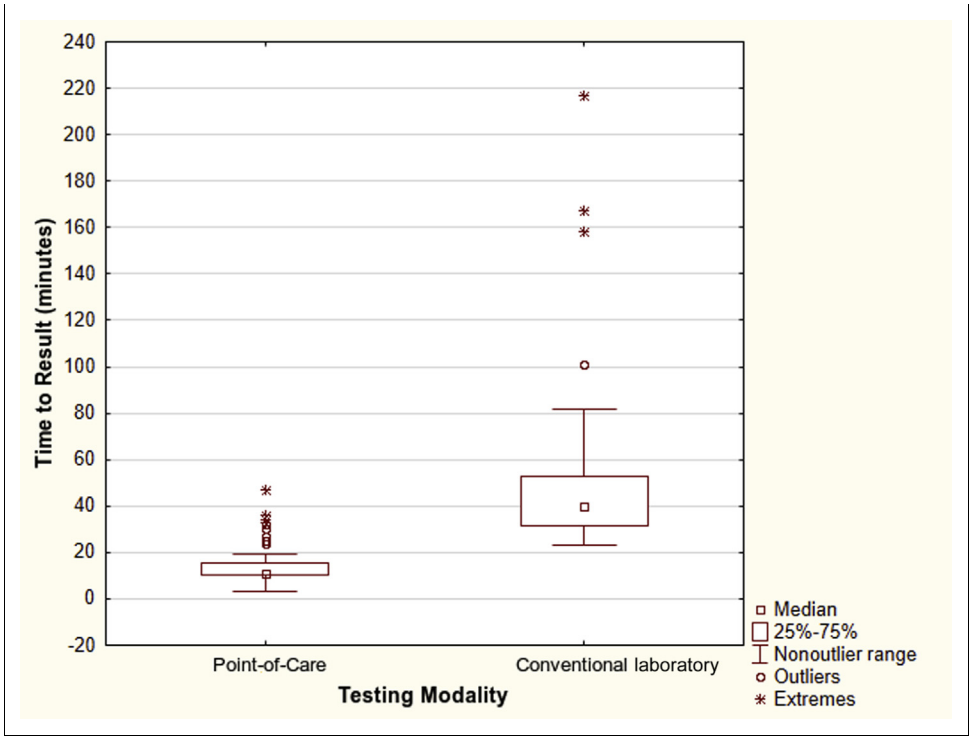
The independent providers who ordered the troponin were blinded to the results of the POC troponin because it was not approved for use at our facility. A provider from the research group obtained consent of the patient before the blood draw used for the conventional and POC troponin assays. If the independent provider determined that the patient required 2 troponin tests, the second laboratory draw was used in the data collection. This was to correlate the time of laboratory result to time of disposition. The i-STAT cTnI assay (Abbott Point of Care Inc) was used for POC troponin I subunit testing (10-minute run time). The central laboratory tests for troponin-T subunit using the Cobas 8000 (Roche Diagnostics) (9-minute run time). Neither test is considered a high-sensitivity troponin test.

Data were collected through direct observation of the activities associated with the process and the electronic medical record. This included time of order, time of blood draw, time of POC result, time of conventional laboratory result, time of discharge order, and troponin results from both testing modalities. All times were recorded in minutes. The data analysis used a Mann-Whitney U test to compare times and reported mean, median, SD, and interquartile range. This was performed using Statistica software (TIBCO Software Inc). Comparative times to result were best represented graphically as a box plot, also created using Statistica. Troponin results from each modality were compared using R software (epiR package) (The R Foundation for Statistical Computing), yielding sensitivity, specificity, positive predictive value, negative predictive value, and 95% confidence interval (CI). Manufacturer reference ranges were used to identify positive values (i-STAT cTnI 0.00-0.08 ng/mL, Roche Trop T Sensitive <0.014 ng/mL).

TABLE 3
**Distribution of HEART scores**

| Subjects' HEART score | N = 56 | % | 95% CI |
|---|---|---|---|
| 0 | 4 | 7.1 | 2.3, 18.1 |
| 1 | 16 | 28.6 | 17.7, 42.4 |
| 2 | 18 | 32.1 | 20.6, 46.1 |
| 3 | 18 | 32.1 | 20.6, 46.1 |

HEART, history, electrocardiogram, age, risk factors, and troponin; CI, confidence interval.




FIGURE

Box plot of the Time to Result for each Testing Modality.

## Results

There were 60 subjects enrolled from February 2018 to January 2019. Two subjects were excluded because of errors with the POC testing equipment. One was due to user error and the other because the cartridge had expired. Two others were excluded owing to a HEART score of 4 or more on review of the subjects. Of the 56 remaining, 6 patients were admitted with diagnoses other than ACS. The mean age of the subjects was 45.2 years, and 60.7% were women. Subject demographics, risk factors, and distribution of their HEART scores can be found in Table 2 and Table 3. The mean times to result for the POC troponin and the conventional troponin assays were 14:25 minutes (SD 9:14) and 50:20 minutes (SD 35:10), respectively. The median times for the POC troponin and conventional troponin assays were 11:00 minutes (interquartile range [IQR] 10:00-15:30) and 40:00 minutes (IQR 31:30-52:30), respectively; $P < 0.001$. These results are represented in the box plot labeled Figure.

The SD and mean values of the conventional troponin assay were skewed from 3 extreme outliers that took longer than 150 minutes. This was due to hemolysis of the blood samples and lost samples, which required repeat blood draws. Extreme outliers from both testing modalities were included in the analysis because they represent delays common in the emergency department.

All troponin results from both testing modalities were negative using manufacturer reference ranges. These results yielded not applicable sensitivity and positive predictive value. Specificity was 1.00 (95% CI 0.94, 1.00), and the negative predictive value was 1.00 (95% CI 0.94, 1.00).

The median time to discharge order after the troponin result was 22 minutes. The 6 patients who were admitted were not included in this time-to-discharge analysis.

## Discussion

The implementation of the HEART score over the last several years has decreased admission rates for chest pain.[9,10] The use of POC testing provided results 29 minutes quicker than conventional troponin assays. This could greatly reduce the ED length of stay in all patients classified as low risk and with chest pain requiring troponin assays. POC testing eliminates the additional delays involved in

TABLE 4
**Costs involved in troponin-testing strategies**[15]

| Point-of-care testing | Cost (dollars) |
|---|---|
| i-STAT (Abbott Point of Care Inc.) | 6,474.83 (estimated 5-y lifespan) |
| POC cartridge | 11.33 (per test) |
| Estimated cost of staff for POC program | 8,093.54 (annually) |
| Estimated cost of calibration | 485.61 (annually) |
| Conventional testing cartridge | 8.09 (per test) |
| Specimen procurement by central laboratory | 9.72 (per test) |

POC, point-of-care.

order transcription, tube transfer, laboratory processing, and data entry. The results of this study and those of prior studies demonstrate the equivalent accuracy of POC testing to conventional troponin testing. These results also validate that there is a significant degree of time separation between the testing modalities. With discharge orders issued only 22 minutes after troponin results, it supports the premise that the disposition in these patients classified as low risk hinges on the troponin results. The time from result to discharge order would likely be less if POC troponin is used because the provider is prompted with the result.

This significant difference in time to result is consistent with prior studies looking at the effects of POC testing.[7] The most similar study—the previously mentioned before-and-after trial—showed a 68-minute reduction in time to result. Our results were not that dramatic, mainly because of the quicker result time of our central laboratory (50 minutes) compared with that of the prior study (83 minutes). This prior trial used data only from admitted patients and focused primarily on their ED length of stay. With the increasing use of the HEART score in recent years, practice patterns have shifted, and more patients with chest pain are being discharged. Our study focused on these patients classified as low risk and on how POC testing could reduce their length of stay irrespective of whether they require single or serial troponin testing.

A Canadian cost analysis of troponin-testing strategies was performed in 2014. Table 4 shows this summary. The Canadian dollar amounts have been converted to present-day United States dollars. The conversion from Canadian dollars and adjustments for inflation were calculated using the Bank of Canada conversion and inflation calculators.[11] Hypothetically, if an emergency department runs 1,000 tests per year, the cost of POC testing and conventional testing would be $21.20 and $17.81 per test, respectively. This analysis did not assume any additional device cost for the laboratory. A previous study estimated the personnel cost per patient bed-hour as $58.20.[12] The 29-minute reduction in the time to result found in our study translates to $28.13 in cost savings. In this scenario, there is a total cost saving of $24.74 per patient and $24,740.00 per annum with the use of POC troponin testing.

## Limitations

There are limitations to this study. It is a single-centered, convenience sample using the laboratory and staff at an academic, urban, military treatment facility. Laboratories at other institutions will have variable times for conventional troponin assays. However, given the ease of POC use and logistics of sending samples to a central laboratory, a significant time difference is expected. Our medical center has a comparatively short length of stay when compared with other emergency departments. Over the last 12 months, our mean length of stay was only 167 minutes. Compare this with 222 minutes, the average ED length of stay reported nationally.[13] The Hawthorne effect could have affected the result time for POC troponin testing because the ED staff were being directly observed by the investigators, whereas the core laboratory staff were not. The obvious next step would be to investigate for a reduction in ED length of stay after the implementation of POC testing for patients classified as low risk and with chest pain. Future research could look more closely at cost-benefit analyses, given various troponin cartridge pricing and ED length of stay–cost estimates.

## Implications for Emergency Nurses

The implementation of POC troponin testing provides nursing staff the advantage of closely following a pivotal laboratory result. Communicating this result to the provider will prompt a discussion on the next step in care and likely disposition. The addition of POC troponin testing to departments already using other POC tests would add minimal burden regarding training and equipment maintenance. The i-STAT analyzer (Abbott Point of Care Inc.) that runs the troponin cartridge used in this study also runs numerous other POC tests, including chemistry, blood gas, and hemoglobin/hematocrit. However, the added task of performing the test adds to the often-saturated workload

of emergency nurses and their support staff. This would be amplified if the staff members are not familiar with the use and maintenance of the equipment running other POC tests.

## Conclusions

This study, and others like it, support the safety and efficiency of POC troponin testing.[3-5,14] It provides results quicker than conventional laboratory testing and seems to be cost-effective. Every emergency department should review its current staffing, bed availability, and current laboratory efficiency when considering implementation of POC troponin testing.

## Author Disclosures

The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government.

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# Factors Affecting Attitudes Toward Defibrillator Use Among Clinical Nurses in South Korea: A Cross-Sectional Study

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**Contribution to Emergency Nursing Practice**

- The current state of scientific knowledge indicates nurses in the hospital are cardiac arrest first responders.
- The main finding of this research is nearly all nurses have been trained in defibrillator use, but only 13.6% have used a defibrillator.
- Key implications for emergency nursing practice from this research are that confidence, image, and job fit affect nurses' attitudes toward defibrillator use.


## Abstract

**Introduction:** Nurses are often first responders to in-hospital cardiac arrests. However, many nurses do not perform defibrillation even when required. Nurses' attitudes toward defibrillator use are influenced by social and psychological context. This descriptive, cross-sectional study explored factors affecting attitudes toward defibrillator use among nurses in South Korea.

**Methods:** A total of 280 nurses with a minimum of 6 months' clinical experience were included. The data were acquired through a self-administered questionnaire. Regression analysis was used to determine factors significantly associated with attitudes toward defibrillator use.

**Results:** Only 13.6% of the participating nurses had experience with defibrillator use in a cardiopulmonary resuscitation situation, whereas 94.6% of the nurses had received training on defibrillator use. Attitudes toward defibrillator use accounted for 37% of variance in measures of self-confidence, image, and job fit.

**Discussion:** To improve clinical nurses' attitudes toward defibrillator use, improving their self-confidence, image, and job fit through ongoing assessment and retraining on defibrillation is required. In addition, relevant institutional support and systematic guidelines should be provided.


**Key words:** Attitude; Defibrillation; Image; Job; Self-confidence

## Introduction

In hospitals, 21% of cardiac arrests are caused by shockable rhythm such as ventricular fibrillation or pulseless ventricular tachycardia.[1] When defibrillation is delivered within 3 minutes of the onset of a cardiac arrest that occurs because of these causes, neurological damage can be prevented. Moreover, 33% of patients treated under such circumstances have been reported as discharged alive.[1,2] This evidence suggests that early defibrillation by witnesses is important to improving the survival rate associated with a sudden cardiac arrest caused by ventricular fibrillation or pulseless ventricular tachycardia. Defibrillation is a safe and effective method of removing shockable rhythms with minor side effects.[3]

Within hospitals, nurses are often the first responders to emergencies such as cardiac arrests.[4] Therefore, nurses should be able to recognize cardiac arrest and perform lifesaving measures such as defibrillation.

However, nurses are unlikely to use a defibrillator even when required. The main reasons for this reluctance are lack

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of relevant experience, low confidence, fear of causing harm, legal liability, anxiety, workload-related tension, and perception of a nurse's role as a doctor's assistant in several international settings.[5,6] These attitudes are influenced by social and psychological environments.[7] The social and psychological determinants of defibrillator use among nurses remain unclear, and related studies in South Korea have been few.

This study examined factors affecting clinical nurses' attitudes toward defibrillator use, general characteristics of respondents and cardiopulmonary resuscitation (CPR)–related characteristics, a psychological (self-confidence) variable, and social (image and job fit) variables within a conceptual framework (Figure).

## Methods

### DESIGN

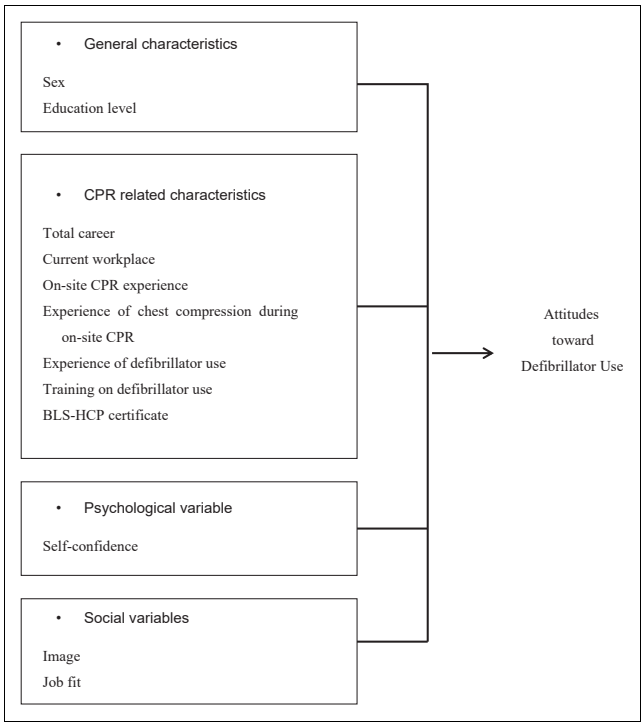
This was a cross-sectional, descriptive study.

### PARTICIPANTS AND SETTING

A convenience sample of clinical nurses was recruited from 7 general hospitals (each with more than 100 beds) from an urban setting in South Korea. Inclusion criteria was registered clinical nurses with more than 6 months of experience. The researcher contacted the directors of seven general hospitals to obtain permission for recruitment. Participation was both voluntary and anonymous. Questionnaires were mailed to clinical nurses who agreed to take part in this study. Questionnaire packages with cover letters were distributed with a return envelope addressed to the researcher. To determine sample size, we performed a power analysis, using G Power 3.1.2 for multivariate regression analysis. The desired sample size for computation of test power ($1 - \beta$) of 0.95 with 13 predictors was 277, with an effect size of 0.10 and an $\alpha$ of 0.05.

### MEASUREMENTS

The questionnaire consisted of 5 sections: general characteristics, CPR-related characteristics, self-confidence (psychological variable), image and job fit (social variables), and attitudes toward defibrillator use. To ensure reliability and validity of the measurements in the present study, data collection involved previously validated tools.[8-11] Before the present study launch, we also consulted 3 qualified experts as the basic life support (BLS) training center faculty to verify the suitability of the measurements used; a pilot study (n = 20) was conducted.




FIGURE

Potential predictors of clinical nurses' attitudes toward defibrillator use: conceptual framework. CPR, cardiopulmonary resuscitation; BLS-HCP, basic life support–health care provider.

(1) General demographic characteristics: General characteristics of interest included sex and education level.
(2) CPR-related characteristics: CPR-related characteristics included on-site CPR experience, experience of chest compression during an on-site CPR, experience of defibrillator use, training experience on defibrillator use, having received a BLS-health care provider (BLS-HCP) certificate, total career duration, and current workplace setting.
(3) Self-confidence: Self-confidence in this study was developed on the basis of a previous study.[8] The Content Validity Index of the scale was 0.87. The final questionnaire comprised 14 items after a pilot test (n = 20). Each item was rated on a 5-point Likert scale, ranging from "strongly disagree" (1) to "strongly agree" (5). High scores indicated higher levels of self-confidence to perform defibrillation. Cronbach's alpha for this scale in the present study was 0.94.
(4) Image: Image was measured with a scale developed by Baek et al.[9] The questionnaire comprised 4 items, and each item was rated on a 5-point Likert

scale, ranging from "strongly disagree" (1) to "strongly agree" (5). High scores indicated higher levels of one's image in one's social system. Cronbach's alpha for this scale in the previous study[9] was 0.86, whereas it was 0.85 in the present study.

(5) Job fit: Lee[10] developed a questionnaire called job fit. The questionnaire comprised 5 items, and each item was rated on a 5-point Likert scale, ranging from "strongly disagree" (1) to "strongly agree" (5). High scores indicated higher levels of job fit. Cronbach's alpha in the previous study[10] was 0.86, whereas it was 0.90 in the present study.

(6) Attitudes toward defibrillator use: Attitudes toward defibrillator use was developed by Kim and Lee.[11] The questionnaire comprised 5 items and each item was rated on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). High scores indicated a positive attitude toward defibrillator use. Cronbach's alpha in the previous study[11] was 0.97, whereas it was 0.95 in the present study.

### DATA COLLECTION

Data were collected from October 2016 to July 2017. The principal investigator met the director of the nursing department in each hospital to obtain permission to address potential participants before launching the study.

### ETHICAL CONSIDERATION

This study was conducted in accordance with the principles of the Declaration of Helsinki. This study was approved by Daejeon University's institutional review board (1040647-201609-HR-001-03). All participants provided written consent ahead of enrollment. Participants were informed that they could withdraw their consent at any point during this study without consequences.

### STATISTICAL ANALYSIS

Data were analyzed using IBM SPSS Statistics for Windows, version 22.0 (SPSS Inc, Chicago, IL). Statistical analyses included descriptive statistics and hierarchical multiple regression analysis. The hierarchical multiple regression models were computed on the antecedents of attitude toward defibrillator use. For independent variables, we used dummy coding (education level, current workplace, experience of defibrillator use, and being a BLS-HCP certificate holder) used in the regression models.

## Results

A total of 320 questionnaire packets were distributed, and 280 responses were included in the analysis (approximately 87.5% response rate).

### DESCRIPTIVE STATISTICS

Most of the respondents were female (96.1%), and the average career span was 6.94 years. Most worked in either a medical/surgical unit (54.3%) or a special care unit (35%). Most of the respondents (67.1%) had experienced on-site CPR more than once, and more than half of the respondents (59.6%) had no experience with chest compressions during CPR. Concurrently, few respondents (13.6%) had experience with defibrillator use during CPR. Most of the respondents (94.6%) had received training on defibrillator use, and one third of the respondents (31.8%) were reported BLS-HCP certificate holders (Table 1).

### FACTORS ASSOCIATED WITH ATTITUDES TOWARD DEFIBRILLATOR USE

Multicollinearity among independent variables was confirmed as follows. The tolerance range was 0.70 to 0.92, which was above 0.1. The Variance Inflation Factor range was 1.11 to 1.71, which was below 10. The Durban-Watson statistic was 1.83, and the assumption of normality of the residuals' distribution was satisfied, given the lack of self-correlation between the error terms of the model. First, in the regression analysis, education level ($\beta = 0.14$, $P = 0.03$) was significantly associated with attitudes toward defibrillator use. Second, the addition of a psychological variable (self-confidence) to model 1 resulted in 22% of variance in attitudes toward defibrillator use explained ($F = 9.69$, $P < 0.001$). Finally, the addition of social variables (image and job fit) to model 2 resulted in 37% of variance in attitudes toward defibrillator use explained ($F = 16.12$, $P < 0.001$) (Table 2).

## Discussion

In this study, on-site CPR experience rate (67.1%) was lower than that reported in the previous study (72.1%).[12] However, the rates of experience with chest compressions during CPR and training experience on defibrillator use reported in this study were consistent with the results of previous studies.[12,13]

TABLE 1
**Characteristics and mean of the major variables among clinical nurses (N = 280)**

| Variables | Category | Frequency | % | Mean | SD |
|---|---|---|---|---|---|
| General characteristics | | | | | |
| Sex | Male | 11 | 3.9 | | |
| | Female | 269 | 96.1 | | |
| Education level (highest obtained) | Some college | 104 | 37.1 | | |
| | Bachelor | 176 | 62.9 | | |
| CPR-related characteristics | | | | | |
| Total career, y | ≤3 | 99 | 35.4 | 6.97 | 7.35 |
| | 4–6 | 75 | 26.8 | | |
| | ≥7 | 106 | 37.9 | | |
| Current workplace, ward/unit | Medical/Surgical | 152 | 54.3 | | |
| | Special (ICU/ED) | 98 | 35.0 | | |
| | Others | 30 | 10.7 | | |
| On-site CPR experience, count | no | 92 | 32.9 | | |
| | 1–5 | 125 | 44.6 | | |
| | ≥6 | 63 | 22.5 | | |
| Experience of chest compression during on-site CPR, count | no | 167 | 59.6 | | |
| | 1–2 | 64 | 22.9 | | |
| | ≥3 | 49 | 17.5 | | |
| Experience of defibrillator use | no | 242 | 86.4 | | |
| | yes | 38 | 13.6 | | |
| Training on defibrillator use, count | no | 15 | 5.4 | | |
| | 1 | 147 | 52.5 | | |
| | ≥2 | 118 | 42.1 | | |
| BLS-HCP certificate | no | 191 | 68.2 | | |
| | yes | 89 | 31.8 | | |
| Self-confidence | | | | 3.70 | 0.63 |
| Image | | | | 3.52 | 0.70 |
| Job fit | | | | 3.39 | 0.62 |
| Attitudes toward defibrillator use | | | | 3.62 | 0.61 |

CPR, cardiopulmonary resuscitation; BLS-HCP, basic life support–health care provider; ICU, intensive care unit; ED, emergency department.

The high training rate (>90%) in the present study might be due to the accreditation program for health care organizations in Korea, in which a hospital certification system was implemented in 2015 to improve the quality of medical services provided to the public.[14] One of the evaluation items requires that all hospital staff receive CPR training, including defibrillator use, once a year.[15] Nevertheless, in the present study, the rate of direct experience with defibrillator use during CPR was lower than that in a previous study.[7] There are several reasons for this result. First, BLS-HCP certificate course received by most nurses participating in this study only provides training on automated external defibrillator (AED) use. Second, most hospitals have defibrillators with an automatic and a manual function, but most facilities encourage the use of the manual function to reduce costs in South Korea. Although the reasons for not using defibrillators were not investigated in this study, previous studies[16,17] have reported that clinical nurses are reluctant to use defibrillators because of the perceived complexity of the process, which is seen as the physician providers' task. Most importantly, because the incidence of cardiac arrest is higher in the emergency department and intensive care units (ICU) than in the general ward/unit (internal/

TABLE 2
**Factors affecting defibrillator use among clinical nurses in South Korea (N = 280)**

| Factors | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | SE | Beta | *P* | B | SE | Beta | *P* | B | SE | Beta | *P* |
| General/CPR-related characteristics | 2.92 | 0.22 | | <0.001 | 1.77 | 0.24 | | <0.001 | 0.86 | 0.24 | | <0.001 |
| Education level* (ref = BSN) | 0.14 | 0.06 | 0.14 | 0.03 | 0.01 | 0.06 | 0.01 | 0.91 | −0.01 | 0.05 | −0.01 | 0.88 |
| Total career | 0.06 | 0.04 | 0.08 | 0.20 | −0.01 | 0.04 | −0.02 | 0.75 | −0.01 | 0.04 | −0.02 | 0.77 |
| Current workplace* (ref = special unit) | 0.02 | 0.08 | 0.02 | 0.80 | 0.00 | 0.07 | 0.00 | 0.99 | 0.01 | 0.06 | 0.01 | 0.82 |
| On-site CPR experience | −0.01 | 0.06 | −0.01 | 0.90 | −0.06 | 0.05 | −0.07 | 0.31 | −0.02 | 0.05 | −0.03 | 0.67 |
| Experience of chest compressions during on-site CPR | 0.07 | 0.06 | 0.08 | 0.28 | −0.03 | 0.06 | −0.04 | 0.56 | 0.00 | 0.05 | 0.00 | 0.98 |
| Experience of defibrillator use* (ref = yes) | 0.15 | 0.11 | 0.08 | 0.20 | 0.10 | 0.10 | 0.06 | 0.33 | 0.00 | 0.09 | 0.00 | 0.96 |
| Training on defibrillator use | 0.10 | 0.06 | 0.10 | 0.11 | 0.09 | 0.06 | 0.08 | 0.13 | 0.04 | 0.05 | 0.04 | 0.41 |
| BLS-HCP certificate* (ref = yes) | −0.03 | 0.08 | −0.02 | 0.72 | 0.00 | 0.07 | 0.00 | 0.99 | 0.01 | 0.07 | 0.00 | 0.94 |
| Psychological variable | | | | | | | | | | | | |
| Self-confidence | | | | | 0.49 | 0.06 | 0.50 | <0.001 | 0.25 | 0.06 | 0.26 | <0.001 |
| Social variables | | | | | | | | | | | | |
| Image | | | | | | | | | 0.22 | 0.05 | 0.25 | <0.001 |
| Job fit | | | | | | | | | 0.30 | 0.06 | 0.31 | <0.001 |
| $R^2$ | 0.06 | | | | 0.24 | | | | 0.40 | | | |
| Adjusted $R^2$ | 0.03 | | | | 0.22 | | | | 0.37 | | | |
| F(p) | 2.22 (0.03) | | | | 9.69 (<0.001) | | | | 16.12 (<0.001) | | | |

BSN, Bachelor of science in nursing; SE, standard error, CPR, cardiopulmonary resuscitation, BLS-HCP, basic life support–health care provider.
* Dummy variables are education level, current workplace, experience of defibrillator use, and being a BLS-HCP certificate holder.

surgical unit) and other wards/units (outpatient department and so on), nurses working at clinical areas who rarely see cardiac arrests except in the emergency department or ICU should receive AED training/education.[18] Although there are no legal regulations in South Korean hospitals, AEDs are installed on major routes of patients such as the outpatient department and laboratory rooms for emergency situations. Further research is needed to determine the differences between emergency nurses and nurses in other specialties.

Given the scarcity of previous studies on the contextual factors affecting the use of defibrillators among nurses, comparisons are difficult. Nevertheless, self-confidence reported in the present study was low compared with previous studies that measured self-confidence at performing CPR or respiratory-assisted therapy[17] in emergency circumstances. These results might be related to the electrocardiogram (ECG) reading process involved in using a defibrillator with a manual function. Concurrently, the mean score on the measure of image was higher than that reported by Baek et al[9] but slightly lower than that reported by Kim.[15] Among Korean nurses, the image of a nurse as obedient and assisting physicians rather than leading in emergency situations persists.[19] The mean score on the measure of job fit was higher in the present study than in the study by Kwon and Kang.[20] The mean score on the measure of attitudes toward defibrillator use in the present study was higher than that in the study by Yun[21] but lower than that in the study by Lee and Jung.[13]

In the present study, the hierarchical multiple regression analysis revealed that self-confidence, image, and job fit are significant factors associated with attitudes toward defibrillator use. Among these variables, self-confidence was found to have a greater influence than did image or job fit.

High self-confidence among nurses could result in a defibrillator being used quickly with patients who require an electric shock. A previous study[6] reported that clinical nurses are reluctant to use a defibrillator because of low self-confidence. Self-confidence at defibrillation may affect the difficulty of ECG reading because of defibrillators with a manual function and the lack of knowledge and use experience of a defibrillator.[5,16] Self-confidence is related to first-hand experience. Nurses should be able to assist physicians and perform defibrillation on their own.[22] Self-confidence can be improved through training based on emergency situations such as team-based intensive education, simulation education, and virtual reality, among others, which should be proposed to nurses. Individual characteristics related to CPR should also be considered.[23]

The concept of image refers to nurses' beliefs, values, and self-confidence, which can increase job satisfaction.[24] Job fit can have a positive effect on job-related attitudes, when it is suitable.[10] Therefore, when nurses consider defibrillator use as part of their role, a more positive attitude toward defibrillator use among nurses can be expected. A previous study[7] has reported that attitudes toward defibrillator use among nurses were influenced by physicians' and institutions' support, including training and policy encouraging defibrillator use. During a cardiac arrest, nurses' positive attitudes toward defibrillator use are important to improve patients' survival rates.[21] Hospital managers and leaders should be aware of multiple factors affecting positive attitude toward defibrillator use. In addition, emergency situations such as cardiac arrest not only require individual knowledge and CPR skills but also a variety of psychomotor skills, clinical decision making, and teamwork behavior.[25] Kim et al[26] reported that clinical nurses lacked the opportunity and training to make decisions about what to do in a cardiac arrest rather than the knowledge of dealing with emergencies. Nurses working in the ICU and emergency department, when compared with those in the general medical/surgical unit and others, have more opportunities to treat cardiac arrest patients. Therefore, defibrillator education and training should be composed of in-hospital–oriented scenarios including the ECG reading process that reflect the actual situation to strengthen problem-solving ability using a team approach. Hospitals should also provide clear guidelines on the scope of a nurse's role in the context of defibrillator use.

## Limitations

One of the limitations of this study was that the study sample was not fully representative of clinical nurses in South Korea, as we only selected participants from one urban area of South Korea. The results of this study might not generalize to all South Korean clinical nurses. Future studies should include a more diverse range of hospitals. Second, this study was a cross-sectional study; any conclusions regarding causality between the antecedents of nurses' attitudes toward defibrillator use should be interpreted with caution. Longitudinal studies are needed to confirm the present findings.

## Implications for Emergency Nurses

The present findings provide evidence for the development of a clinical-oriented education program to improve self-confidence, image, and job fit, which may contribute to increasing patient survival rate by improving nurses' positive attitudes toward defibrillator use. In addition,

the program should reflect the cultural considerations, characteristics of the working ward/unit, and interdisciplinary role clarity, teamwork, and communication with physicians.

## Conclusions

The results of this study suggest that self-confidence, image, and job fit influenced attitudes toward defibrillator use among clinical nurses in one urban area of South Korea. Almost all of the respondents in this study had received training on using a defibrillator, but only 13.6% of respondents had experience with defibrillator use during CPR. Most hospitals in South Korea use manual defibrillators, so enhancing their self-confidence, image, and job fit through ongoing assessment and retraining with instruction on the ECG rhythm that requires defibrillation is needed. Further research is needed on the differences between emergency nurses and nurses in other specialties. Finally, defibrillator use should be considered within the nursing scope of practice, and clear guidelines should be developed in South Korean hospitals.

## Author Disclosures

Conflicts of interest: none to report.

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# Importance Ranking of Electrocardiogram Rhythms: A Primer for Curriculum Development

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### Contribution to Emergency Nursing Practice

- The interpretation of electrocardiograms (ECG) is an essential skill for emergency and acute care nurses and physicians. Accurate ECG interpretation can make a significant difference in clinical decisions, leading to rapid recognition and treatment of cardiac emergencies.
- The purpose of this study was to develop an importance ranking of the 120 American Heart Association ECG diagnostic labels as a primer for the development of a training curriculum.
- The findings from this study can assist educators in developing an ECG interpretation curriculum for emergency and critical care nursing and multidisciplinary audiences.

## Abstract

**Introduction:** Electrocardiogram interpretation is an essential skill for emergency and critical care nurses and physicians. There remains a gap in standardized curricula and evaluation strategies used to achieve and assess competence in electrocardiogram interpretation. The purpose of this study was to develop an importance ranking of the 120 American Heart Association electrocardiogram diagnostic labels with interdisciplinary perspectives to inform curriculum development.

**Methods:** Data for this mixed methods study were collected through focus groups and individual semi-structured interviews. A card sort was used to assign relative importance scores to all 120 American Heart Association electrocardiogram diagnostic labels. Thematic analysis was used for qualitative data on participants' rationale for the rankings.

**Results:** The 18 participants included 6 emergency and critical care registered nurses, 5 cardiologists, and 7 emergency medicine physicians. The 5 diagnoses chosen as the most important by all disciplines were ventricular tachycardia, ventricular fibrillation, atrial fibrillation, complete heart block, and normal electrocardiogram. The "top 20" diagnoses by each discipline were also reported. Qualitative thematic content analysis revealed that participants from all 3 disciplines identified skill in electrocardiogram interpretation as clinically imperative and acknowledged the importance of recognizing normal, life threatening, and time-sensitive electrocardiogram rhythms. Additional qualitative themes, identified by individual disciplines, were reported.

**Discussion:** This mixed-methods approach provided valuable interdisciplinary perspectives concerning electrocardiogram curriculum case selection and prioritization. Study findings can provide a foundation for emergency and critical care educators to create local ECG educational programs. Further work is recommended to validate the list amongst a

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larger population of emergency and critical care frontline nurses and physicians.

**Key words:** Electrocardiogram; Diagnoses; Nursing; Education; Interdisciplinary education; Curriculum

## Introduction

The interpretation of electrocardiograms (ECGs) is an essential skill for frontline providers, including nurses and physicians working in emergency and acute care settings. Accurate ECG interpretation can make a significant difference in clinical decisions, leading to rapid recognition and treatment of cardiac emergencies and avoiding unnecessary interventions resulting from false-positive interpretations. Despite advancements in ECG interpretation technologies, machine readings are not 100% accurate. They should always be over-read by an expert who will be able to implement appropriate clinical protocols on the basis of the ECG findings.[1-4]

Nursing ECG training programs have evolved from traditional classroom instructor–led courses to technology-aided approaches, including the use of simulations and e-learning platforms.[5-8] The use of these learning technologies has a positive impact on learners' ECG knowledge and confidence,[5,6] as well as performance, attitudes, motivation, and critical thinking skills in ECG interpretation.[7] The Emergency Nurses Association[9] recommends the use of imPULSE 3.0 (Apex Innovations), which is an online ECG training program that includes a comprehensive review of ECG monitoring and interpretation of abnormal ECG rhythms as well as standards of care for the patient with acute coronary syndrome suitable for emergency and acute care staff training and development. Despite improvements in ECG teaching modalities and learning technologies, there is limited evidence concerning the education required for initial competency and subsequent maintenance of ECG interpretation skills for emergency and critical care nurses and physicians.

A primary assumption in the design of educational interventions for the development of ECG interpretation is that some ECG diagnoses are clinically more important than others and require more instructional time and resources. This importance weighting may depend on the health care provider discipline, specialty area, and local priorities.[10] Therefore, an ECG learning intervention would ideally consider the relative importance of possible diagnoses when blueprinting a curriculum and selecting cases to present to learners. The purpose of this study was to develop a process for importance ranking of the American Heart Association (AHA) ECG diagnoses with interdisciplinary perspectives to inform the selection of ECG cases by discipline (or clinician type) for the development of ECG training curricula.

The AHA has developed a taxonomy of diagnostic statements for ECG interpretation.[11] These 120 statements encompass most of the possible diagnoses. In this study, we had expert clinicians and educators (emergency and critical care registered nurses, cardiologists, and emergency physicians) rank the AHA diagnostic statements as to their clinical importance for their discipline and share their perceptions about the educational significance of specific ECG diagnoses for frontline providers.

## Methods

### STUDY DESIGN, SAMPLING, AND SETTING

This was a mixed-methods study using quantitative and qualitative descriptive approaches. The participants, including emergency and critical care registered nurses as well as physicians who were experienced in emergency medicine and cardiology, were purposively sampled. The nurse experts were invited because of their extensive nursing experience (at least 20 years) in emergency and critical care areas, having interpreted ECGs as part of their practice, and having conducted ECG teaching in classroom and clinical settings. Similarly, the physicians were invited because they interpreted ECGs in emergency and critical care areas in their daily practice and had a role in teaching ECG interpretation to trainees.

An importance ranking was achieved using a card-sort methodology where each participant was provided with a physical deck of 120 cards, each containing 1 diagnostic statement. The participants then sorted the cards into piles after being asked "which of the following ECG diagnoses are the 20 most important according to the definition you have specified?" and the "20 least important ECG diagnoses."

After the card sort, focus groups were conducted for the emergency medicine physicians and cardiologists independently. The nurses' data were collected through key informant interviews because we could not achieve a focus group quorum owing to scheduling issues. The focus groups were conducted in a private conference room on a medical school campus, and the interviews were conducted in the participants' private offices or in secured conference rooms at their respective workplaces.

Participation in the study was voluntary. Before starting each focus group or interview session, each participant provided informed consent after a verbal explanation of the

study, including confidentiality issues. This study was approved by the NYU School of Medicine Institutional Review Board (approval number: i16-01442).

### DATA COLLECTION

During the focus groups and individual interviews, each participant individually completed the importance ranking. The importance ranking was completed after a warm-up reflection activity in which the participants were asked to identify what makes for an educationally important ECG. After this, the participants were asked to individually assign relative importance scores to all 120 AHA ECG labels. Data from the card sort were transcribed into an Excel spreadsheet (Microsoft Corporation) by 2 study investigators for quantitative analysis. After this, the participants were asked to discuss their rationale for ranking and prioritization of these diagnoses as well as to discuss the educational importance of ECG interpretation for frontline providers (nurses and physicians).

Two focus groups were conducted, 1 with the emergency physicians and 1 with the cardiologists. Individual face-to-face interviews were conducted with the nurse experts. All focus groups and interviews were recorded on audiotape and transcribed for qualitative analysis.

### DATA ANALYSIS

#### *Quantitative Analysis*

For each ECG diagnostic statement, we calculated the number of times it was listed as belonging to the 20 most important diagnoses. We further analyzed the "top 20" (numerically most commonly listed) diagnoses among the registered nurses, emergency physicians, and cardiologists.

#### *Qualitative Analysis*

The interviews were transcribed, and a content analysis was conducted.[12,13] Qualitative analyses were carried out manually using Excel spreadsheets to organize the interview texts. The transcripts were reviewed and coded by 2 study investigators who (1) individually read the transcripts several times to familiarize themselves with the information; (2) individually categorized ideas and generated initial codes; (3) individually searched for, reviewed, and defined themes; and (4) met to compare and combine individual themes into final themes by consensus.

## Results

Eighteen participants for this study included 6 emergency and critical care registered nurses, 5 cardiologists, and 7 emergency medicine physicians.

### QUANTITATIVE RESULTS

The top 5 diagnoses listed across all participants were ventricular tachycardia, ventricular fibrillation, atrial fibrillation, complete heart block, and normal ECG. Table 1 presents the ranking of the 20 most important diagnoses across disciplines. Table 2 shows the ranking of the 20 most important diagnoses selected by each discipline. The full ranking of all 120 diagnoses, including the "bottom 20," has been provided in Supplementary Table 1.

### QUALITATIVE RESULTS

#### *Common Themes Across Disciplines*

When the nurses' responses were compared with those of the physicians, 7 common themes were identified across disciplines (Supplementary Table 2). The results were similar in that both disciplines identified that ECG interpretation is clinically imperative and acknowledged the importance of recognizing ECGs that are life-threatening, time-sensitive, indicative of myocardial infarction, or normal. They also highlighted the importance of recognizing ECGs reflecting technical issues such as wrong lead placement, electrical interference, or incorrect machine interpretation. In addition, both nurses and physicians identified the importance of considering the clinical context for an appropriate ECG interpretation.

#### *Themes Unique to Nurses*

Nurses emphasized their role as bedside providers who may initially identify ECG changes. They also acknowledged the importance of recognizing reportable ECG findings as an essential nursing skill (Supplementary Table 3).

#### *Themes Unique to Physicians*

Both physician groups (cardiologists and emergency medicine) highlighted the importance of using pattern recognition in ECG interpretation as well as the importance of identifying commonly mistaken or confusable diagnoses (Supplementary Table 3). The cardiology physicians emphasized the differences between ECG diagnoses that are commonly mistaken and those that are commonly

TABLE 1
**Ranking of "top 20" electrocardiogram diagnoses across disciplines**

| AHA ECG Labels | Nurses (N = 6) | Cardiology medicine (N = 5) | Emergency medicine (N = 7) | Sum (N = 18) |
|---|---|---|---|---|
| 1. Ventricular tachycardia | 6 | 5 | 7 | 18 |
| 2. Ventricular fibrillation | 6 | 5 | 7 | 18 |
| 3. Atrial fibrillation | 6 | 5 | 5 | 16 |
| 4. AV block, complete (third-degree) | 5 | 5 | 6 | 16 |
| 5. Normal ECG | 6 | 4 | 4 | 14 |
| 6. Anterior MI | 3 | 4 | 5 | 12 |
| 7. Inferior MI | 3 | 4 | 5 | 12 |
| 8. Atrial flutter | 4 | 5 | 2 | 11 |
| 9. Supraventricular tachycardia | 5 | 4 | 2 | 11 |
| 10. Ventricular tachycardia, torsades des pointes | 2 | 4 | 5 | 11 |
| 11. Second-degree AV block, Mobitz type II | 4 | 2 | 5 | 11 |
| 12. Posterior MI | 2 | 3 | 6 | 11 |
| 13. Lateral MI | 3 | 3 | 4 | 10 |
| 14. Hyperkalemia | 3 | 1 | 6 | 10 |
| 15. Anteroseptal MI | 2 | 4 | 3 | 9 |
| 16. Right ventricular MI | 3 | 3 | 3 | 9 |
| 17. Acute pericarditis | 1 | 4 | 4 | 9 |
| 18. Acute pulmonary embolism | 1 | 3 | 5 | 9 |
| 19. Ventricular tachycardia, polymorphous | 2 | 3 | 3 | 8 |
| 20. Wide-QRS tachycardia | 2 | 2 | 4 | 8 |

Table results depict the number of participants who placed the diagnostic label into the category of "which of the following ECG diagnoses are the 20 most important?"
AHA, American Heart Association; ECG, electrocardiogram; AV, atrioventricular; MI, myocardial infarction.

missed and have a potential for high impact on patient outcomes—life-threatening, time-sensitive, and treatable. They also discussed the importance of differentiating ECG diagnoses that are urgently treatable from those that are less urgent and do not require immediate intervention. In addition, the emergency medicine physicians highlighted the importance of recognizing "actionable" ECGs—those that require immediate intervention.

## Discussion

In this mixed-methods study, we used the AHA ECG diagnostic labels to have participants prioritize ECG diagnoses. The ultimate goal was to inform local educators about potential curricular design related to ECG interpretation. The list of 120 ECG diagnoses used in this study comes from a consensus publication of the AHA and is also endorsed by the American College of Cardiology and the Heart Rhythm Society.[14] These 3 bodies are nonprofit medical associations that lead in delineating and disseminating the standards and guidelines for cardiology practice in the United States. Originally published in 2001, the list forms the basis of a more recent 2018 statement from the same organizations.[11]

In this study, all participants prioritized learning about discerning normal ECGs from abnormal ones, especially ECGs that are life-threatening, time-sensitive, or indicative of myocardial infarction. The themes identified by individual disciplines, such as pattern recognition and commonly mistaken/confusable diagnoses, provided additional perspectives. Nurses placed relatively more importance on normal rhythms, including sinus tachycardia and bradycardia, than did the physicians, highlighting their use of the ECG tracing as an early warning signal for monitored patients. As indicated by the nursing participants, "nurses may notice ECG changes first," and, as bedside providers, they should be able to identify abnormal ECG changes that are "reportable" to the provider and require an immediate course of action.

TABLE 2
**Ranking of "top 20" electrocardiogram diagnoses by discipline**

| Nurses AHA ECG labels | Total (N = 6) | Cardiology medicine AHA ECG labels | Total (N = 5) | Emergency medicine AHA ECG labels | Total (N = 7) |
|---|---|---|---|---|---|
| Normal ECG | 6 | Atrial fibrillation | 5 | Ventricular tachycardia | 7 |
| Atrial fibrillation | 6 | Atrial flutter | 5 | Ventricular fibrillation | 7 |
| Ventricular tachycardia | 6 | Ventricular tachycardia | 5 | AV block, complete (third-degree) | 6 |
| Ventricular fibrillation | 6 | Ventricular fibrillation | 5 | Posterior MI | 6 |
| Sinus tachycardia | 5 | AV block, complete (third-degree) | 5 | Hyperkalemia | 6 |
| Sinus bradycardia | 5 | Normal ECG | 4 | Atrial fibrillation | 5 |
| Supraventricular tachycardia | 5 | Supraventricular tachycardia | 4 | Ventricular tachycardia, torsades de pointes | 5 |
| AV block, complete (third-degree) | 5 | Ventricular tachycardia, torsades de pointes | 4 | Second-degree AV block, Mobitz type II | 5 |
| Sinus arrhythmia | 4 | Anterior MI | 4 | Anterior MI | 5 |
| Atrial flutter | 4 | Inferior MI | 4 | Inferior MI | 5 |
| Second-degree AV block, Mobitz type II | 4 | Anteroseptal MI | 4 | Acute pulmonary embolism | 5 |
| Sinus rhythm | 3 | Acute pericarditis | 4 | Acute ischemia | 5 |
| Ventricular tachycardia, unsustained | 3 | Extremity electrode reversal | 3 | Normal ECG | 4 |
| Second-degree AV block, Mobitz type I | 3 | Narrow-QRS tachycardia | 3 | Wide-QRS tachycardia | 4 |
| Prolonged QT interval | 3 | Ventricular tachycardia, polymorphous | 3 | Left bundle-branch block | 4 |
| Anterior MI | 3 | Ventricular preexcitation | 3 | Lateral MI | 4 |
| Inferior MI | 3 | Posterior MI | 3 | Acute pericarditis | 4 |
| Lateral MI | 3 | Lateral MI | 3 | Brugada abnormality | 4 |
| Right ventricular MI | 3 | Right ventricular MI | 3 | Digitalis toxicity | 4 |
| Hyperkalemia | 3 | Acute pulmonary embolism | 3 | Pericardial effusion | 4 |

Table results depict the number of participants who placed the diagnostic label into the category of "which of the following ECG diagnoses are the 20 most important?"
AHA, American Heart Association; ECG, electrocardiogram; AV, atrioventricular; MI, myocardial infarction.

This study provides an initial prioritization of the clinically relevant ECG diagnoses for emergency and acute care settings, using a process that is easily reproducible. This data can be a contribution to inform previously discussed national practice standards (eg, AHA ECG diagnostic labels).[9] Our process of local prioritization and customization of the national lists allows the content of emergency and acute care ECG training courses to match the clinical needs of the patient population served, as recommended by the AHA.[10]

The use of a mixed-methods design provided complementary perspectives on ECG ranking and educational importance. The quantitative ranking process was illuminated by the themes elucidated by the thematic analysis of the interview and focus group transcripts. Addressing a gap in the literature concerning ECG curriculum case selection and case prioritization, we provide emergency and critical care educators a place to start when developing or adapting their own ECG training intervention.

## Limitations

A limitation of this study includes differences in data collection procedures between nurses and physicians (individual interviews vs focus groups, respectively). Focus groups may differ from individual interviews in that they may allow

participants to express their ideas more freely as well as eliminate personal response biases. However, focus group dynamics are known to foster a bias toward consensus; individual interviews may allow contentious ideas to be probed more deeply, and they are less prone to issues related to group dynamics, such as having 1 participant or a few participants dominate the entire conversation.[15] Despite data collection differences, the quantitative and qualitative results were relatively consistent among the disciplines.

The results are also limited by the fact that the AHA diagnostic labels are only first-level labeling of an individual ECG case; for many ECGs, multiple diagnostic labels would apply. However, our process did allow a relative prioritization of this comprehensive list, and there are relatively few diagnoses that regularly co-occur in a way that would alter these prioritizations. In addition, the quantitative results may have misestimated the importance of myocardial infarction recognition owing to the relatively large number of myocardial infarction diagnoses (listed by all anatomic regions) provided in the AHA list.

The generalizability of our findings should be interpreted with appropriate caution, given that only 1 geographical region is represented, and the sample size was limited. However, this is the only study in this area providing interdisciplinary perspectives that may serve as a guide in the initial consensus process for ECG educational programs' case selection in emergency and acute care settings.

## Implications for Emergency Nurses

The results of this study, including comparative ECG rankings by discipline, can assist in curriculum development of ECG learning programs in nursing, medical, or multidisciplinary education in emergency or acute care settings. The themes identified can inform instructional designs as well. Content experts suggest that instructional designers prioritize the actionable diagnoses that are time-sensitive, such as malignant dysrhythmias, in their curriculum. In addition, well recognized was the duality of processes for reasoning through ECG diagnoses: pattern recognition tempered by a systematic "routine" to avoid missing diagnoses.[16] Other suggestions have been less commonly cited. For example, the less specific category of "reportable" ECG was identified as being of greater importance to nurses than was the precise determination of the diagnostic label. As a result, a curriculum designed for the novice ECG learner might be oriented to discriminating between "normal" and "not normal," with an emphasis on danger signs, instead of full integration of the findings into a mechanism-based diagnosis, although an appropriate response to ECG abnormalities—on the basis of the level of training and scope of practice—is a critical element in staff education.[10] A second example is the "confusable diagnosis" theme identified by some of the physicians. They suggested the importance of knowing how to discriminate among specific rhythms that otherwise might be confused, such as pericarditis and ST-elevation myocardial infarction. They believe that there is an educational necessity in finding confusable exemplars that allow the development of an acceptable level of proficiency.

Emergency and critical care educators (or hospital administrators responsible for staff development) play an essential role in helping nurses and physicians achieve competency in ECG monitoring and interpretation. Adequate ECG training programs should be part of the orientation process and should continue on an ongoing basis.[10] The American College of Cardiology has established guidelines for ECG training for fellows in clinical cardiology, including the training requirements and core competencies to be achieved.[17] However, there are no current guidelines for nursing ECG training that establish minimal competencies, educational standards, or ECG case selection—making nursing ECG education unique to each health care organization, service line, or care unit.[10] A scientific statement from the AHA that includes updated practice standards for ECG interpretation in hospital settings[10] recommends that "the content of electrocardiographic monitoring education needs to match the nature and complexity of the patient population served" (p. e321)—highlighting the importance of this study and future validation studies focusing on ECG case selection for educational programs that are specific to a hospital service or care unit. In response to the AHA's call to customize ECG education to local needs, our study method can be replicated when performing unit- or department-based needs assessment studies to validate ECG training content. Furthermore, consistent with study results, these practice standards make up a list of ECG diagnoses to include in ECG education, including normal rhythms, intraventricular conduction defects, bradyarrhythmias, tachyarrhythmias, premature complexes, and ECG abnormalities of acute myocardial infarction.[10]

It is important to highlight that our study results, including most of the top 20 ECG diagnoses selected across disciplines, correlate with the AHA Advanced Cardiovascular Life Support (ACLS)[18] and Pediatric Advanced Life Support[19] curricula, including normal sinus rhythm, pulseless rhythms (ventricular fibrillation, ventricular tachycardia, and pulseless electrical activity), bradyarrhythmias (heart

blocks), and tachyarrhythmias (supraventricular tachycardia, atrial flutter, atrial fibrillation, and wide-QRS tachycardia). Other top 20 ECG rhythms, including those indicative of hyperkalemia and acute pulmonary embolism (pulmonary thrombosis), may also be covered in ACLS courses under differential diagnoses or treatable reversible causes.[20] Although this is significant cross-validation of our process, by ranking all 120 diagnostic statements on the very granular AHA list, we hope to have aided the emergency or critical care educator who is charged with developing and evaluating ECG training programs at a breadth beyond focused courses. National courses (eg, ACLS, Pediatric Advanced Life Support, and imPULSE 3.0) or consensus expert groups (eg, AHA committees) can provide wide-ranging (yet valuable) ECG training courses and recommendations for emergency and acute care ECG curriculum development. Our process lies in the middle ground, allowing transparent multidisciplinary local customization of broad national recommendations.

As represented in this study, ECG curriculum development may be strengthened by using a multidisciplinary approach, including a team of experts who care for the same patient population. ECG learning and evaluation systems that rely on a single educator or on a few educators or program developers to select the cases presented to learners may present a threat to ECG curriculum validity. The perils of having a single educator, no matter how expert, predict which cases are relevant for learners are well described.[21,22] This potential suboptimal prioritization would be exacerbated in local situations where 1 discipline makes selections that would be used by another.

## Conclusions

In this study, nurses, emergency medicine physicians, and cardiologists demonstrated considerable agreement in ranking ECG diagnoses regarding their importance in the clinical context. Despite sample limitations, these ratings can provide initial steps in the ECG consensus process when prioritizing the teaching and learning of interpretation skills for various ECG diagnoses. With the continuous growth of ECG learning technologies, emergency and critical care nursing education may benefit from developing standardized curriculum and evaluation guidelines, which must be informed by more rigorous content validation studies for ECG case selection. More studies like this one are recommended among a larger diverse population of educators and frontline emergency and acute care nurses and physicians.

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## Author Disclosures

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## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.11.005.

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# Emergency Care EMTALA Alterations During the COVID-19 Pandemic in the United States

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**Contribution to Emergency Nursing Practice**

- The current literature on the Emergency Medicine Treatment and Active Labor Act, or EMTALA, indicates that although the statute has existed in US law since 1986, many health care practitioners are unfamiliar with the requirements of the Act and how they apply to them.
- During the 2020 coronavirus pandemic, changes to EMTALA and its enforcement have been enacted by the Department of Health and Human Services/Centers for Medicare and Medicaid Services, but many clinicians are unaware of how this affects their daily practice in emergency care.
- To practice to the best of our ability, knowledge of how emergency clinical practice, law, and regulation interact is critical, and this article gives a concise update for those in this clinical practice area.

**Abstract**

The coronavirus 2019 pandemic has affected almost every aspect of health care delivery in the United States, and the emergency medicine system has been hit particularly hard while dealing with this public health crisis. In an unprecedented time in our history, medical systems and clinicians have been asked to be creative, flexible, and innovative, all while continuing to uphold the important standards in the US health care system. To continue providing quality services to patients during this extraordinary time, care providers, organizations, administrators, and insurers have needed to alter longstanding models and procedures to respond to the dynamics of a pandemic. The Emergency Medicine Treatment and Active Labor Act of 1986, or EMTALA, is 1 example of where these alterations have allowed health care facilities and clinicians to continue their work of caring for patients while protecting both the patients and the clinicians themselves from infectious exposures at the same time.

**Key words:** Emergency Medicine Treatment and Active Labor Act; Coronavirus disease 2019; Emergency medicine; Telemedicine

The coronavirus disease 2019 (COVID-19) pandemic has affected almost every aspect of health care delivery in the US, and the emergency health care system has been hit particularly hard while dealing with this public health crisis. In an unprecedented time in our history, health care systems and clinicians have been asked to be creative, flexible, and innovative, all while continuing to uphold the important standards we trust in our US health care system. To continue providing quality services to patients during this extraordinary time, care providers, organizations, administrators, and insurers have needed to alter longstanding models and procedures to fit the contextual dynamics of the pandemic. Although there have understandably been some errors and confusion, there has also been some pivotal assistance from leaders during this upheaval. Provisions disseminated by the government issuing guidance regarding the Emergency Medicine Treatment and Active Labor Act of 1986 (EMTALA) are 1 example where quickly enacted changes assisted the

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US health care system in carrying on the business of caring for patients while ensuring safety in the middle of a worldwide health catastrophe.[1]

## The History of EMTALA and Emergency Medical Care in the US

In 1986, as part of the Omnibus Spending Act passed by Congress into law, EMTALA began to ensure patients were afforded protections when seeking care at emergency departments.[2] Under EMTALA, all persons seeking emergency care must be evaluated and stabilized by the health care team.[3] Before this landmark legislation was enacted, persons presenting to the hospital for emergent reasons were routinely turned away and denied proper care, often based on financial motivations.[4] In this much needed statute, lawmakers attempted to provide a threshold at which all patients would be entitled to emergent care when needed.[2] This administrative law was the first federal statute in the US to provide for an affirmative right to health care, irrespective of a patient's ability to pay for that care. In addition, the use of the term "duty to treat" became irrevocably tied to ED care in the US, whereas earlier there existed wide latitude afforded to providers in choosing who to see and who not to. In EMTALA, a clear exception to the "no-duty principle" was established for cases of emergency medical care, mandating that a duty to treat a patient does exist for emergency health care providers and facilities for all patients who present for care, regardless of prior relationship or ability to pay for services.[4]

The so-called "dumping" of patients based on their demographics or insurance has become a practice of the past, and health care entities and providers face stiff penalties if care is refused to anyone who meets the criteria under EMTALA.[5] Specifically, provisions were put into the application of the law to clearly identify what constituted an emergency medical condition and what qualified as seeking care. Persons were deemed to be able to decide for themselves if they needed to go the emergency department for care, with the prudent layperson standard stating that a "reasonable person with no medical training to devise that the situation is emergent, and care is needed" was sufficient.[4] In addition, the comes-to test was applied liberally in this new legislation, indicating that patients desiring medical evaluation who travel near, not just to the emergency department, should be considered under this rule.[2]

## Historical EMTALA Requirements

Since 1986, EMTALA has required that a medical facility's responsibility to a person presenting to the emergency department for care is twofold: a qualified medical screening examination must be provided and treatment given must be sufficient to achieve stabilization of the patient's presenting condition.[4]

### MEDICAL SCREENING EXAMINATION

Any patient presenting to the emergency department for what they have deemed to be an emergency, under the prudent layperson standard, must receive an appropriate medical screening examination by a clinician.[2] Generally, the examination must be performed by a licensed, independent health care provider denoted as a "qualified medical professional" or QMP (usually a physician, nurse practitioner, or physician assistant), and registered nurses, paramedics and other personnel are restricted from performing this duty based on their scope of practice.[1] There are no clear rules in the statute about what this examination must consist of, and so they may be cursory and lack any additional diagnostic evaluation, but the edict is clear that provider screening of any person who comes to the emergency department for care is mandatory.[4] There are many avenues to minimize impact of this requirement, but this burden must be met, as for facilities and clinicians this is a common foundation of EMTALA investigations from the Department of Justice.

### STABILIZATION OF THE PATIENT

If an emergent condition is identified during the medical screening examination, there is an obligation to treat the patient to the point of stabilization before discharge or transfer.[2] Under the provisos of EMTALA, sufficient treatment must be given before advising a patient to seek care elsewhere or continue self-care at home. To clarify, the law does not state that any presenting condition must always be treated in the emergency department to a point of resolution; just stabilization is required.[5] Transfers to another location or facility are particularly tricky under EMTALA, and require stabilization of the patient and certifying the medical necessity of the transfer to the receiving facility, or the burden of the statute has not been met by the provider.[4]

## EMTALA in the Age of COVID-19

During the COVID-19 public health crisis in the US, deviations to standard practice became necessary to provide care to patients. The current pandemic emergency challenges health care systems to balance the need for extraordinary measures to ensure patient and staff safety and the desire to preserve the delivery of exemplary patient care.[3] Individuals and systems have struggled to balance their 2 primary goals during this emergency: protecting patients and staff from the risk of infection and continuing to ensure each person receives safe, prompt care.[6]

### 1135 WAIVERS

Early on in the pandemic in the US, official guidance on how to relieve some of the mounting pressure on US emergency departments came from the Department of Health and Human Services (HHS)/Centers for Medicare and Medicaid Services (CMS).[1] As a result of emergency declarations made by the US President and Section 1135 of the Social Security Act, a waiver to lighten restrictions historically imposed by EMTALA on facilities and providers was possible.[3] In a directive distributed to the health care community in March of 2020, CMS announced "aggressive actions [in] exercising regulatory flexibility" surrounding the requirements for compliance with EMTALA during the COVID-19 emergency.[7] These 1135 waivers, as they are known, are broad and can apply to many other legal statutes, including Stark and Stafford laws, and have ramifications for almost every aspect of patient care in various types of facilities. This waiver is termed a "blanket" and thus applies to all US emergency departments, and facilities do not have to apply individually for these protections.[1] These exceptions to EMTALA do not nullify the responsibility of facilities and providers with regard to patients seeking emergent care, but they do alter what constitutes providing a qualifying examination and stabilizing treatment to satisfy EMTALA responsibilities.[3]

## How EMTALA has been Altered

The 2 major traditional provisions in EMTALA that were altered during this time are: (1) the ability to redirect individuals to on- or off-site alternative locations for their mandated medical screening examination and (2) allowance to transfer patients who are not medically stabilized fully.[7] In addition, and of note, during this time under the emergency order, CMS waived the necessity for a Medicare or Medicaid patient to be under the direct care of a physician, encouraging the use of "other practitioners to the fullest extent possible," which is a monumental step forward for advanced practice providers in the US.[1,7] Physician assistants and nurse practitioners are suitable QMPs according to CMS, and with this loosening of the oversight requirement, their ability to function as an invaluable part of the emergency department is enhanced.[6]

### CHANGES TO MEDICAL SCREENING EXAMINATION

To the first point, the allowance to defer the immediate medical screening examination of a person seeking care at an emergency department "for the direction or relocation of an individual…to an alternate location" was included in this publication by CMS.[7] Under this change, patients may be directed prior to entering the emergency department to present elsewhere to begin their evaluation and the alternative location can be on- or off-campus from the emergency department itself.[1] During a time of very scarce health care resources, such as during this pandemic, focusing on patients who necessitate emergency management, and triaging those who do not to alternative locations, maintains quality delivery of care while prioritizing safety of everyone involved.[3] Facilities can encourage the community to use settings other than a hospital for screening under this policy alteration to decrease ED use, but CMS does encourage facilities to plan how to handle more emergent cases that present to these locations inappropriately.[1] Posting signage and advertising that directs individuals to go to these alternate locations for screening and treatment is allowable, but should not create unreasonable barriers for patients seeking care. Specifically, under this statutory change, as long as the medical screening examination is performed by a QMP and care is given accordingly, persons presenting to the physical facility of the emergency department need not be seen at that time/place.

In addition, telemedicine, which, in the past, has been less used in the emergency department, was also clearly emphasized as an option for evaluation and treatment of patients during COVID-19.[1] QMPs may be on- or off-location while providing telehealth services and, as long as they act within their scope of practice, they will be able to bill at full, appropriate E/M CPT codes. Telemedicine is described, in a situation such as this pandemic, as being an "electronic Personal Protective Equipment," providing an efficient and safe alternative means to evaluate patients.[6]

### ALTERATIONS IN STABILIZATION/TRANSFER PLANS

Secondly, changes to the process of transferring patients, which includes discharge from the facility, was altered under the waiver for EMTALA in 2020.[4] Traditionally under

EMTALA, this transfer requirement mandates that persons seeking care in the emergency department must be given sufficient treatment to stabilize them from likely deterioration of their condition. However, under this new, revised statute under the COVID-19 alterations, this does not have to be the case.[5] What in the past may have been deemed an inappropriate transfer would now be acceptable under EMTALA provided the discharge or transfer is necessary based on the current declared emergency situation, as long as the facility is operating in compliance with local/state emergency plans.[1] Care still needs to be taken to ensure risks to the patient (or unborn child) are minimized as much as possible; however, transfer of an individual who has not yet been stabilized medically is potentially allowed.

## Limitations on EMTALA Waiver

It is important to remember that the term blanket waiver refers to the edict affecting the entire country as a whole and covers all health care entities and providers.[1] This blanket waiver allows all facilities to make changes to their practice and procedures without applying to CMS directly for individual variances. It does not indicate, however, that there is a wholesale suspension of EMTALA or protection against prosecution for unlawful violation of this statute. In fact, most of the requirements of the law remain in force. For example, an unlawful violation would involve creating signs or public posts that create real or perceived barriers to seeking care.[7] Further, aligning alternative plans for patient care with current state and local emergency actions is critical to remain in compliance.[7] Entities must still be very careful to ensure they are providing the required medical screening examination by qualified professionals to protect themselves from possible investigation and/or litigation. The 1135 waivers are only intended to allow extra flexibility with providing the required screening examination and services to patients during this time of national emergency.[1]

## The EMTALA Waiver in Practice

Since the publication of the HHS COVID-19 Guidelines in March of 2020, health care facilities have used the flexibility provided in this document to creatively sustain patient care during the pandemic. Many examples can be found in the current literature of how this newfound flexibility has allowed creative, potential solutions to the crisis in our emergency departments to be implemented.

### EXAMPLE 1: ON-SITE ALTERNATIVE

One example of this flexibility is the Surge Clinic designed by Massachusetts General Hospital.[8] In this plan, an alternate area was designed, adjacent to but separate from the existing emergency department, to handle evaluation and treatment of noncritical patients. Often these persons arrived at the request of primary care providers, and if inclusion criteria were met upon discussion with a staff provider, limited testing and discharge could be accomplished in the ambulance bay without traditional ED management. This model, highlighting the use of an alternate on-site location for providing the medical screening examination to patients, has worked optimally to serve patients while limiting the possible infectious exposure of the main ED patients and staff.[1]

### EXAMPLE 2: TELEHEALTH SERVICES

Another example of using the EMTALA waiver in the emergency department is from Baylor Scott and White Medical Facilities in Texas. Here, the facility employed telemedicine to screen presenting ED patients.[9] Whereas in the past, telemedicine was used to overcome a physical barrier between provider and patients, here it was harnessed to provide a physical barrier and protection against COVID-19 exposure. Because of the expansion CMS allowed specifically for ED clinicians to bill for telehealth services in the EMTALA waiver announcement, this method of protecting against infection by avoiding face-to-face interaction was possible. In this example, once isolated by staff, high risk patients can be evaluated by a clinician remotely via videoconference on an iPad, thus satisfying the requirement for both audio and video components of the visit to allow for full E&M billing.[1]

### EXAMPLE 3: OFF-SITE ALTERNATIVE

Finally, diverting patients to a separate off-site setting for care has become an option during our current health care crisis.[3] In a novel idea for delivery of patient care under the EMTALA waiver, members of the American Dental Association have suggested partnerships with local dental facilities to see patients presenting to the emergency department with isolated dental issues. As a result of the exception carved out by HHS during COVID-19, the 79% of patients with dental emergencies who initially present to the emergency department could be, immediately and legally, diverted to a local oral health provider. Situations such as the 1 described here would need additional approval by CMS, unless the 2 entitles are owned or operated by the

same company, but it is another example of resourcefulness during this pandemic.[7] Redirecting patients who meet criteria to such off-campus options will decrease consumption of valuable ED time and resources and will minimize the risk of nosocomial exposures for the patient.[3]

## Conclusion

In the midst of a global pandemic, and resulting toll on health care in the US, it is unclear how long the need for measures such as the COVID-19 emergency declaration and its related waivers will exist. The current legal and regulatory provisos will remain active at least until any emergency order currently in place in the US is allowed to expire.[7] Thus far, the emergency declarations and waivers have provided much needed relief to emergency departments, allowing flexibility and creativity with plans to continue providing high-quality care to patients while protecting those same patients and their own workforce.[1] EMTALA is a landmark piece of legislation, providing legal protections to citizens who were often neglected or purposefully overlooked, and has stood up to challenges since its passage in 1986.[4] However, during the COVID-19 pandemic public health crisis we are in currently, appropriate relaxations of some of the provisions of the statute have allowed facilities and clinicians to continue their work of caring for patients with protection from infectious exposures.

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**Submissions** to this column are encouraged and may be submitted to jenonline.org. Authors are encouraged to seek presubmission guidance from Darleen Williams, DNP, CNS, CEN, CCNS, CNS-BC, EMT-P, darleenw.JENAP@gmail.com.

# Transcutaneous Pacing: An Emergency Nurse's Guide

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## Abstract

Transcutaneous pacing is commonly performed in emergency departments to treat patients with cardiac dysrhythmias. Although emergency nurses are required to complete a standardized course that reviews components of transcutaneous pacing, such as Advanced Cardiac Life Support, performing transcutaneous pacing on patients may be done infrequently in some facilities and can lead to anxiety and fear for bedside emergency nurses, especially novice emergency nurses and nurses who infrequently care for patients requiring external pacing. This manuscript provides a practical guide for emergency nurses to care for patients who require transcutaneous pacing. Key information found in this manuscript includes indications for transcutaneous pacing, the nurse's role when performing transcutaneous pacing, and transcutaneous pacing troubleshooting information.

**Key words:** Cardiac Pacing; Transcutaneous; Arrhythmias; Electrical Stimulation Therapy; Emergency Nursing

## Introduction

Cardiovascular dysrhythmias are 1 of the most common causes of ED visits among adults aged 65 years or older.[1] The number of patients seeking care for cardiovascular emergencies will continue to increase as a result of the growing number of aging people in the "baby boomer" generation (1946-1964 birth years) with cardiovascular disease.[2] Therefore, it is important that emergency nurses feel confident when providing care for these patients during cardiovascular emergencies. Treatments of cardiac dysrhythmias can include a combination of medications, defibrillation, pacing, and/or cardioversion. The goal of this manuscript is to provide emergency nurses with a practical guide on the application and use of transcutaneous pacing (TCP) on the basis of current evidence-based practice recommendations and current clinical guidelines. Although the guidelines for TCP have not changed, it is important to ensure that novice nurses are adequately prepared to manage patients presenting with cardiovascular emergencies. Continuing education and training on critical skills are increasingly important owing to the increased number of novice nurses entering critical care environments as a result of a large number of experienced nurses retiring from practice.[3]

## What Is TCP and When Is It Used?

TCP is a temporary treatment option or therapeutic bridge that can be initiated to stabilize a patient until the cardiac functioning recovers or until more permanent treatment options are available; it is never a replacement for permanent pacing options.[4,5] The goal of TCP for patients with bradycardia is to increase the heart rate so that cardiac output is normalized and the perfusion of brain and other end organs is maintained to meet the physiologic demand.[5,6]

TCP is most commonly used in the ED setting to treat patients presenting with bradycardia who are unresponsive to pharmacologic therapy and/or experiencing signs of clinical instability, such as systolic blood pressure less than 90 mm Hg, heart rate less than 40 beats per minute (bpm), or an arrhythmia that is compromising organ perfusion.[4,5] TCP temporarily re-establishes regular electrical activity when the electrical conduction of the patient's heart is abnormal; it works by monitoring the patient's cardiac rate and rhythm and supplying pacing impulses through the skin and muscle tissue in the chest wall to cause

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depolarization and subsequent cardiac contraction to promote cardiac output.[5]

The American Heart Association recommends that TCP be immediately initiated for patients with symptomatic bradycardia if atropine sulfate fails to alleviate the bradycardia.[4] TCP should also be considered when more invasive methods of pacing are not recommended, for example, in patients with the potential for excessive bleeding, an increased potential for infection, or where placement of a temporary wire might be difficult. TCP can be used to stabilize patients presenting to the emergency department with the aforementioned issues. Therefore, it is important for emergency nurses to possess clinical competency when caring for patients requiring TCP.

## Emergency Nurses' Role in TCP

Before performing any type of pacing, if possible, it is important that the patient and family are notified of the treatment plan and given an explanation of the procedure. External pacing can create patient discomfort owing to skeletal contractions associated with pacing and cutaneous nerve stimulation.[4,7] The pain level can vary, depending on the level of current delivered to the patient and the level of anxiety that the patient is experiencing. If feasible, depending on the hemodynamic stability of the patient, sedation or analgesia should be considered to improve the patient's level of comfort during the procedure.[4,7]

Necessary supplies to perform TCP include an electrocardiogram (ECG) monitor, ECG electrodes and cables, pacing electrodes and cables, and the defibrillator device.[7] Patient preparation interventions include preparing the skin for electrodes, removing excessive chest hair, and cleaning and drying the skin.[5] ECG electrodes should be positioned as distant from the pacing electrodes as possible to promote a clear ECG signal and reduce interference of the ECG signal by the pacing current.

Pacing electrodes may serve many functions, including monitoring, defibrillation, and pacing, although some are single-function electrodes that only allow for pacing. It is important that the emergency nurse determine what type of supplies their facility has on hand before performing the procedure to promote the safety and effectiveness of the procedure. Pacing electrodes can be applied on the patient using various types of placement. The manufacturer's recommendations for the application of pacing electrodes should be followed. It is important to ensure that the reversal of electrode placement does not occur because this can result in failure to capture or extremely high capture thresholds.

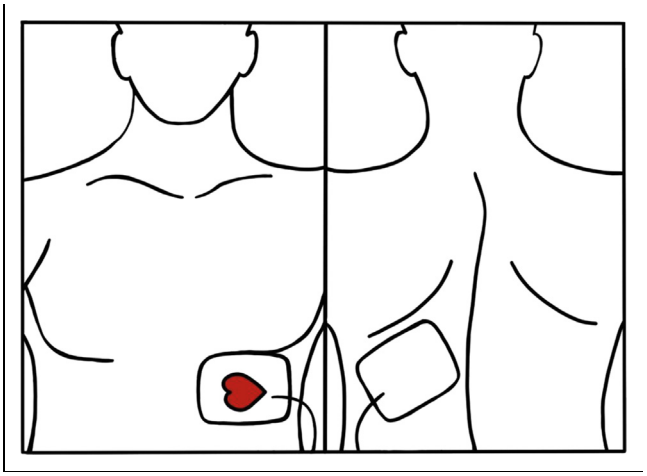

FIGURE 1

Anterior-posterior pad placement. (Illustrations: Casey Adams, BSN, RN, CEN.)

The most common pacing electrode placement for TCP is anterior-posterior placement, which is performed when the anterior electrode is placed on the left anterior chest wall, halfway between the xiphoid process and the left nipple at the apex of the heart (avoiding placement over the nipple, diaphragm, or sternum).[7,8] The posterior electrode is then placed on the left posterior chest beneath the scapula and lateral to the spine at the heart level (avoiding placement over the bony prominences of the spine or scapula) (Figure 1).[7] In female patients, breast tissue may need to be lifted out of the way to ensure that the electrode can adhere firmly to the skin beneath the breast. The anterior-posterior position is the preferred method because it minimizes electrical impedance by "sandwiching the heart" between the 2 pads.[8] The anterior-lateral placement may also be used when performing TCP, which is performed when the lateral electrode is placed on the left anterior torso, just lateral to the left nipple in the midaxillary line, and the anterior electrode is placed in the right subclavicular area lateral to the sternum (Figure 2).

It is important to note that pacing electrodes and equipment compatibility may vary from unit to unit in the same facility and from emergency medical services (EMS) to hospital. The nurse should anticipate potentially needing to reapply pacing pads using the facility-specific equipment and have supplies ready to prevent delays in treatment, which can result in poor patient outcomes. For example, if a patient who is actively being paced arrives to the emergency department from EMS, the emergency nurse may need to replace the pacing pads and ECG electrodes on the patient to ensure equipment compatibility and to

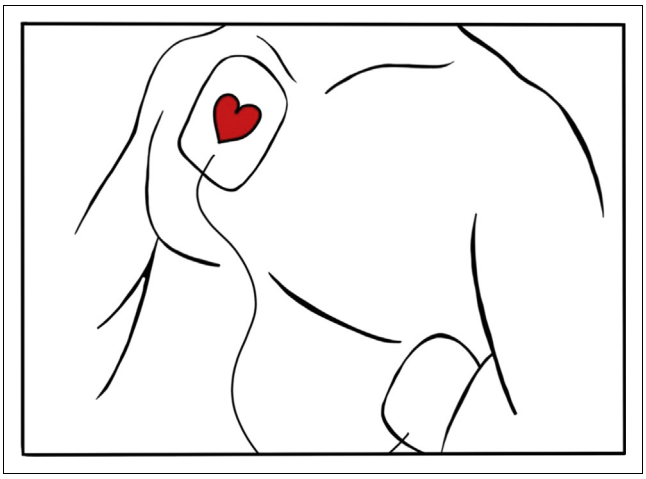

FIGURE 2

Anterior-lateral pad placement.(Illustrations: Casey Adams, BSN, RN, CEN.)

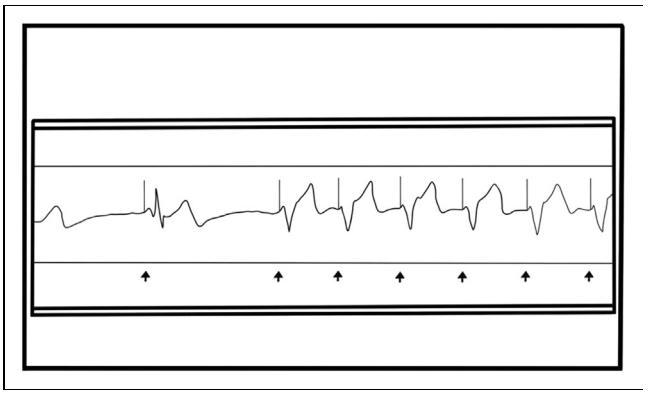

FIGURE 3

Electrocardiogram demonstrating pacemaker capture. (Illustrations: Casey Adams, BSN, RN, CEN.)

avoid delays in TCP. New pads should be applied and be ready to begin treatment before removing the noncompatible pacing pads from EMS or a transferring facility. Precautions should be taken to ensure that noncompatible pacing pads are not removed prematurely to ensure that therapy is continued. In addition, it is important to ensure that the pacing pads and wires are not damaged, removed, or cut when transferring patients onto the ED stretcher or when clothing is removed on arrival to the emergency department.

After application of the pacing electrodes, the pacing device should be turned on, and the pacing mode (demand or fixed) should be selected. The demand or synchronous mode is preferred, if available, because it paces only when the patient's heart rate falls below the level set by the operator.[7] The fixed or asynchronous mode paces at the rate set by the operator, regardless of the patient's actual heart rate.[7] This mode is not preferred; it is usually used when the pacer cannot adequately sense the patient's heart rate or when an ECG artifact prevents the pacer from adequately sensing the patient's heart rate.[7]

When setting up the pacing device, the pacing current should remain at 0 mA until the prescribed pacing mode has been set, and proper sensing of the device has been verified. Sensing refers to the pacemaker's ability to recognize the electrical activity of the heart.[7] The current can then be increased until capture is recognized (Figure 3). Electrical capture refers to the depolarization of the ventricles that occurs as a result of the pacing stimulus and is represented on the ECG monitor indicated by a wide-complex QRS after every pacer spike.[6] It is important to increase the current level slowly while assessing for capture in patients who are conscious to decrease discomfort. However, in unresponsive patients or code situations, the current can be increased quickly and adjusted downward to threshold when capture is obtained. The prescribed pacing rate should be selected to ensure adequate perfusion; the common range in adult patients is 60 bpm to 80 bpm.[6,8] The American Heart Association recommends an initial starting rate for TCP of 60 bpm and to adjust it up or down on the basis of the patient's clinical response.[4] The dose for pacing is set at 2 mA above the dose that produces observed capture.[6]

While performing TCP, it is necessary to continuously monitor the patient's ECG and to assess for mechanical and electrical capture. Mechanical capture is the contraction of the heart and is recognized by confirming a pulse that matches the set pacemaker rate by palpation; echocardiogram; pulse oximetry; arterial waveform; and signs of increased cardiac output, including increased blood pressure, increased level of consciousness, and improved skin color and temperature.[6,8] A quick guide to implementing TCP is found in Table 1.

## Troubleshooting

When performing TCP on a patient, the nurse may experience multiple unexpected issues that they will need to address, including pain; failure to capture; excessive artifact; undersensing or oversensing; and, rarely, cutaneous burns.[6] Some patients may experience discomfort that becomes intolerable during the procedure. Research indicates that without sedation and analgesia, most patients are unable to tolerate pacing currents above 50 mA.[9] Therefore, analgesia and sedation should be considered for patients. Pacing electrode repositioning may also be considered to reduce discomfort.[7] Pain levels should be continuously reassessed and managed while the patient is receiving TCP.

TABLE 1
**Quick guide to transcutaneous pacing**

| Steps |
|---|
| 1. Locate pacer/defibrillator and obtain pacer pads. |
| 2. Place ECG leads on the patient at the appropriate site. |
| 3. Apply pacer pads to the patient at the appropriate site. |
| 4. Connect ECG monitor and pacer/defibrillator device per manufacturer's specifications (if using an external ECG monitoring device). |
| 5. Turn on the pacer/defibrillator ensuring that pacer mode is selected. |
| 6. Confirm that the pacer/defibrillator is displaying the patient's 5-lead ECG rhythm. |
| 7. Set milliamperage and rate per provider's prescription:<br>Rate: Initial starting rate of 60 bpm (recommended adult rate) and adjust as needed.<br>Milliamperage: Initial starting dose of 0 mA, adjust until capture is observed, set at 2 mA above the amount that produces observed capture. |
| 8. Begin pacing. |
| 9. Observe the patient closely for response. |
| 10. Adjust pacer settings as needed on the basis of the patient's response and condition. |

ECG, electrocardiogram.

A common complication that the nurse may face when performing TCP is failure to capture (Figure 4). This is often a result of failing to increase the pacing current to a sufficient level to electrically stimulate the heart.[8] Capture thresholds will vary on the basis of the patient and may change over time during treatment. The current must be increased to ensure that electrical capture occurs, or the treatment will be ineffective. Repositioning of the pacing electrodes may also facilitate capture if the nurse is still experiencing failure to capture after an increase in the pacing current level.[7]

Excessive artifact or noisy ECG signals on the ECG monitor may also occur. This can be addressed by ensuring adequate skin preparation or moving the ECG electrodes farther away from the pacing electrodes. ECG signal noise or excessive artifact may also be a result of electromagnetic interference caused by equipment in close proximity, including cell phones or radios. This can be addressed by ensuring that adequate distance is maintained between the patients and electromagnetic interference sources. The emergency nurse should make sure that no person uses their mobile phone or other electronic devices near the patient because this may interfere with the pacing unit.[5]

Finally, undersensing and oversensing can occur while performing TCP. Sensing is the ability of the pacemaker to identify electrical activity of the myocardium. Undersensing can take place when the pacemaker does not sense activity and delivers a pace pulse.[8] Oversensing happens when detection of signals other than the R wave signal, such as muscle artifact or T waves, occurs, leading to an ineffective or inadequate pace rate.[8] Both these issues can be addressed by repositioning the ECG electrodes or selecting a different monitoring lead. Applying new ECG electrodes with appropriate skin preparation may also be necessary to address the issue.

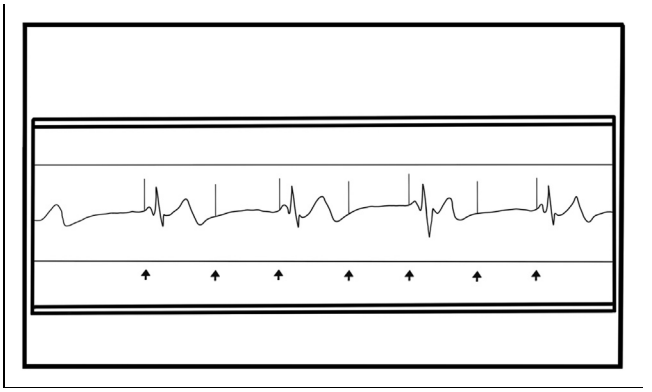

FIGURE 4
Electrocardiogram demonstrating failure to capture. (Illustrations: Casey Adams, BSN, RN, CEN.)

## Clinical Considerations

When performing TCP, the patient should never be left unattended. To ensure safety of both the patient and health care personnel, it is important to ensure that the electrodes are properly adhering to the chest and that the area is kept as clean and dry as possible. It is safe to touch the patient during TCP, and procedures such as cardiopulmonary resuscitation can be performed. However, it is important to avoid contact with the conductive surface of the pacing electrodes to avoid transmission of the pacing current to the health care personnel. Universal precautions should be used when performing procedures on a patient receiving TCP therapy. Gloves are recommended to improve the safety of both patients and health care providers.

The emergency nurse should continuously monitor for signs of adequate perfusion, including blood pressure, level of consciousness, skin color, and temperature to monitor the effectiveness of the treatment. In addition, the patient's ECG monitor and pain level should be continuously monitored during TCP therapy to identify and address potential treatment complications. Charting should include rhythm strips before and during pacing, the selected pacing rate and the pacing current (in mA) required to perform adequate

TABLE 2
**Internet links for resources to guide health care professionals to understand TCP**

| Resource | URL |
|---|---|
| Up-to-date TCP recommendations | https://cpr.heart.org/ https://www.ahajournals.org/ |
| Additional detailed TCP information and instructions | https://www.elsevier.com/__data/assets/pdf_file/0019/271027/ch0049.pdf |
| TCP skills checklist | http://www.micunursing.com/transcut.htm |
| Patient education on cardiac pacing | https://www.uptodate.com/contents/pacemakers-beyond-the-basics |
| TCP information video | https://www.medmastery.com/magazine/mastering-transcutaneous-pacing |

TCP, transcutaneous pacing.

pacing on the patient, the patient's response to the treatment, and any medications administered to the patient. Rhythm strips should be printed and included in the patient's chart after any acute changes to the patient's rhythm or after any modifications to the pacing rate and/or pacing current (in mA).

It is important for the nurse to follow the provider's prescription orders regarding pacing settings and to notify the provider immediately of any potential complications or signs of decreased cardiac output and perfusion. If TCP is ineffective, it may be necessary to prepare for alternative emergency treatment options, including the insertion of a transvenous pacemaker. The emergency nurse needs to be prepared for alternative treatment options if TCP is ineffective and should have a transvenous pacer system kit and atropine at the bedside.[5] Treatment for a patient experiencing symptomatic bradycardia may also include the administration of an intravenous chronotrope medication such as EPINEPHrine or DOPamine.[4]

Owing to the temporary nature of TCP, it is important for the emergency nurse to be prepared for the transfer of patients to an outside facility or an inpatient specialty area for further treatment. Patients must continue to receive TCP during transfer; therefore, pacing pads and equipment must be transported with the patient. The patient will need to be continuously monitored by a licensed clinician and frequently reassessed to ensure adequate capture and perfusion during transfer. Additional resources to assist the emergency nurse with TCP can be found in Table 2.

## Conclusion

TCP is a valuable therapeutic technique in emergency settings to temporarily support adequate cardiac output and tissue perfusion to patients experiencing cardiac dysrhythmic emergencies. TCP can be rapidly initiated to stabilize patients and improve their outcomes. Emergency nurses should be adequately prepared to implement TCP and care for patients requiring TCP therapy in the ED setting.

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**Submissions** to this column are encouraged and may be submitted to jenonline.org where submission instructions can be found in the Author Instructions. Presubmission guidance may be offered by Amber Adams, Section Editor, at bcamber19@gmail.com.

# Emergency Nursing Review Questions: March 2021

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**Section Editor:** Carrie A. McCoy, PhD, MSPH, RN, CEN

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. The nurse is caring for a patient admitted to the emergency department with possible neuroleptic malignant syndrome. Which of the following would be an expected assessment finding in this patent?
   - **A.** Flaccid muscles
   - **B.** Hypothermia
   - **C.** Bradycardia
   - **D.** Diaphoresis
2. An older patient with mild shortness of breath and fever is brought to the emergency department by their spouse. The spouse states that their partner has Alzheimer disease. While triaging this patient, which of the following would be an appropriate intervention while providing person-centered care to this patient?
   - **A.** Avoid direct eye contact.
   - **B.** Ask open-ended questions.
   - **C.** Give step-by-step instructions while placing the blood pressure cuff.
   - **D.** When assessing orientation, correct errors in orientation as they occur.
3. Which of the following patients presenting to the emergency department with a wound has the highest priority?
   - **A.** A 70-year-old farmer with erythema around a tick bite discovered 24 hours ago
   - **B.** A 6-year-old child who was bitten on the leg by a dog 3 hours ago
   - **C.** A 50-year-old construction worker who stepped on a spike that went through his dirty work boot
   - **D.** A 65-year-old patient with diabetes who has erythema and crepitation around a laceration sustained 24 hours ago
4. In a patient with trauma being treated for hemorrhagic shock, the nurse should plan care to address which of the following problems associated with coagulopathy?
   - **A.** Alkalosis
   - **B.** Hypothermia
   - **C.** Hypocalcemia
   - **D.** Hyperkalemia
5. A patient with diabetes with history of an earache for the past week is brought to the emergency department by family. They report that the patient has suddenly developed a fever and a headache. They also report that the patient is sensitive to light and becoming confused. On the basis of this patient's history and presentation, the nurse would anticipate diagnostic tests for which of the following?
   - **A.** Bacterial meningitis
   - **B.** Subarachnoid hemorrhage
   - **C.** Otitis externa
   - **D.** Brain abscess

## ANSWERS

1. Correct answer: D

Patients with neuroleptic malignant syndrome present with severe muscle rigidity, hyperthermia, and autonomic central nervous system changes. Diaphoresis, elevated blood pressure, and tachycardia are often seen in early stages of the condition. The severe muscle contraction can lead to elevated serum creatine levels and decreased renal function from myoglobinuria. Neuroleptic malignant syndrome is associated with dopamine antagonist medications or rapid withdrawal of these medications. Interventions are directed

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at removing the cause as well as providing supportive care to address dehydration, cardiovascular instability, prevention of renal failure, and restoration of normothermia.[1]

2. Correct answer: C

When caring for patients with dementia, such as a patient with Alzheimer disease, explain each step in a process or activity such as applying a blood pressure cuff. Communication with patients with dementia, such as a patient with Alzheimer disease, includes both verbal and nonverbal communication. Nonverbal communication begins with approaching the patient from the front and establishing eye contact; a gentle touch is also appropriate. It is important to avoid open-ended questions because short-term–memory issues may make it difficult for the patient to respond to these types of questions. When assessing orientation, if the patient makes an error, rather than correcting them directly, incorporate this information into your conversation with them.[2]

3. Correct answer: D

All these patients need attention. However, the 65-year-old patient may be exhibiting signs of a necrotizing soft-tissue injury (NSTI). NSTIs need immediate evaluation and treatment because this condition can rapidly progress to sepsis. In addition to antibiotics, NSTIs require surgical debridement. NSTIs are rare, and the initial symptoms may be subtle, but they can result in a deep soft-tissue injury called necrotizing fasciitis. Patients at higher risk are those with comorbidities such as diabetes, immunosuppression, alcoholism, or obesity. A classic symptom is extreme pain or tenderness that is out of proportion to the injury's appearance, but this symptom may be blunted in a patient with neuropathy.[3]

4. Correct answer: B

In the patient with hemorrhagic shock, coagulopathy can be worsened by hypothermia and is detrimental to coagulation, even in the absence of acidosis, which also reduces the ability to form effective clots. Calcium and potassium levels are not associated with coagulopathy. However, these levels should be monitored because alterations in acid-base will affect potassium levels, and administration of blood products may affect calcium levels. Patients may become hypocalcemic after massive transfusions of blood products owing to binding of calcium by citrate used in anticoagulation of blood products.[4]

5. Correct answer: A

This patient is exhibiting signs and symptoms of bacterial meningitis, which include high fever, severe headache, photophobia, nuchal rigidity, and mental status changes. The risk factors include compromised immune system, diabetes, otitis media, and dormitory-style living. In this case, the patient's diabetes contributed to the risk of bacterial meningitis when the infection invaded the meninges. Subarachnoid hemorrhage would not include a fever. Otitis externa would include external symptoms such as ear drainage but is not associated with neurologic symptoms. Brain abscess can be caused by otitis media, but fever is not always present, and the symptoms are more similar to a space-occupying lesion.[5,6]

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Send submissions to Carrie McCoy, PhD, MSPH, RN, CEN at: MCCOY@nku.edu or submit five questions with rationale and references directly to *JEN*.

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# Cardiopulmonary Resuscitation Feedback: A Comparison of Device-Measured and Self-Assessed Chest Compression Quality

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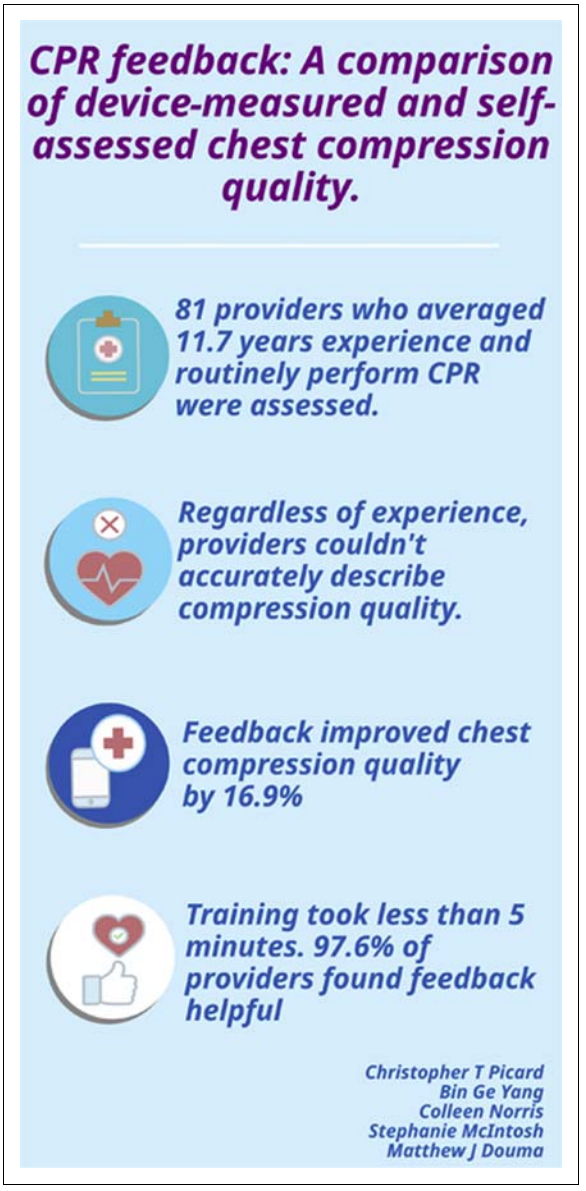




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# Cardiopulmonary Resuscitation Feedback: A Comparison of Device-Measured and Self-Assessed Chest Compression Quality

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CE Earn Up to 10.5 Hours. See page 359.

**Contribution to Emergency Nursing Practice**

- Chest compression feedback devices can improve the quality of chest compressions. International guidelines have supported the clinical use of chest compression feedback devices since 2010, and in 2021, will make them mandatory for basic life support training. Despite this, feedback devices have not been broadly incorporated into clinical care.
- This article suggests that ED providers overestimate the quality of their chest compressions and cannot accurately assess the quality of chest compressions and that chest compression feedback devices can yield immediate and significant improvements in chest compression quality with minimal training.
- Chest compression feedback devices are modestly priced and could be considered for both training and clinical care.

## Abstract

**Background:** High-quality cardiopulmonary resuscitation is the foundation of cardiac arrest care. Guidelines specify chest compression depth, recoil, and rate, but providers often fail to achieve these targets. Furthermore, providers are largely unable assess the quality of their own or other peoples' chest compressions. Chest compression feedback devices can improve chest compression quality; their use is endorsed internationally, but they remain largely absent in clinical care.
This article analyzes preclinical data collected during a quality improvement project. It describes provider demographics and perceptions about their chest compression quality and correlates them to measured chest compression quality, compares clinician perception of chest compressions to objective measures, and describes the effect of feedback on compression quality.

**Methods:** Clinicians were recruited from 2 metropolitan emergency departments. A questionnaire was used to assess participants' levels of training and experience. A before-and-after assessment of chest compression quality was performed using a Laerdal CPRmeter 2 and a CPR mannequin. Pretest measures of chest compression quality were made by covering the device screen thereby blinding providers to feedback; repeat measures were then collected from the same participants but unblinded to feedback. Provider charecteristic were collected by survey. Correlations

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between blinded chest compression quality and provider charecteristics; the reliability of providers estimated compared to measured quality; and the effects of feedback on chest compression quality were assessed using Pearsons correlations, Cohens $\kappa$, and paired $t$ testing.

**Results:** 84 participants were assessed. The mean years of certification were 11.74. Ninty-five percent of the providers self-assessed as more experienced than novice and 81% reported performing cardiopulmonary resuscitation at least occasionally. The frequency of performing chest compressions was correlated with self-assessed skill ($r = 0.58$, $P < .001$). However, self-assessed skill was only weakly correlated with chest compression quality ($r = 0.29$, $P = .01$) and not at all with the frequency of performing chest compressions or years of certification. There was no agreement between self-assessed and device-measured chest compression depth ($\kappa = -0.10$, $P = 0.11$), recoil ($\kappa = -0.14$, $P = .03$), or rate ($\kappa = 0.06$, $P = .30$). The overall quality of compressions improved by 16.9%; the percentage of chest compressions achieving target depth by 3.58%; recoil by 22.82%; and rate by 23.66% with feedback. A total of 97.6% of the staff rated chest compression feedback helpful.

**Conclusions:** Our findings suggest that participants' demographics were not correlated with chest compression quality and that providers cannot reliably assess chest compression quality. The data also demonstrate that with minimal training, feedback can significantly improve chest compression quality.

**Key words:** Cardiopulmonary resuscitation; Feedback; Quality improvement; Chest compression; Resuscitation

## Introduction

An out-of-hospital cardiac arrest is the third leading cause of death in Europe.[1] High-quality chest compressions are an important intervention for cardiac arrest that can improve defibrillation success,[2] return of spontaneous circulation,[3,4] and neurologically intact survival.[5] International guidelines promote high-quality chest compressions.[6] Unfortunately, chest compressions are often suboptimal; even trained providers fail to achieve adequate compressions much of the time during training and resuscitation.[7,8]

Advanced measures for monitoring chest compressions such as end-tidal carbon dioxide and invasive blood pressure monitoring offer important feedback and prognostic data but have limitations. End-tidal carbon dioxide monitoring can be deployed with blind insertion airway devices, and the values can be used to prognosticate clinical outcomes, but there are no established parameters for using the values to guide chest compression metrics (depth, recoil, rate).[6] Invasive blood pressure monitoring offers feedback on the hemodynamic response to compressions but is typically only available in critical care environments. Most providers report using no form of objective compression feedback.[9-11] Compression feedback devices have been shown to significantly improve compression quality in preclinical settings.[8,12] Although survey data suggests most providers would use feedback devices if the resources and funding were available to do so,[9] they are unavailable in many practice areas,[9,10] and there is a paucity of direct evidence to support their use.[6]

This article examines chest compression quality during a multidepartment quality improvement project. It adds to previous work by describing provider characteristics, correlating these characteristics to compression quality, comparing self-assessed to measured compression quality, and comparing compressions quality with and without feedback.

## Methods

### DESIGN

Data were collected as part of a quality improvement project in August 2019 using a pre- posttest design. For testing, a cardiopulmonary resuscitation (CPR) mannequin (Laerdal Resusci Anne Q-CPR) was fixed to a backboard, atop a Stryker-brand stretcher (1105 Model) (Stryker Corporation, Kalamazoo, MI). The CPRmeter 2 (Figure) was attached using purpose-built adhesive backing. Chest compressions throughout were performed using the CPRmeter 2. During the pretest, the participants were asked to perform 2 minutes of high-quality continuous chest compressions using the CPRmeter 2 but were blinded to the device's feedback by covering the device's display. Immediately after the pretest, they received 2 minutes of rest during which they were asked to self-assess their quality of chest compressions and received a demonstration on the use of the feedback device. After the rest interval, the providers were again asked to perform 2 minutes of chest compressions using the CPRmeter 2, but this time, receiving visual feedback from the device screen. After the second round of chest compressions, the providers completed a questionnaire and rated their satisfaction with the device (Supplementary Appendix).

### SETTING AND ETHICS

Two metropolitan emergency departments were selected for this project. Site A was a community hospital without access to cardiac surgery or cardiac catheterization that services

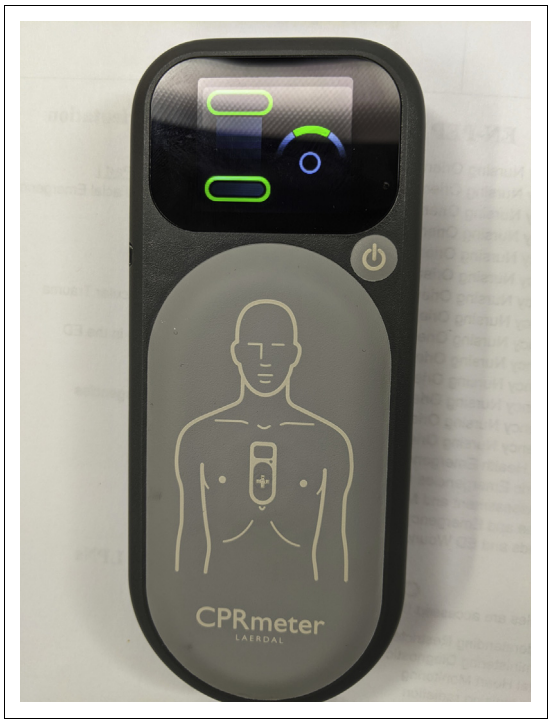


FIGURE 1
Laerdal CPRMeter2.

approximately 50 000 patients per year. Site B was a tertiary academic hospital with access to cardiac surgery and cardiac catheterization that services 85 000 patients per year. They were 2 of 4 metropolitan hospitals that serve a community of 1.4 million people.[13] The quality improvement project received institutional and zone funding and approval. Data were collected to assess staff satisfaction with the devices selected and to ensure that brief staff orientation was sufficient to improve chest compression quality. The authors used the A Project Ethics Community Consensus Initiative Ethics Guideline Tool.[14] The use of the previously collected quality improvement data was assessed as low risk and not requiring further ethics review. The reporting of the quality improvement project followed the Standards for Quality Improvement Reporting Excellence 2.0 guidelines.[15]

## STUDY PROVIDERS

A convenience sample of 84 providers, 43 from site A and 41 from site B, was assessed with the feedback devices. Although all staff were invited, participation was not mandated. All staff provided verbal consent before participating and were made aware that they could withdraw at any point. Providers with injuries or employment restrictions were excluded. All providers were provincially licensed physicians, nurses, and prehospital providers who would be required to provide chest compressions during work and, as a condition of employment, annually renewed their CPR certification.

## MEASURES

Compression quality data were collected using a CPRmeter 2 device (Laerdal, Stavanger, Norway),[16] which measures 4 metrics: depth, recoil, rate, and overall quality (a proprietary combination of depth, recoil, and rate), and recorded by one of the authors (C.P., B.G.Y., or M.J.D.) using Microsoft Excel (Microsoft Corporation, Redmond, WA). Data were expressed as the percentage of compressions that met 2015 guideline recommendations[17] during the assessment interval. Provider characteristics were collected using a questionnaire that collected data on the number of years with CPR certification, where they last obtained CPR certification, self-assessment of expertise, and how frequently they performed chest compressions as part of their job. The providers were also asked to self-assess their compression quality (depth, recoil, rate) during the blinded period and to evaluate the device and were given the opportunity to provide unstructured feedback as a comment.

## STATISTICAL ANALYSIS

Blinded and unblinded chest compression metrics (depth, recoil, and rate), as well as questionnaire responses, were extracted into Excel, and the statistical analysis was performed using IBM SPSS statistics version 25 (IBM, Armonk, NY). Continuous data were normally distributed, and a predetermined significance level of .05 was set. Descriptive statistics (means and SDs) were used to examine provider characteristics and device impressions. Kappa statistics were used to examine the degree of agreement between the provider's self-assessment of compression quality and the feedback device-measured quality. Pearson correlations were used to assess the relationships among self-assessed chest compression quality, years of certification, frequency of performing CPR clinically, and chest compression quality. The effect of the feedback device on chest compression quality was assessed using a 2-tailed paired *t* test. Post-hoc power calculations were calculated using an online power calculator (statulator.com).[18]

## Results

### PROVIDER CHARACTERISTICS

We assessed 43 providers at site A and 41 at site B (n = 84). Complete data were collected for 80 providers. The mean years of certification was 11.74 years (SD = 8.40). A total of 95% (n = 80) of the providers self-assessed as intermediate, advanced, or expert; and 81.0% (n = 68) of the providers reported at least occasionally performing CPR. Table 1 provides the provider characteristics.

### QUESTIONNAIRE DATA

When the questionnaire results were compared with the recorded data, there was moderate positive correlation (r = 0.58, $P < .001$, n = 82) between providing chest compressions more frequently and self-assessed skill. However, chest compression quality was found to be weakly correlated with self-assessed skill (r = 0.29, $P = .01$, n = 83) and not at all with frequency of performing chest compressions or years of certification. There was no agreement between self-assessed and device-measured chest compression depth ($\kappa = -0.10$, $P = .11$), recoil ($\kappa = -0.14$, $P = .03$), or rate ($\kappa = 0.06$, $P = .30$) (Table 2 and Table 3).

### EFFECT OF FEEDBACK

There was a significant improvement in the overall quality and consistency of chest compressions provided at both sites using feedback devices. Exposure to feedback resulted in a 16.9% (SD = 13.83) improvement in overall chest compression quality from 72.19% (SD = 16.66) to 89.08% (SD = 11.09), $t_{(79)} = -10.92$, $P < .001$. The percentage of chest compressions achieving target depth improved from 91.65 (SD = 14.90) to 95.23 (SD = 8.01), a mean increase of 3.58 (SD = 9.64) $t_{(82)} = -8.22$, $P < .001$; and target recoil improved from 64.19 (SD = 29.77) to 87.01 (SD = 15.11), a mean increase of 22.82 (SD = 25.29); $t_{(82)} = -3.38$, $P < .001$. The percentage of chest compressions at the correct rate had the largest increase from rate 61.66 (SD = 33.64) to 85.33 (SD = 20.17), a mean increase of −23.66 (SD = 31.22); $t_{(79)} = -6.78$, $P < .001$ (Table 4). Post hoc power calculations suggest that, assuming findings are similar to ours, future similar studies would need a sample of 59 participants to assess for differences in depth, 13 to assess for differences in recoil, and 17 to assess for differences in rate. Not only were there improvements in quality and consistency for all metrics, but 97.6% of the staff rated the chest compression feedback as "mostly" or "very" helpful.

TABLE 1
**Provider questionnaire data**

| Questionnaire Responses | Response | |
|---|---|---|
| | n | % |
| Total sample | 84 | 100 |
| Female | 63 | 75.0 |
| Male | 21 | 25.0 |
| Years of certification | | |
| Total responses | 82 | 97.6 |
| *Mean (SD)* | *11.74* | *(8.40)* |
| Self-assessed skill | | |
| Total responses | 84 | 100 |
| Expert | 30 | 35.7 |
| Advanced | 28 | 33.3 |
| Intermediate | 22 | 26.2 |
| Novice | 3 | 3.6 |
| Beginner | 1 | 1.2 |
| How often do you perform CPR? | | |
| Total responses | 82 | 97.6 |
| Frequently | 14 | 17.1 |
| Somewhat frequently | 27 | 32.9 |
| Occasionally | 27 | 32.9 |
| Seldom | 11 | 13.4 |
| Never | 3 | 3.7 |
| Was feedback helpful? | | |
| Total responses | 83 | 98.8 |
| Very | 71 | 85.6 |
| Mostly | 10 | 12.0 |
| Somewhat | 2 | 2.4 |
| Not very | 0 | 0 |
| Not at all | 0 | 0 |

CPR, cardiopulmonary resuscitation.

## Discussion

The combination pre- posttest design and questionnaire application allowed us to make several noteworthy comparisons. The questionnaire data offered insight into the composition of ED providers: years of practice, frequency of performing chest compressions, and self-assessed skill levels.

TABLE 2
**Correlation between demographics, cardiopulmonary resuscitation experience and performance**

| Control Variable | | % compressions at target | Years of CPR certification | How often do you perform CPR? | Self-assessed skill |
|---|---|---|---|---|---|
| Percentage compressions at target | Pearson correlation | 1 | −0.13 | 0.18 | 0.29 |
| | Sig | | .26 | 0.11 | .01 |
| | N | 83 | 81 | 81 | 83 |
| Years of CPR certification | Pearson correlation | −0.13 | 1 | 0.06 | 0.08 |
| | Sig | .26 | | .59 | .43 |
| | N | 81 | 82 | 80 | 82 |
| How often do you perform CPR? | Pearson correlation | 0.18 | 0.06 | 1 | 0.58 |
| | Sig | .11 | .59 | | < .001 |
| | N | 81 | 80 | 82 | 82 |
| Self-assessed skill | Pearson correlation | 0.29 | 0.80 | 0.58 | 1 |
| | Sig | .01 | .47 | < .001 | |
| | N | 83 | 82 | 82 | 84 |

CPR, cardiopulmonary resuscitation; Sig, significance.

Correlating providers' self-assessed compression quality with their measured quality suggests providers cannot accurately assess compression quality in both a global (overall quality) or granular sense (depth, recoil, and rate) (Table 3). Inaccurate assessments for depth and rate have been previously established,[8,19] but there is an apparent lack of data comparing perceived with measured chest recoil rates in the literature. The participants in this study tended to underestimate their percentage of chest compressions at the correct depth, wherein previous studies have shown overestimation.[8] Because of the better-than-expected chest compression depth achieved in this study cohort, the data still support that chest compression feedback, although not mandatory, can improve chest compression quality, which is frequently of unnecessarily low quality.[9-11,19-21]

There were significant improvements in compression quality metrics when feedback was used. Each component of high-quality chest compressions had an overall improvement in both quality and consistency, even when pretest quality was already high (depth) (Table 4). These findings reinforce previous research on the effect of chest compression feedback[8,12] and can help to describe more fully the degree to which feedback can improve overall quality, specifically in the emergency department.

There was a high degree of satisfaction with the chest compression feedback device; most providers found it helpful. There were 2 providers who described discomfort in providing chest compressions with the CPRmeter 2. Although there are not enough data to extrapolate these findings, it does suggest that the CPRmeter 2 may be more comfortable than other devices of which discomfort has been listed as a reason for not using the device clinically.[22]

## Limitations

Our project had several noteworthy limitations. The providers volunteered their participation; therefore, this may not have been a representative sample. The questionnaire was completed in view of quality improvement personnel, and the provider responses could have been influenced by desirability bias. Furthermore, the questionnaire data collected the provider perceptions in a categoric manner (quintiles), and the retrospective coding of continuous CPRmeter data into quintiles could have exaggerated the discrepancy between providers' perceptions and measured quality. Performing 2 rounds of chest compressions on a mannequin in a controlled environment likely presents a lower physical, cognitive, and emotional demand on providers than an actual resuscitation, which may last for significantly longer periods; real-world performance could thus be worse than what was recorded. There was a fixed before-after sequence with all participants performing blinded chest compressions before compressions with feedback; as a result, performance could have been negatively skewed by fatigue or

TABLE 3
**Agreement between providers' assessment and objective measurement**

| % of compressions at target | Subjective estimate | | Objective measurement | | κ | Standard error | 95% CI | Sig |
|---|---|---|---|---|---|---|---|---|
| | N | % | n | % | | | | |
| Depth (%) | | | | | −0.10 | 0.06 | 0.06-0.17 | 0.11 |
| 81-100 | 45 | 54.2 | 71 | 85.5 | | | | |
| 61-80 | 33 | 39.8 | 6 | 7.2 | | | | |
| 41-60 | 5 | 6.0 | 5 | 6.0 | | | | |
| 21-40 | 0 | 0 | 1 | 1.2 | | | | |
| 0-20 | 0 | 0 | 0 | 0 | | | | |
| Total | 83 | | 83 | | | | | |
| Recoil (%) | | | | | −0.14 | 0.06 | 0.05-0.16 | 0.03 |
| 81-100 | 43 | 52.4 | 28 | 34.1 | | | | |
| 61-80 | 27 | 32.9 | 21 | 25.6 | | | | |
| 41-60 | 11 | 13.4 | 18 | 22.0 | | | | |
| 21-40 | 1 | 1.2 | 5 | 6.1 | | | | |
| 0-20 | 0 | 0 | 10 | 12.2 | | | | |
| Total | 82 | | 82 | | | | | |
| Rate (%) | | | | | −0.06 | 0.06 | 0.05-0.17 | 0.30 |
| 81-100 | 42 | 50.6 | 33 | 39.8 | | | | |
| 61-80 | 35 | 42.2 | 17 | 20.5 | | | | |
| 41-60 | 6 | 7.2 | 11 | 13.3 | | | | |
| 21-40 | 0 | 0 | 7 | 8.4 | | | | |
| 0-20 | 0 | 0 | 15 | 18.1 | | | | |
| Total | 83 | | 83 | | | | | |

Sig, significance.

positively skewed by a maturation effect. There is an ongoing debate about the utility of power estimations for interpreting negative results,[23] as a surrogate for examining confidence intervals,[24] and for estimating required sample sizes,[25] so caution should be taken when interpreting our suggestions. A randomized design would be needed to establish if feedback is causally linked to improved chest compressions, and clinical replication is needed to determine if the correlations found in this study extend beyond simulated CPR.

TABLE 4
**Before-after measurements and compression improvement**

| Categories | Pretest | | Post-test | | Difference | | Standard error mean | 95% CI | *t* | df | Sig (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | | | | | |
| Depth | 91.65 | 14.90 | 95.23 | 8.01 | 3.58 | 9.64 | 1.06 | 1.47-5.68 | 3.38 | 82 | < .001 |
| Recoil | 64.19 | 29.77 | 87.01 | 15.11 | 22.82 | 25.29 | 2.78 | 17.30-28.34 | 8.22 | 82 | < .001 |
| Rate | 61.66 | 33.64 | 85.33 | 20.17 | 23.66 | 31.22 | 3.47 | 15.31-29.11 | 6.78 | 79 | < .001 |
| Overall | 72.19 | 16.66 | 89.08 | 11.09 | 16.88 | 13.83 | 1.55 | 13.81-19.96 | 10.92 | 79 | < .001 |

## Conclusions

The results of this analysis suggest that a provider's years of certification, self-assessed skill level, and frequency of performing chest compressions are poor predictors of compression quality. Furthermore, it suggests providers are unable to accurately self-assess their compression quality. In this sample, there was a significant improvement in all chest compression quality metrics and the overall quality of chest compressions provided when feedback devices were used, despite high–prefeedback chest compression quality. These findings suggest that chest compression quality feedback, with limited training, can yield a significant improvement in chest compression quality, with a high degree of provider satisfaction, in a simulated setting. We noted significant improvements in a controlled setting but believe there is even greater potential for improvement in clinical practice in which fatigue, arousal, and prolonged effort may lead to deteriorations in chest compression quality. Further research is needed to assess the causal nature of chest compression improvements and to determine if improvements extend to clinical practice in the emergency department.

## Author Disclosures

Conflicts of interest: none to report.

For Matthew J. Douma, Laerdal has provided resuscitation equipment for the purposes of resuscitation evaluation and research though they have had no influence of the design, conduct, or analysis of any project.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.10.003.

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## Supplementary Appendix

Participant survey

1) For how many years have you had CPR certification?
2) How often would you estimate you have performed chest compressions in "real-life"?
   - ☐ Frequently
   - ☐ Somewhat frequently
   - ☐ Occasionally
   - ☐ Seldom
   - ☐ Never
3) Where did you receive your CPR training?
   - ☐ AHS/Covenant Health
   - ☐ St.John Ambulance
   - ☐ Heart and Stroke
   - ☐ Red Cross
   - ☐ Other, describe:
4) How satisfied were you with the training?
   - ☐ Very
   - ☐ Mostly
   - ☐ Somewhat
   - ☐ Not very
   - ☐ Not at all
5) How would you describe your chest compression/CPR ability? (circle one)
   - ☐ Expert
   - ☐ Advanced
   - ☐ Intermediate
   - ☐ Novice
   - ☐ Beginner
6) After compressing for two minutes, how fatigued do you feel? Indicate by marking on the line below. Zero being "no fatigue" and 10 being "completely exhausted."
   0 1 2 3 4 5 6 7 8 9 10
7) What percentage of your compressions were at the correct rate? (circle one)
   - ☐ 81-100%
   - ☐ 61-80%
   - ☐ 41-60%
   - ☐ 21-40%
   - ☐ 0-20%
8) What percentage of your compressions had correct depth? (circle one)
   - ☐ 81-100%
   - ☐ 61-80%
   - ☐ 41-60%
   - ☐ 21-40%
   - ☐ 0-20%
9) What percentage of your compressions had correct recoil?
   - ☐ 81-100%
   - ☐ 61-80%
   - ☐ 41-60%
   - ☐ 21-40%
   - ☐ 0-20%
10) Was the CPR meter useful for feedback?
   - ☐ Very
   - ☐ Mostly
   - ☐ Somewhat
   - ☐ Not very
   - ☐ Not at all
11) Do you have any feedback about the device?

_____-
_____-
_____-
_____-
_____-
_____-
_____

Thank you for participating!
Name (optional):
Participant ID number:

# Syncope in the Emergency Department: A Guide for Clinicians

**Authors:** Mohamed Toufic El-Hussein, PhD, NP, and Alexander Cuncannon, Calgary, Alberta, Canada
**Section Editor:** Mohamed Toufic El-Hussein, PhD, NP

CE Earn Up to 10.5 Hours. See page 359.

### Contribution to Emergency Nursing Practice

- Syncope remains unexplained after ED evaluation, possible cardiac etiologies are crucial to identify because of an increased risk of serious adverse events. Existing guidance on risk stratification is limited and practitioners' risk aversion can lead to unnecessary low-risk admissions.
- A systematic approach to syncope that integrates a patient's history; examination and electrocardiogram; additional testing; risk stratification; and team-based, patient-centered care may help ED practitioners to rapidly and accurately identify patients classified as high risk.
- ED practitioners should be cognizant of the high-risk features of syncope, which increase the likelihood of cardiac etiology. Supplement clinical judgment with risk scores when no serious cause is evident. Engage patients in shared decision-making to arrange appropriate outpatient and follow-up care, observation, or admission.

### Abstract

Syncope is a common presenting symptom to emergency departments, but its evaluation and initial management can be challenging for ED practitioners and particularly urgent in the presence of high-risk features that increase the likelihood of cardiac etiology. Even after thorough clinical evaluation, syncope may remain unexplained. In such instances, practitioners' clinical judgment and risk assessments are critical to guide further management. In this article, evidence-informed strategies are outlined to approach the diagnosis of syncope and provide an overview of syncope clinical decision rules and shared decision-making. By incorporating risk stratification and shared decision-making into syncope care, practitioners can more confidently engage patients and families in disposition decisions to organize appropriate outpatient and follow-up care, observation, or admission.

**Key words:** Syncope; Emergency department; Risk stratification; Shared decision-making

## Introduction

Transient loss of consciousness (TLOC) is a frequent presentation to emergency departments, accounting for 0.6% to 1.0% of ED visits in North America,[1,2] and most commonly manifests in the form of syncope. All classifications of syncope result from cerebral hypoperfusion,[3] but the precise underlying cause can be challenging for ED practitioners to determine. The 3 general classifications of syncope include reflex syncope and syncope due to orthostatic hypotension (OH), which together make up approximately one-third of the ED diagnoses, and cardiac syncope, which makes up approximately 10% of the ED diagnoses.[3,4] Cardiac etiology is particularly imperative to

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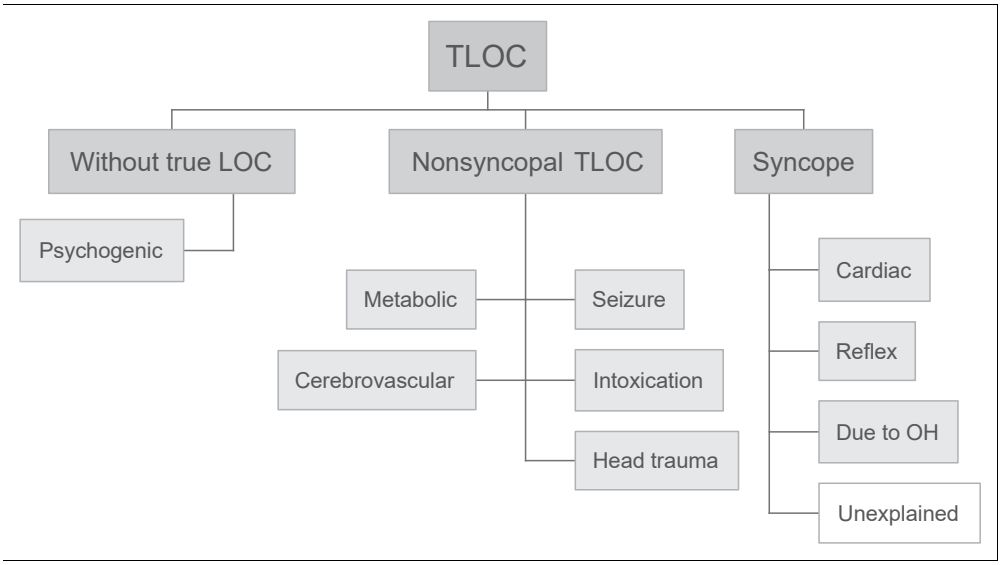


FIGURE 1

Differential diagnosis of TLOC. OH, orthostatic hypotension; TLOC, transient loss of consciousness. (Adapted from Williford and Olshansky.[17])

identify because of an increased risk of death and serious adverse events (SAEs) (eg, life-threatening arrhythmia or bleeding, sudden cardiac death (SCD), acute myocardial infarction, and stroke) and an increased need for procedural intervention.[4-7] Furthermore, even after thorough clinical evaluation, the underlying cause of syncope can remain unexplained in nearly one-third of the cases.[4] In these instances, licensed independent practitioners (including nurse practitioners, physicians, and physician assistants) must integrate clinical judgment and risk assessments to guide further management.

HERERetrospective studies estimate that hospitalization rates for syncope range from 25% to 35% in the United States.[1,8] For patients at low risk of SAEs and in the absence of serious medical conditions, hospitalization may be unnecessary because of its limited diagnostic value and potentially harmful outcomes.[3,6,9,10] Amid risk-averse contexts, varying risk perceptions, and occasional diagnostic uncertainty, ED practitioners are challenged with not only identifying patients at high risk for SAEs but also avoiding unnecessary hospitalizations.[11,12] Accordingly, researchers have called for more standardized and risk stratification–based approaches to syncope evaluation to improve practitioners' diagnostic confidence, decrease unnecessary admissions, and reduce costs associated with testing and hospitalization.[7,12]

Clinical decision rules (CDRs), which supplement risk assessments, and shared decision-making (SDM), which engages patients and families in the disposition decision, are 2 areas of recent innovation that have the potential to improve syncope evaluation and care experiences.[13,14] At a time of crowded emergency departments and disparities in access to primary care, ED advanced practice registered nurses are essential to increase underserved populations' access to, and experiences of, care.[15] The purpose of this article is to empower ED practitioners, and nurse practitioners in particular given their expertise in patient education and health promotion,[16] to incorporate CDRs and SDM into their practice. This article also outlines evidence-informed strategies to approach the diagnosis of syncope and discusses special considerations for older adults, syncope mimics, and rare presentations to augment practitioners' knowledge and clinical judgment.

## Pathophysiology

TLOC is a state of real or apparent loss of consciousness characterized by amnesia, motor control abnormalities, and unresponsiveness, with numerous causes (Figure 1).[3,17] Syncope is a form of TLOC characterized by rapid onset and spontaneous recovery and specifically results from cerebral hypoperfusion.[3,17] Syncope must be differentiated from nonsyncopal TLOC (eg, seizure and head trauma) as well as mimics (eg, psychogenic pseudosyncope).[3,6] Presyncope refers to the symptoms preceding syncope (eg, nausea, vomiting, or sweating in reflex syncope, lightheadedness in OH, or palpitations in cardiac syncope).[3] European Society of Cardiology (ESC)

TABLE 1
**Low- and high-risk features at index ED evaluation**[3,6,31]

| Assess | Low risk | High risk |
|---|---|---|
| Context of TLOC | • Features suggestive of reflex syncope<br>• Prodrome (eg, lightheadedness, warmth, sweating, nausea, or vomiting)<br>• Specific triggers (eg, fear, pain, or unpleasant smell)<br>• Situational triggers (eg, micturition, deglutition, defecation, cough, or sneeze)<br>• Being in crowded or hot spaces<br>• Prolonged standing<br>• Standing from supine or sitting position | • New-onset chest pain, dyspnea, abdominal pain, or headache<br>• Syncope on exertion or while supine<br>• Sudden-onset palpitations preceding syncope |
| Medical history | • Absence of heart disease<br>• Long history of recurrent low-risk syncope similar to current syncope | • Severe structural heart disease or coronary artery disease (eg, heart failure, low LVEF, or previous myocardial infarction) |
| Family history | • No family history of SCD | • Family history of SCD |
| Physical examination | • Normal physical examination | • Unexplained SBP <90 mmHg<br>• Evidence of bleeding (eg, gastrointestinal bleeding)<br>• Persistent abnormal vital signs (eg, bradycardia in awake nonathletes)<br>• Undiagnosed systolic murmur |
| ECG | • Normal ECG | • Abnormal ECG |

ECG, electrocardiogram; LVEF, left ventricular ejection fraction; SBP, systolic blood pressure; SCD, sudden cardiac death; TLOC, transient loss of consciousness.

guidelines recommend that presyncope be evaluated and managed similarly to syncope because the 30-day risk of SAEs is comparable.[3,18]

The underlying mechanism of all 3 classifications of syncope is that it often starts with low cardiac output and decreased peripheral resistance, resulting in hypotension and cerebral hypoperfusion.[3] Reflex (neurally mediated) syncope has vasovagal or situational (eg, micturition) causes, whereas syncope due to OH can be caused by drugs (eg, vasodilators and diuretics), volume depletion (eg, hemorrhage), and primary or secondary autonomic failure.[3] Treatment for these classifications of syncope usually involves first-line education and lifestyle measures (eg, reassurance and awareness of triggers, situations, and prodromes) but may also extend to pharmacotherapy, drug discontinuation, and other therapies.[3] In cardiac syncope, arrhythmias, structural disease, and other less common causes (eg, acute coronary syndromes, pulmonary embolism, aortic dissection, and cardiac tamponade) are implicated in low cardiac output.[3] Cardiac syncope requires prompt treatment (eg, catheter ablation, device implantation, or surgical intervention) to address the underlying cause.[3]

## Diagnostic Approach

Both ESC and American College of Cardiology/American Heart Association guidelines provide similar recommendations for the initial evaluation of syncope.[3,6] Key elements of the history, physical examination, and electrocardiogram (ECG) assist a practitioner in the diagnosis, risk assessment, and plan of care.

### HISTORY

The history-taking in syncope has been referred to as history-building to emphasize its mutuality and diagnostic value.[19] The history should include the context of the TLOC, medical history, and family history to

TABLE 2
**Features associated with classifications of syncope**[3,6,22]

| Cardiac syncope | LR+, 95% CI* | Reflex syncope | Syncope due to OH |
|---|---|---|---|
| AF | 7.3 (2.4-22) | • History of recurrent syncope | • Prolonged standing |
| Severe structural HD | 3.3-4.8 | • Specific triggers (eg, fear, pain, or unpleasant smell) | • Postprandial hypotension |
| History of HF | 2.7-3.4 | • Situational triggers (eg, micturition, deglutition, defecation, coughing, sneezing, or laughing) | • Recent change in vasodepressive medications |
| Age >35 y | 3.3 (2.6-4.1) | • Being in crowded or hot spaces | • Volume depletion (eg, hemorrhage, diarrhea, or vomiting) |
| On exertion | 14-15 | • Pallor, sweating, or nausea/vomiting | • Primary or secondary autonomic failure (eg, Parkinson disease, autonomic neuropathy) |
| Supine position | 1.1-4.9 | | |
| Dyspnea | 3.5 (1.5-9.1) | | |
| Chest pain | 3.4-3.8 | | |
| Palpitations | 1.9 (0.86-4.5) | | |
| Cyanosis | 3.2 (1.6-24) | | |
| Absence of prodrome | 1.6 (1.0-2.6) | | |
| HD and/or abnormal ECG | 2.3 (1.7-3.0) | | |

AF, atrial fibrillation; ECG, electrocardiogram; HD, heart disease; HF, heart failure; LR+, positive likelihood ratio; OH, orthostatic hypotension.
* 95% CI for LR+ as reported in a systematic review on the detection of cardiac syncope by Albassam et al[22]

enable rapid triage on the basis of the presence of low- and high-risk features (Table 1). Syncope must be differentiated from nonsyncopal TLOC (Figure 1). For instance, features suggestive of seizure include the absence of a trigger; tongue-biting, head-turning, and unusual posturing; duration in minutes; and memory deficit.[3]

If syncope is suspected, the history may help differentiate cardiac syncope from reflex syncope or syncope secondary to OH (Table 2). Practitioners should note the association between the presence of high-risk features and greater likelihood of cardiac syncope.

## CLINICAL EXAMINATION

Cardiac and pulmonary examinations should be performed for all patients, with close attention paid to the features that suggest the presence of structural heart disease (eg, murmurs, gallops, or rubs). A basic neurologic examination should also be performed. Because syncope generally presents without focal neurologic deficits, any identification of focal deficits requires further evaluation for cerebrovascular disease (eg, vertebrobasilar or carotid transient ischemic attacks or subclavian steal syndrome).[3,6] Practitioners should be aware that although rare, focal deficits and syncope may coexist; in this instance, treatment after a stroke misdiagnosis would aggravate hypotension.[20]

## ELECTROCARDIOGRAM

A resting 12-lead ECG should be obtained for all patients presenting with syncope because of wide availability and utility in pinpointing arrhythmic syncope.[3,6] Practitioners should keep in mind that an arrhythmia may be intermittent or not recognized on an initial ECG and that a normal initial ECG cannot rule out 30-day serious cardiac arrhythmia.[21] High-risk ECG features that suggest a serious condition include abnormalities in rhythm and conduction, ventricular hypertrophy, changes consistent with ischemia, and several syndromes (eg, Wolff-Parkinson-White syndrome, Brugada syndrome, and long QT syndrome).[3]

## FURTHER INVESTIGATIONS

If syncope remains unexplained after evaluation, further testing (eg, cardiac imaging and monitoring) may help clarify a diagnosis and prognosis when clinically indicated.[3,6] Routine laboratory testing in syncope is not well supported by evidence; however, recent studies have explored the utility of cardiac biomarkers (eg, B-type natriuretic peptide [BNP], N-terminal pro-BNP [NT-pro-BNP], and high-sensitivity cardiac troponins [high-sensitivity cardiac troponin T {hs-cTnT} and high-sensitivity cardiac troponin I]) in the detection of cardiac syncope and risk stratification.[22-24] Two recently developed CDRs, the Canadian Syncope Risk Score (CSRS) and the FAINT (heart failure,

arrhythmia, Initial ECG result abnormal, Elevated NT-proBNP, Elevated hs-troponin T) Score, include cardiac biomarkers as predictors.[25,26]

## Special Considerations

### COMPREHENSIVE GERIATRIC ASSESSMENT

Complex interactions exist between syncope and aging, multimorbidity, polypharmacy, frailty, and functional decline.[27] ESC guidelines recommend multifactorial evaluation and intervention for older adults with syncope, including potential discontinuation of hypotensive and psychotropic drugs, cognitive and physical assessments, and following the approach for unexplained syncope in the presentation of unexplained falls.[3]

### SYNCOPE MIMICS AND CHAMELEONS

Syncope mimics are disorders that can seem similar to syncope, including seizures, metabolic disorders, stroke and transient ischemic attack, and psychogenic pseudosyncope.[28] Syncope chameleons are instances in which true syncope presents atypically, seeming to be similar to other disorders.[28] Chameleons include convulsive syncope, which resembles seizure activity, and syncope that resembles subclavian steal syndrome or subarachnoid hemorrhage. A thorough history and clinical examination are key to identifying life-threatening conditions and differentiating true syncope.

## Rare Causes of Syncope

Although uncommon, multiple system atrophy (MSA) and inherited arrhythmia syndromes (IAS) can both cause syncope. These 2 particular causes are discussed here because they illustrate the multifactorial etiology of syncope and encourage practitioners to think critically.

### MULTIPLE SYSTEM ATROPHY

MSA is a progressive neurodegenerative disorder thought to result from misfolded α-synuclein and includes both Parkinsonian (MSA-p) and cerebellar (MSA-c) variants.[29] MSA is characterized by autonomic failure and typically presents with early urogenital dysfunction followed by OH.[29] Autonomic studies and neuroimaging are central to evaluation, and management is directed toward addressing symptoms.

### INHERITED ARRHYTHMIA SYNDROMES

IAS are genetic disorders that cause mutations in cardiac ion channel genes and may result in life-threatening arrhythmias and SCD.[30] IAS include long QT syndrome, Brugada syndrome, and catecholaminergic polymorphic ventricular tachycardia. Features suggestive of arrhythmic syncope or a family history of SCD, particularly in younger patients, should prompt evaluation for IAS as well as cardiac imaging and testing.[30] Management includes pharmacotherapy (eg, β-blockers), implantable cardioverter-defibrillators, and avoidance of triggers (eg, exercise and stress).[30]

## Risk Stratification

Risk stratification involves identifying a patient's risk of SAEs to guide further management.[3,6] By identifying patients at low risk of SAEs, many of whom can safely be discharged and receive outpatient follow-up,[3] health care service use is optimized and patients' quality of life is improved by avoiding unnecessary and prolonged hospitalization.

The prospective cohort Intermediate-Risk Syncope study found a low rate of 30-day SAEs in patients classified as being at intermediate risk of SAEs compared with those classified as high risk (0.8% vs 27.8%; $P < .01$).[31] Patients classified as being at intermediate risk did not meet all low-risk criteria nor present with any single high-risk feature (eg, family history of SCD, syncope on exertion or while supine, palpitations or chest pain, or marked ECG abnormalities). Notably, patients classified as being at intermediate risk possessed features such as stable cardiovascular disease and potentially related but stable comorbidities (eg, history of stroke or gastrointestinal bleeding, anemia, or Parkinson disease). In risk-averse contexts, these patients might be unnecessarily hospitalized despite being clinically stable. The Intermediate-Risk Syncope findings substantiate that generally, if patient education is provided and appropriate outpatient follow-up is arranged, patients classified as being at intermediate risk can safely be discharged after ED observation.

### CLINICAL DECISION RULES

Numerous CDRs have been developed to predict short-term SAEs in patients presenting with syncope. ESC and American College of Cardiology/American Heart Association guidelines underscore that good clinical judgment continues to offer better prognostic yield than CDRs, and thus CDRs should merely supplement practitioners' clinical

TABLE 3
**Canadian Syncope Risk Score**[26]

| Category | Points |
|---|---|
| Clinical evaluation | |
| Predisposition to vasovagal symptoms* | −1 |
| History of heart disease† | +1 |
| Any systolic pressure reading <90 or >180 mm Hg‡ | +2 |
| Investigations | |
| Elevated troponin level (> 99th percentile of normal population) | +2 |
| Abnormal QRS axis (< −30° or >100°) | +1 |
| QRS duration >130 ms | +1 |
| Corrected QT interval >480 ms | +2 |
| Diagnosis in emergency department | |
| Vasovagal syncope | −2 |
| Cardiac syncope | +2 |
| Total score (−3 to 11) | |

The Canadian Syncope Risk Score was developed by Thiruganasambandamoorthy et al[26]
* Triggered by being in a warm, crowded place; prolonged standing; fear; emotion; or pain.
† Includes coronary or valvular heart disease, cardiomyopathy, congestive heart failure, and nonsinus rhythm (electrocardiogram evidence during index visit or documented history of ventricular or atrial arrhythmias or device implantation).
‡ Includes blood pressure values from triage until disposition from the emergency department.

judgment.[3,6] Meta-analyses have found that syncope CDRs are limited by varying ECG interpretation and definitions of syncope and arrhythmia; lack of external validation; and, if validated, poor sensitivity and specificity.[32-34] CDRs integrated into information technology systems, such as in clinical decision-support systems, have the potential to assist nurses and all practitioners in triage decision-making and the identification of high-risk conditions.[35]

Practitioners should keep in mind that the outcomes predicted by syncope CDRs are fundamentally associated with underlying disorders, of which syncope itself is a symptom.[3] Moreover, CDRs should be only used when no evident serious causes are identified during initial clinical evaluation.[33,36]

### *San Francisco Syncope Rule*

The San Francisco Syncope Rule (SFSR) predicts the short-term risk of SAEs in syncope that remains unexplained after initial ED evaluation.[37,38] There are 5 risk factors that make up the SFSR: history of congestive heart failure, hematocrit <30%, abnormal ECG, shortness of breath, and systolic blood pressure <90 mmHg. A patient is considered to be at high risk of short-term SAEs if they have any 1 of the 5 risk factors. The SFSR derivation study found a sensitivity of 96% (95% CI, 92%–100%) and specificity of 62% (95% CI, 58%–66%).[38] Meta-analyses of external validation studies, however, have found lower sensitivity (87%; 95% CI, 79%–93%) and specificity (52%; 95% CI, 43%–62%) for the SFSR.[33,34] Considerable heterogeneity in sample and outcome definition may limit evidence for its generalizability.

### *Canadian Syncope Risk Score*

The CSRS estimates the risk of 30-day SAEs not identified during initial ED syncope evaluation.[26] Nine top predictors (Table 3) were identified from an initial list of 43 candidate predictors through statistical analysis and predictive modeling of standardized presentation variables and outcomes during a prospective cohort study across 6 Canadian emergency departments (n = 4030). Importantly, the model was corrected for overfitting and internally validated through bootstrapping. The CSRS separates an abnormal ECG into individual predictor variables and further includes practitioners' diagnostic impression as a category, underscoring the value of clinical judgment. A score greater than or 4 confers a high or very high risk (>12%) of SAEs within 30 days.

The CSRS was externally validated in a prospective cohort study across 9 Canadian emergency departments (n = 3819).[36] The model demonstrated excellent calibration, with no statistically significant difference between predicted and observed risks, as well as excellent discrimination, with an area under the receiver operating characteristic curve of 0.91 (95% CI, 0.88–0.93). In this validation cohort, less than 1% of the patients classified as very low risk and low risk, 20% of those classified as high risk, and 50% of those classified as very high risk experienced 30-day SAEs. At a threshold score of −1 (low risk), CSRS sensitivity was 97.8% (95% CI, 93.8%–99.6%) and specificity was 44.3% (95% CI, 42.7%–45.9%).

### *Canadian Syncope Arrhythmia Risk Score*

The Canadian Syncope Arrhythmia Risk Score (CSARS) is a CDR developed to predict the 30-day risk of arrhythmia unidentified during initial ED evaluation and death.[39] The 8 clinical predictors that make up the CSARS were derived from an additional prospective cohort study at 6 Canadian emergency departments (n = 5010) and are similar to CSRS predictors, although point values differ. Scores for the CSARS range from −2 to 8, with scores greater than or 4

conferring high or very high risk of arrhythmia or death within 30 days. Although the CSARS was internally validated through bootstrapping, it must be externally validated before it can be implemented in clinical settings. Once validated, it may help practitioners identify patients at low risk of arrhythmia who do not require admission, as well as guide follow-up care (eg, outpatient cardiac monitoring).

### *FAINT Score*

The FAINT score is a CDR developed to rule out 30-day SAEs among older adults presenting to emergency departments with syncope.[25] Derived during a prospective cohort study at 11 emergency departments in the US (n = 3177), the FAINT score comprises 5 clinical predictors: history of heart failure, history of cardiac arrhythmia, initial abnormal ECG result, elevated NT-pro-BNP, and elevated hs-cTnT. Practitioners should keep in mind that the NT-pro-BNP and hs-cTnT assays may not be readily available in all emergency departments, although the researchers anticipate wider availability in the coming years. Although the FAINT score was internally validated through cross-validation, it must be externally validated before it can be implemented in clinical settings.

## Shared Decision-Making

SDM is a means to alter power differentials in health care and requires practitioners to continually reflect on their language, communication, and ways of knowing during clinical encounters. In ED settings, SDM involves actively engaging patients and families, to the extent they desire and as clinically appropriate, in mutual information-sharing and consensus when a risk-benefit balance and several reasonable care options exist.[40,41] SDM aims to ensure that patients are well informed about their condition as well as the benefits, risks, and consequences of care options. Barriers to SDM implementation in emergency departments include the high-stakes, time-sensitive clinical situations of ED practice as well as the perceptions that patients would rather that practitioners make all the decisions.[13,41] SDM improves patients' knowledge and care experiences, provided that the proposed care options are well supported by evidence and that a risk-benefit balance exists.[13]

In syncope, SDM benefits patients at low to intermediate risk of SAEs or whose syncope remains unexplained after ED evaluation because multiple care options (eg, discharge with primary care or specialist follow-up vs observation vs admission) are made clear.[14,42] Outpatient management may even be indicated for select patients with suspected cardiac syncope in the absence of serious conditions.[6] For example, outpatient cardiac testing is an underused alternative to inpatient cardiac monitoring despite established safety and convenience.[6]

The disposition decision involves collaboration between a patient and practitioner that weighs the patient's condition, values and preferences, and life context and determinants of health.[14] Practitioners should specifically inquire into a patient's risk perceptions and tolerance, living circumstances (eg, support from informal or formal caregivers), and access to outpatient follow-up care if discharge is appropriate.[14,21] If observation or admission is indicated, a practitioner should inquire into a patient's socioeconomic status and implications of potentially missing work or other responsibilities.

### SHARED DECISION-SUPPORT TOOLS

Shared decision-support tools (SDSTs) are aids (eg, paper- or computer-based tools and videos) that facilitate SDM between practitioners and patients and families.[13] Practitioners should tailor SDSTs to patients and families, which involves consideration of person-first language and patients' life circumstances, access to care, risk perceptions and tolerance, and literacy and numeracy (Figure 2). To ensure this, SDSTs may be supplemented to individualize care. For instance, Winokur et al[43] developed pictographs to improve patients' and families' comprehension of discharge instructions (eg, fever in children and gastroenteritis).

An SDST has recently been developed and tested to facilitate SDM in syncope. SynDA (Patient Decision Aid for Syncope) is a paper-based patient decision aid intended to meaningfully engage patients with unexplained syncope judged to be at low to intermediate risk of SAEs—but without any identified serious conditions—in disposition decisions (Figure 2).[42] In a randomized controlled pilot trial at 1 emergency department, SynDA demonstrated feasibility and showed promise in improving patients' active involvement in care and optimizing health care use.[44]

## Implications for Emergency Clinical Practice

The initial management and risk assessment of syncope challenges many ED practitioners and often leads to unnecessary low-risk admissions, particularly in risk-averse contexts. At the same time, it is imperative that practitioners accurately identify the small but important subset of patients, primarily those with suspected cardiac syncope,

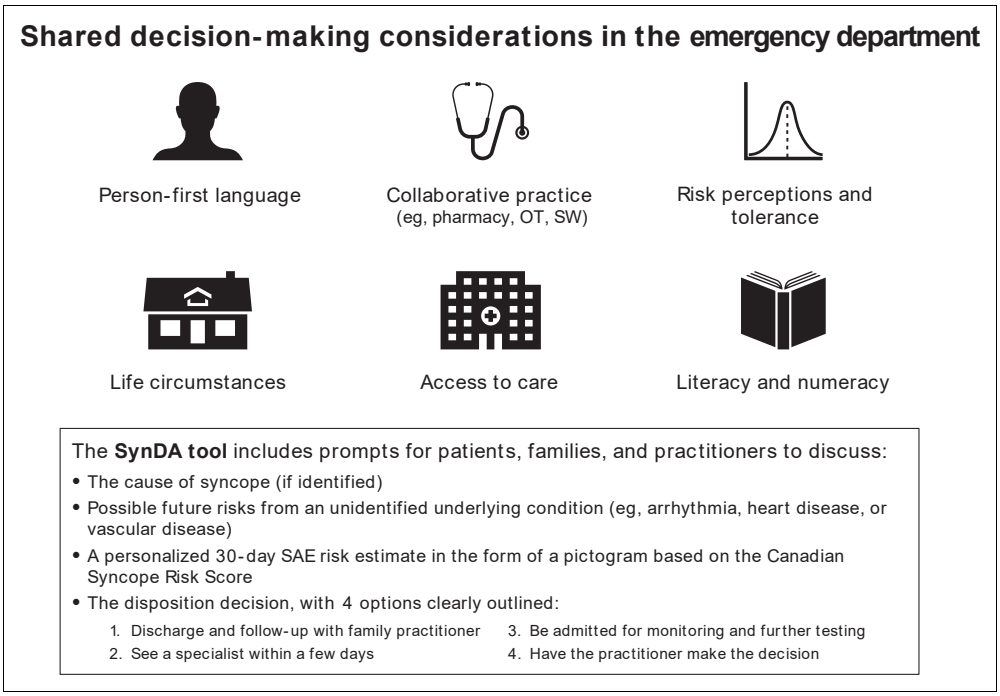


FIGURE 2

Shared decision-making considerations[14,21] and key aspects of the SynDA tool.[42] OT, occupational therapy; SAE, serious adverse event; SW, social work. (The SynDA tool was developed by Probst et al[42])

at high risk of SAEs. Moreover, syncope can often remain unexplained even after thorough clinical evaluation. In this article, we have presented 2 innovative, complementary, and evidence-informed strategies—risk stratification and SDM—with which practitioners can supplement their knowledge and clinical judgment to navigate complex clinical presentations of syncope. Practitioners can use the CSRS, a rigorously developed and validated CDR, to predict the risk of 30-day SAEs. To facilitate the disposition decision, the SynDA tool shows promise to engage patients at low to intermediate risk of SAEs in SDM.

## Conclusions

TLOC and its manifestation of syncope are complex ED presentations. In this article, we briefly summarized the pathophysiology of syncope. Although reflex syncope and syncope due to OH generally entail a benign course, cardiac syncope confers an increased risk of SAEs. We outlined a diagnostic approach to discern the differential diagnosis of syncope and underscored the importance of a thorough history and clinical examination. When syncope remains unexplained and no serious causes are evident, practitioners' clinical judgment may be supplemented with CDRs to inform risk assessments. Finally, we highlighted the value of SDM in improving patients' active involvement in care decisions. Patient education, risk stratification, SDM, and appropriate follow-up care are pivotal to reduce unnecessary hospitalization as well as to improve outcomes and quality of life for patients with syncope. Incorporating these principles into practice will strengthen practitioners' knowledge and clinical judgment, and further empower them to provide safe, evidence-informed, and comprehensive care.

## Author Disclosures

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# Providing a Safe Haven: Staff Response to a Simulated Infant Relinquishment in the Emergency Department

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**Section Editor:** Jacqueline Stewart, DNP, RN, CEN CCRN, FAEN

## Abstract

Every state in the United States has established laws that allow an unharmed newborn to be relinquished to personnel in a safe haven, such as hospital emergency departments, without legal penalty to the parents. These Safe Haven, Baby Moses, or Safe Surrender laws are in place so that mothers in crisis can safely and legally relinquish their babies at a designated location where they can be protected and given medical care until a permanent home can be found. It is important for health care professionals to know about and understand their state's law and how to respond should an infant be surrendered at their facility. No articles were found in the peer-reviewed literature that describe a method to evaluate nurse competency during infant relinquishment at a Safe Haven location. This article will describe commonalities and differences among these Safe Haven Laws, responsibilities of the hospital and staff receiving a relinquished infant, and 1 hospital's experience when running an infant relinquishment drill in their emergency department.

**Key words:** In situ simulation, Infant relinquishment, Newborn abandonment, Safe Haven Law, Baby safe haven, Competency

## Background

In response to 13 newborn abandonments in less than a year's time, legislators in Texas introduced and then passed the first Safe Haven Law in 1999.[1] The vast majority of states quickly followed, and by 2009, every state had a similar version of the law. On a national scale, more than 4100 babies have been legally relinquished in the United States since the passing of this first law in Texas, per the National Safe Haven Alliance (NSHA),[2] most into the arms of health care personnel in emergency departments, according to D. Geras, President, Illinois Save Abandoned Babies Organization, in a phone communication of January 14, 2020. During this same time period, 1567 babies were reported as illegally abandoned, 885 of whom died, according to D. Geras, President, Illinois Save Abandoned Babies Organization, in a phone communication of December 1, 2020. It is impossible to know exactly how many babies have been illegally abandoned in the US, as many remain unknown by authorities and not all states track these statistics.

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## Commonalities and Differences Among the State Laws

Specific components of these laws can vary among states and may even change as of the time of this writing. These variations relate to definitions of a safe haven, who may relinquish the baby, age limit of the baby, whether the relinquishing person can remain anonymous, and if medical information is requested of the parents. The most updated version of each state's law can be found on the NSHA website (see Resources) or from state hospital associations.

### SAFE HAVEN LOCATIONS

Given that Safe Haven Laws were put in place to protect newborns and give them the medical care they need to stay safe, all states, the District of Columbia, and Puerto Rico authorize health care providers at hospitals to accept an infant.[3] Approximately 42 states also authorize emergency services personnel,

such as those at fire stations and police stations, to accept an infant and/or allow relinquishment through the 911 emergency systems. Several states designate locations such as a licensed adoption facility or faith organization (eg, church, temple, mosque) as safe havens with a caveat that personnel are known to be present at the time the infant is left.[4]

## WHO MAY LEAVE A BABY AT A SAFE HAVEN

In most states, either parent may surrender their baby to a safe haven, whereas some states stipulate that only the biological mother, or birthing person, may do so. Nineteen states specify that someone who has approval of the parent may bring a baby to a safe haven,[3] whereas 8 states do not specify.[4] Parents may remain anonymous in most states, and if information is voluntarily provided by a parent, 15 states offer an assurance of confidentiality with regard to this information.[4] Parental anonymity is forfeited if there is evidence of child abuse or neglect. For states where safe haven personnel are required to ask parents for their name and family history, but parents decline, the hospital should still accept the baby, attempt to give the parent a way to provide information anonymously, and allow them to leave. When anonymity cannot be maintained, such as when a relinquishing mother or birthing person delivers the baby at the hospital while an inpatient, the nursing staff may contact the social worker/case manager to speak with the patient about developing a formal adoption plan. Another option for the mother or birthing person is to be discharged from the hospital with the baby and then immediately return to the emergency department to relinquish the baby under the law.

## AGE LIMITS OF THE BABY

Nebraska's Safe Haven Legislative Bill, when initially enacted in 2008, did not include a limit on the age of a child who could be legally relinquished. After 19 children between the ages of 10 and 17 were left with hospital employees during a 6-week time period, the Bill was quickly amended to include an age limit.[5] Infant age limits across the US range from 3 to 90 days. Although a shorter window for surrendering an infant may appear to limit options to parents, it helps reduce a newborn's exposure to adverse conditions in an unsafe home environment.[6]

## RESPONSIBILITIES OF SAFE HAVEN PROVIDERS

Personnel at designated safe havens are required to take emergency protective custody of the infant, provide medical care as indicated, and immediately notify the local child welfare department that an infant has been relinquished under the law.[4] Safe Haven laws in a handful of states require personnel to also call local law enforcement agencies to check if the baby is a missing child, but unless there is actual or suspected evidence of child abuse or neglect, or coercion to relinquish the baby, police involvement is rarely, if ever, necessary. Nearly half the states require that personnel at the safe haven ask parents for family/medical history, whereas approximately a third need to offer parents a packet that includes information on parent legal rights, postpartum care of the mother or birthing person, and community resources such as family planning, psychological counseling, and local health clinics. Packets need to also contain instructions on how parents can anonymously report family/medical/birth history.[3,4] A copy of the infant's identification bracelet should be offered to the relinquishing parent in 4 states to help link a parent with their child if reunification is sought at a later date.[3,4]

Once the parent leaves the hospital premises and personnel notify the local child welfare agency that a baby was legally relinquished, the agency assumes custody and begins the task of placing the infant, initially in a preadoptive home. Many states require that the agency first determine if the baby has been reported as a missing child and/or if the baby's father is listed in the state's putative father's registry, which would protect the parental rights of an unmarried father.[3,4] In many states, the act of relinquishing an infant to a safe haven is presumed to be a relinquishment of parental rights, whereas approximately 20 states have procedures in place for a parent to reclaim their child within a specified amount of time, before parental rights have been terminated.[4]

## IMMEDIATE RESPONSE TO RELINQUISHMENT

A nurse may only have a few moments to reassure the parent that they are in a safe place and that staff are there to assist. When nurses are prepared, caring, and knowledgeable of the law at the time of a relinquishment, they can help to ensure a smooth transition and improve outcomes for both the parent and the baby. Research shows, however, that many nurses may not feel prepared to receive a baby.[1] Of 605 nurses in Texas who responded to a survey about the Safe Haven Law soon after it was enacted in their state, 92% reported feeling unprepared to receive an infant and scored an average of 40% on a test of knowledge about the law. In addition, 70% of the nurses surveyed reported that they had a negative attitude toward women who would relinquish an infant.[1] Physicians too, may not be prepared to receive an infant under a Safe Haven Law.[7] Emergency medicine residents in the state of New York were surveyed to determine the

percentage who were familiar with their state's Safe Haven Law and the level of their knowledge. Findings showed that 71% had never heard of the law. Of the 29% who did hear of it, more than a third did not understand it correctly. Researchers reported that both police and fire departments in New York include information on the Safe Haven Law in their training, whereas emergency medicine residencies do not.[7]

## Protocol Components

Hospital policy and protocols should follow state law and clearly describe the roles and actions of personnel at the time of a legal infant relinquishment. Although protocols will vary slightly depending on institutional resources, all need to include similar components (Supplementary Box).

## Simulation

### LOCAL BACKGROUND

When Safe Haven laws were passed, hospitals around the US created policies and developed staff education. However, assessing staffs' potential reaction if someone were to hand them a baby and ask, "You are a Safe Haven hospital, right?" is done less frequently. NSHA has developed online education modules as well as simulation checklists and other materials that hospital educators can use to assess staff competency.[2] Similar to regularly occurring infant hospital abduction drills, infant relinquishment drills can identify gaps in knowledge and prepare staff to ensure the safety of a relinquished baby and support the parent at this challenging time in their life.

The needs assessment at our large academic medical center in the Midwest began when hospital educators presented on the Safe Haven Law at a Women's and Children's Nursing Grand Rounds. Staff had misperceptions and asked many questions at this presentation. It became clear that the best way to know if staff would correctly assess a relinquishment situation, contact the team, and take appropriate action was to run an infant relinquishment drill in the emergency department, using equipment and resources from that unit and involving actual members of the health care team.[8] This in-situ drill would evaluate for 3 factors: (1) what the staff knew, (2) how they would respond without previous knowledge of the drill, and (3) opportunities for immediate improvement.

## Methods

Following the best practice standards established by the International Nursing Association for Clinical Simulation and Learning,[9] the intervention was the development and feasibility testing of an educational in-situ drill for infant relinquishment in the emergency department (Table). In-situ, live actor simulation can be used to identify knowledge gaps, solidify teamwork, and highlight the importance of communication in a unique situation.[10] This initiative was deemed quality improvement, nonhuman subjects research by the institutional review board.

## Planning the Simulation

The authors invited the clinical nurse specialists from the emergency and obstetrics departments and the assistant security director to assist with planning of the drill. The discussions considered the likely entrance points and places where it might be challenging to process the request of relinquishing a baby. The situation would be a young mother entering the hospital at the information desk and asking the staff if this was a Safe Haven hospital. The "relinquishing mother," a volunteer from the volunteer services department, met with the team a day before the drill to review the Safe Haven Law and her role as the young mom who is afraid and knows she cannot keep the baby. Her goal was twofold: find someone at the hospital to take her baby without having to answer too many questions and stay in the scenario long enough that it could end in the emergency department. Because it was in situ and took place in an actual patient care unit, the only equipment needed was a realistic-looking baby doll and blanket. The authors, clinical specialists, and security served as facilitators at different points during the drill: 2 near the information desk to ensure the drill had a good start and the mother was escorted to the emergency department, 1 near the ED admission/triage area to observe the activity of the staff and clients in the waiting room, and the final 2 inside the emergency department to meet the staff and mother for the final counseling discussion and infant examination. The lead facilitator developed a checklist of key steps and points that

TABLE
**Logic model - infant relinquishment in-situ simulation drill**

| Resources/Inputs | Activities | Outputs | Outcomes |
|---|---|---|---|
| Policy | Review policy for needed resources and consistency with state law | Determined objectives/checklist of critical points | Short-term: Amend policy to be feasible, safe, and consistent |
| Illinois state law | Review state law | Policy consistent with state law | Short-term: Materials to be available to parent |
| Personnel:<br>OB & ED CNS, volunteer services, security, guest services, ED staff<br>Interprofessional staff:<br>Emergency nurses, social worker, case manager, security | Needs assessment<br>Plan simulation<br>• Live unit<br>• Two contact points<br>• Facilitator locations<br>Hold prebrief<br>Walk-through<br>In-situ simulation drill | Identify gaps in knowledge<br>Propose simulation to ED leadership<br>Develop the scenario<br>Details and roles of simulation personnel finalized<br>Minor change to start of the drill based on walk-through<br>On unit simulation of parent relinquishing her infant | Support received from ED leadership for simulation drill<br>Scenario complete<br>Roles clarified<br>Fidelity to policy assessed |
| Equipment:<br>Doll<br>Blanket<br>Checklist | Secure materials from childbirth class<br>Develop checklist on the basis of policy and simulation objectives | Contributed to realism of the scenario<br>Assess for fidelity | Staff responses that did not match policy were noted |
| Room for debrief | Postsimulation debrief to review staff response | Areas for improvement identified and discussed | Short-term: Summarize event/make recommendations<br>Update policy<br>Make immediate corrections as indicated<br>Intermediate: Repeat drill<br>Long-term: Standardize annual drill/education |

OB, obstetrical; ED, emergency department; CNS, Clinical Nurse Specialist.
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should occur during the simulation to assess for fidelity to the policy and if the team met the objectives of the simulation (Supplementary Table).

## Stages of the Simulation

### PREBRIEFING

The simulation experience began with a prebriefing. The facilitators and volunteer met to discuss final details and alternate plans if the staff were unable to progress at any point. This was followed by a walk-through with the volunteer to identify the route and the staff she would most likely encounter. The goal of the walk-through was to "identify any confusing, missing, or underdeveloped elements of the simulation-based experience."[9] During the walk-through, it became evident that there would likely be a wait at the information desk and that the volunteer would need to move closer to the guest services person to be recognized more quickly than waiting in the line.

### IN-SITU DRILL

To begin the unannounced in-situ drill, the mother entered the hospital through the parking garage into the main entrance. She stood a little off to the side of the waiting line holding the baby doll, which was wrapped in a blanket, and waited to be noticed. When the guest services staff acknowledged her, the relinquishing person stated: "Are you a Safe Haven hospital?" This was a defining moment.

The guest services staff asked the volunteer to stand closer to her and then called for a security escort. The volunteer acted nervous to hearing the word "security" but was quickly reassured that they would be escorting her and her baby to the correct location for Safe Haven. Quietly, the security officer met the relinquishing person and asked her to follow him. Not speaking, they left to head toward the emergency department.

In the busy emergency department, the security officer stepped up to the intake desk to inform the triage nurse that there was a request to relinquish a baby. The triage nurse correctly observed a young woman with a doll who was acting as if the doll was a real baby. The nurse quickly assessed the situation and contacted the hospital's psychiatric team, an unforeseen consequence of an unannounced in-situ simulation. One of the facilitators was able to step in behind the nurse to explain this was a Safe Haven drill. The alert was changed from the psychiatric team to the social worker, case manager, and charge nurse. The relinquishing person was escorted to a consult room where she was met by the charge nurse who asked the patient her name. The baby doll was carried to an examination room.

Two of the facilitators joined the charge nurse as they waited for the social worker, who was looking for the packet of information. Not finding it, they checked the hospital policy on legal infant relinquishment and were able to access information by searching the internet for The Safe Haven Law (Illinois law: 325 ILCS 2/1-70). The online site allows full access to the Act, the brochure "Taking Care of Yourself After Giving Birth," a summary of the law, and the brochure "Help is Here," which includes the optional health history form and instructions in case the relinquishing person changes their mind within 72 hours or wishes to petition the court within 60 days.[11]

While waiting for the social worker, the charge nurse sensitively spoke to the relinquishing person to check on her physical health, offering a free postpartum check. The nurse also asked if she was comfortable to share whether she felt safe in her home environment. The social worker entered with the packet and informed the mother that her baby was healthy and that the Department of Children and Family Services would ensure a safe transfer to an adoption agency. At that point, the mother had stayed in the scenario long enough to meet the goals and asked to leave. She was asked to complete the health history form and mail it in the stamped envelope to the local child welfare agency as it would help the adopting family to better care for her child. That ended the single-event, 20-minute simulation.

## DEBRIEF

In a debrief, all personnel involved with the simulation come together to reflect on the expectations and consequences of staff response. The facilitators, volunteer mother, emergency charge nurse, social worker, and case manager met to openly communicate about what was learned as a result of the drill. Using the fidelity checklist to guide the discussion, the lead facilitator compared the responses of all personnel during the drill with the simulation objectives and the procedural steps outlined in the policy: the initial situational awareness at the guest services desk, the prompt response from security to escort the volunteer to the emergency department, that although she was asked to provide her name, the anonymity of the mother was maintained, the information packet was not immediately available, the mother was escorted to a private room while the child was examined, and the social worker was aware of the need to call the local child welfare department. The emergency triage nurse was unable to attend the debrief owing to needs of the unit but shared her thinking when she saw a woman with a doll and called the psychiatric team. Because this hospital is a large medical center with easy access from anywhere in Chicago, it is not unusual for a client with mental health needs to come to the emergency department. The ED team asked if it would be just as effective if the team knew beforehand that there was going to be a drill so that they could practice the correct steps. The ED team recognized infant relinquishment was a high-risk, low-volume event and requested more information about their responsibilities.

## EVALUATION

In the debrief, the team concluded that the drill was executed as planned and for the most part, the ED team adhered to the policy. The drill uncovered areas of the policy that needed updating or reviewing such as making information packets immediately available at the triage desk and in the case management office and not asking the relinquishing person their name. It also became evident that because of the extra time that the staff took to learn more about the mother and search for the packet of information, they risked that she would leave, possibly with the baby. After the evaluation, the plan was to revise the policy to improve efficiency, educate the staff, and inform all involved personnel that the drill would be repeated at a future date.

Here, we have added uniquely to the published literature by describing a method to evaluate emergency nurse competency during infant relinquishment at a safe haven location. We determined the simulation was feasible,

recommended the intervention should be repeated routinely, and relayed several lessons learned and recommended intervention adjustments to future replications of our live actor simulation. Future work should also measure knowledge, skill, attitude, and behavior changes of the clinical nurse participants with the intervention and provide more detail from the clinical nurse participant perspective.

## Implications for Emergency Clinical Practice

On the basis of our findings, we recommend that hospital and ED educators establish a plan to regularly evaluate interprofessional staff response to simulated infant relinquishment. On the basis of our lessons learned, hospital educators who plan to run an infant relinquishment simulation should inform staff of the drill in advance. If available, include a person experienced with simulation that can provide additional guidance during development, running, and evaluation of the drill. Using a timed checklist during the drill, as recommended by NSHA,[2] allows hospital educators to record the length of time it takes for staff to complete each critical step of the relinquishment process. This establishes a baseline from which improvements can be noted in subsequent drills. We recommend attempting to have all involved personnel attend the debrief session as this is when misperceptions and misinformation are clarified. We recommend the simulation team circle back to those who could not attend the debrief to see if they have any questions. Once identified, address the gaps in knowledge and resources that can be immediately corrected. We also recommend that individual clinical nurses and emergency care teams review policy, revise as needed, inform staff or colleagues, and repeat infant relinquishment simulations.

## Conclusion

Infant relinquishment is a rare event, and there is little room for error should it arise at your institution. Outcomes may be improved for both parent and baby if they are met by a knowledgeable nurse at the time of relinquishment. Training and simulation are excellent ways to ensure that safe and best practice is implemented in the event that a parent wishes to relinquish their baby under the Safe Haven Law. This article describes 1 hospital's experience in running an in-situ drill so that other institutions can prepare staff to accept a relinquished baby in a way that adheres to their state's law and provides a safe haven to both parent and newborn. Individual clinical nurses can also cognitively rehearse to prepare for a potential infant relinquishment in their practice.

Outside of the hospital, nurses are in a position to educate staff at other safe haven locations and raise the public's awareness about Safe Haven laws. See the Resources provided to order pamphlets and posters, which can be shared and displayed at health fairs and community congregating areas such as hair salons, faith community buildings, or high schools. Inform parents, teachers, neighbors, and friends about the law, particularly in networks where people may know someone who is trying to conceal a pregnancy.

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## Author Disclosures

Conflicts of interest: none to report.

J. B. Rousseau is a volunteer with the Illinois Save Abandoned Babies Foundation.

## Resources

Find a safe haven location. National Safe Haven Alliance. Accessed September 15, 2020. https://www.nationalsafehavenalliance.org/safe-haven-locations

Save Abandoned Babies Foundation. Accessed September 15, 2020. www.Saveabandonedbabies.org

National Safe Haven hotline: 888-510-BABY.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2020.12.005.

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## Supplementary Data

**Supplementary Box. Infant relinquishment policy and procedure template**

Purpose of the policy - To provide a mechanism for an unharmed newborn to be relinquished to a safe environment and for the parents of the infant to remain anonymous and free from civil or criminal liability for the act of relinquishing the infant.

Definitions – relinquishment, anonymous, unharmed infant, reclaiming.

Information about the law and how it affects hospital personnel, such as hospital personnel being immune from criminal liability for acting in good faith, that the hospital has temporary protective custody, and if the law applies to mothers who give birth while they are in the hospital.

Regulatory elements – Include a link to the state's Safe Haven law.

Outcomes – The optimal outcomes are that the relinquishing parent is given the option to provide medical history (anonymously if they choose), and the healthy infant is turned over to a child-placing agency, which could include the parent making a formal adoption plan.

Responsibilities and procedures – This section identifies the specific steps hospital personnel take to enact the policy; includes security personnel, front desk personnel, triage/charge nurses, physician/nurse practitioner, child protection staff, and patient liaison (case manager, social worker). Depending on state law and institutional resources, steps may include placing an ID bracelet on the baby, a medical examination of the infant, use of an interpreter when indicated, providing a professional to support and attend to relinquishing person's needs, calling child-placing agency and/or law enforcement, and materials to give to the relinquishing person that describes their rights and a way to provide medical history on the baby. Should the baby's mother be the one presenting to your institution, a professional such as a social worker should be available to assess for medical needs, emotional well-being, and safety.

Related hospital policies – such as child abuse and neglect, admission of a newborn, and interpreter services.[12]

Guidance on what to do in situations that are less clear, which will be state/hospital dependent:

- The baby is obviously older than state law allows.
- There is evidence of harm/positive drug screen.
- The infant is born in the hospital, and the mother or the birthing person wants to leave the baby.
- The parent returns to reclaim the baby soon after relinquishment.

**Supplementary Table. Fidelity checklist**

| Action | Met/Not Met | Time |
|---|---|---|
| The team, wherever this simulation would begin, will recognize the serious nature and work to protect the relinquishing person by activating the Security team. | | |
| The Security team will respectfully guide the relinquishing person to the emergency department without hesitation. | | |
| ED personnel will offer to bring the relinquishing person and infant to a private room and provide a counselor or a nurse to remain with them. | | |
| At no time will staff ask the patient's name, until given permission by the patient to do so. | | |
| The nurse and counselor will provide the designated packet of information (described earlier) as per state law to support the relinquishing person in their decision and guide them in the next steps. | | |
| The infant will be moved to an exam room to be assessed for health, safety, and age. | | |
| The relinquishing person would be offered emergency health care related to post-partum complications if indicated. | | |

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