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An Improved Perspective on Courage in Leadership and Embracing New Experiences

Jennifer Schmitz, MSN, RN, CEN, CPEN, CNML, NE-BC, FNP-C, EMT-P

As I sit and ponder what readers will want to hear from me when my President's Message is published nearly 3 months after I write it, I hope that the words that I write today will resonate with emergency nurses. That hope is what sparked my message for this issue of the journal. This year, a true pinnacle of my career, has been moving at lightning speed. At the end of 2021, I was unsure of how I would perform in the role of Emergency Nurses Association (ENA) President and, honestly, felt a bit like an imposter. I considered the previous ENA Presidents, appreciating all of their expertise and their accomplishments. They are truly an amazing group of professionals that I have looked up to throughout my career, and now I was heading into the lead role with the association that has been my professional home for years. I was full of excited energy and maybe bit fearful of the unknown. Needless to stay, the first half of this year as President has been one of the most rewarding experiences of my life. I also hit my 20th year in nursing this year. Twenty years! Time truly does fly. My role as ENA President is the best honor I could have asked for as an emergency nurse and as a leader. My love and passion for nursing has always lived in emergency nursing, no matter what role I've had.

You may be wondering why I am opting to share my thoughts on this role with all of you. My perspective after being in the role, doing the job, and being able to be a courageous leader is vastly different from how it was when I took on this role. Yes, I was apprehensive about my first interview on live television and jittery about speaking in front of a live audience for the first time in 2 years, but I did it, and the feeling afterward was better than I could have imagined. I would encourage each of you to try and face the challenges in front of you; start small if you would like, and the payoff could be big. It could change your life and open new doors for you that you couldn't ever have imagined.

This year we have focused on how nurses can recharge, taking care of ourselves so that we can better take care of others. Part of my own recharging is to stay present, to stay in the moment, and take it in. So now, rather than focusing on the worry or the things I don't feel confident in, I am trying to slow down and take in each moment for what it is.

ENA has also focused on finding ways to support emergency nurses and the care they provide. The association has made great strides in developing new programs and offering continuing education and, most recently, the launch of the Emergency Nurse Residency Program. In September, we will participate in our first in person annual conference since 2019. This will be a great way for emergency nurses to connect and recharge through networking with peers and attending the learning events. The conference will consider all important safety measures.

I am incredibly grateful for the experiences, friendships, and professional connections I have made through this association. These will last a lifetime, even as my role changes. I am excited for the rest of the year ahead and looking forward to connecting with you all in my last two President's Messages.

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Implementing the Total Worker Health Program in a Shared Governance Context

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Healthy work environments are critical to the stability and well-being of the nursing workforce, in addition to promoting optimal patient safety and patient outcomes and ensuring the viability of health care organizations.[1] The National Academy of Medicine's Future of Nursing 2020 to 2030 notes the importance of supporting the health and well-being of nurses, stating "…it is essential to address the systems, structures, and policies that create workplace hazards and stresses that lead to burnout, fatigue and poor physical and mental health among the nursing workforce."[2] For years, unrealistic workloads, risk of infection and workplace violence, insufficient resources, and moral distress/injury have contributed to turnover, burnout, and poor professional quality of life—threatening the viability of nurses in the health care workforce.[2] In addition, the ongoing pandemic disaster has intensified nurse exposures to occupational hazards, resulting in increased negative physical/mental health outcomes and a continuing exodus from the profession.[3] As emergency clinicians, we are focused on achieving optimal patient outcomes, but who is focused on monitoring and improving our work-related well-being and occupational health outcomes?

The World Health Organization recognizes occupational health as an area of public health that seeks "to promote and maintain highest degree of physical, mental and social well-being of workers in all occupations."[4] In 1970, the National Institute for Occupational Safety and Health (NIOSH) was established as part of the US Centers for Disease Control and Prevention to function as a research agency with a mission of generating new knowledge in the field of occupational safety and health and to translate that knowledge to practice. NIOSH seeks to advance worker well-being and empower workers and employers to create healthy, safe workplaces.[5] In the early 2000s, NIOSH launched an initiative to improve the health of the United States workforce that eventually became known as the Total Worker Health (TWH) Program. This model aims to protect the safety and enhance the health and productivity of the US workforce through policy, programs, and practices that advance worker well-being.[6] The purpose of this editorial is to consider how the concept and resources of TWH can be used by shared governance/unit-based practice councils and nurse leaders to positively affect the occupational health of nurses and other health care workers.

Shared Governance/Unit-Based Practice Councils

Shared governance is a working model or management style of participatory decision making that promotes principles of nurse involvement, empowerment, ownership, accountability, team building, leadership, innovation, and autonomy to promote quality care.[7-9] Essentially, it is a complex organizational component that encompasses the ways professionals regulate, direct, and control goal-oriented efforts.[10] Originally introduced to improve the work environment of nurses, patient/staff satisfaction, and retention,[7] the principles of shared governance are promoted by the American Association of Critical Care Nurses,[11] American Nurses

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Credentialing Center, Magnet,[8] and Pathway to Excellence programs.[12] Notable variation exists in theoretical underpinnings, forms, and scopes of shared governance committees, which makes rigorous outcome evaluation challenging.[7] In a recent integrative review, Kanninen et al[12] noted the success of shared governance committees depends on organizational support, work culture, and resources, rather than its mere existence, to produce optimal outcomes. Unit-based councils are shared governance models tailored to individual nursing units.

Given the systems, structures, and policies that create workplace hazards that lead to burnout, fatigue, and poor health outcomes among nurses (contributing to subsequent, negative impacts on the quality of patient care/outcomes), the prioritization of nurse health within a unit-based council is intuitive and easily justifiable. The Emergency Nurses Association's Healthy Work Environment in the Emergency Care Setting Position Statement recognizes the component of mutual responsibility between the leadership and health care workers in creating a healthy work environment.[11] The National Academy of Medicine advocates for a systems approach to support professional well-being and address clinician burnout.[13] Unit-based councils are composed of frontline staff, making this a setting where meaningful and impactful dialog can be exchanged to address unique strengths, barriers, and facilitators within a unit to optimize work environments and staff well-being. Nurse leaders can promote the engagement and empowerment of staff within a shared governance context to advance the well-being of health care workers on their units by evaluating, revising, and implementing policies, programs, and practices that both reduce work-related hazards and promote injury prevention.[14] Maintaining a high-level focus with simultaneous support of ED leadership is key to success. The Hierarchy of Controls is a model of controlling exposures to occupational hazards and is considered a fundamental concept in worker protection. It emphasizes organizational-level interventions to protect the health, safety, and well-being of workers. As the Hierarchy of Controls applied to the NIOSH TWH model[15] depicts (Figure 1), encouraging personal change by focusing on individual determinants is only a small part of both worker health and health in general. In other words, burnout is an organizational issue that affects individuals, rather than an individual issue as it has been historically considered.[16] Even the most generous and consistent amounts of self-care will likely be insufficient to mitigate burnout in chronically depleting or under resourced work environments. Environmental conditions (ie, the work environment), health protective/enhancing policies, programs and practices, and education have the potential for the greatest impact and warrant our attention as frontline health care professionals, leaders, researchers, and equity advocates.[15]

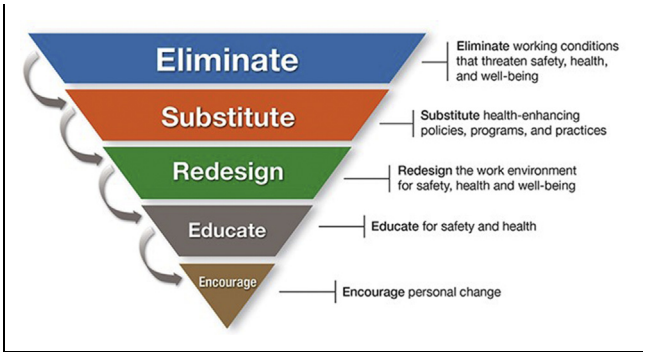

FIGURE 1

Hierarchy of controls applied to NIOSH TWH.[14] NIOSH, National Institute for Occupational Safety and Health; TWH, Total Worker Health.

Shared Governance and TWH

The TWH approach has 5 defining elements, listed in Figure 2, that are explained in detail in the Fundamentals of Total Worker Health Approaches workbook[14] (Table). Below, we review various ways these elements could be incorporated in an ED unit-based practice council—with the support of ED management and directors—to address issues relevant to advancing the health of nurses and other health care workers. Issues that NIOSH has identified as relevant to advancing worker well-being through TWH can be visualized in Figure 3.[14]

1. Demonstrate leadership commitment to worker safety and health at all levels of the organization.

Unit-based councils can discuss which initiatives currently exist and evaluate whether existing initiatives necessitate change. Conducting a preliminary needs assessment is a great place to start within this first element. Measurements and surveys not only support needs assessments but aid in program/intervention evaluation and optimization. The NIOSH Worker Well-Being Questionnaire can be used for these purposes.[17] This 5-section, 63-item questionnaire is published in the public domain and is free to use (Table). Other instruments such as safety climate scales,[18] the National Database of Nursing Quality Indicators,[19] and various types of annual surveys used by health care organizations may also be used to measure various aspects of occupational health, safety climate/culture, satisfaction, turnover intent, resources, etc. Other workplace assessment instruments and resources can be found online in the National Academy of Medicine's Clinician Well-Being and

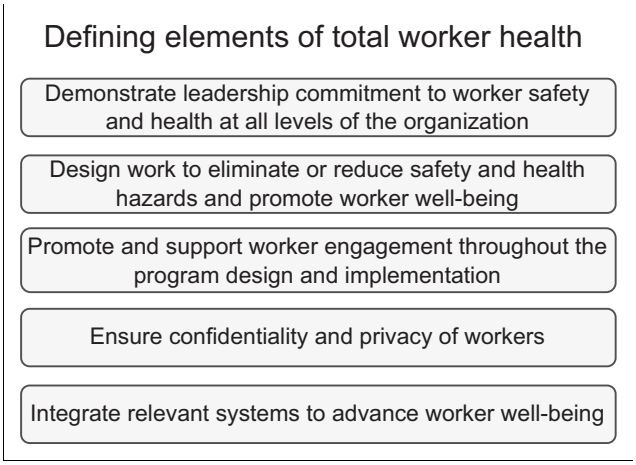

FIGURE 2

The defining elements of TWH established by NIOSH to advance worker safety, health, and well-being.[14] NIOSH, National Institute for Occupational Safety and Health; TWH, Total Worker Health.

Resilience Toolkit.[20] Annual assessments can be useful to unit councils in assessing needs and trends within their department. TWH emphasizes the importance of considering organizational readiness to change. Weiner[21] refers to this concept as a shared team property, a psychological state where members of an organization share a sense of commitment to implement an organizational change and are confident they can do so. This concept is critical to successful innovation and implementation.

Commitment to worker health must be prioritized among top leaders and should hold the same value as quality patient care and outcomes. This could include incorporating safety/health related standards into performance evaluations, establishing a budget for acting on employee recommendations, or providing adequate resources (ie, staff, time). Caution should be exercised to prevent productivity targets from compromising resources in a way that interferes with the nurse's ability to deliver quality care. Midlevel managers can review Making the Business Case[22] (Table) to quantify and project the value that TWH initiatives can bring to the organization (such as reduced turnover, workforce sustainability, etc.). Just as midlevel management links ED staff and upper management, unit-based councils have the ability to connect ED staff with midlevel management. ED leaders can welcome and encourage employee feedback through and from unit-based practice councils on working conditions and willingly collaborate for change. Nurse leaders can reward staff for achieving reporting goals of safety concerns or incidents and celebrate benchmarks in employee health/safety. Increasing active participation, input, and involvement from frontline staff and/or unit councils is empowering and promotes respect, contributing to an environment where change is welcome and innovative programs can thrive.[14]

2. Design work to eliminate or reduce safety and health hazards and promote worker well-being.

The clinical work environment is a social determinant of health. NIOSH and TWH recognize that the most effective means of prevention is to eliminate or reduce recognized workplace hazards (Figure 2). The Hierarchy of Controls applied to NIOSH TWH visually emphasizes that organizational-level interventions are the most impactful when it comes to protecting the health, safety, and well-being of employees.[15] As frontline workers, unit council members can expertly identify job-related hazards in the work environment. During shared governance meetings, workers can brainstorm to identify hazards and potential ways to redesign or reorganize the work environment to

TABLE

TWH resources for nurses and health care leaders

Total worker health resource	Description
Essential Elements of Effective Workplace Programs and Policies for Improving Worker Health and Wellbeing[25]	This document includes 20 guiding principles for organizations and nurse leaders seeking to pursue work-related safety/health.
Fundamentals of TWH Approaches[14]	Available as a free PDF, this workbook can assist nurse leaders in optimizing existing initiatives or developing new TWH initiatives. Videos, printable guides, and other relevant resources are also included in this workbook.
Assess where your organization is on the TWH continuum and develop an action plan to start implementing TWH approaches[14]	These free worksheets are available for organizational self-assessment and for developing action plans.
Making the business case[22]	Review examples of how the TWH approach can benefit the organization and its workers.

PDF, portable document format; TWH, Total Worker Health.

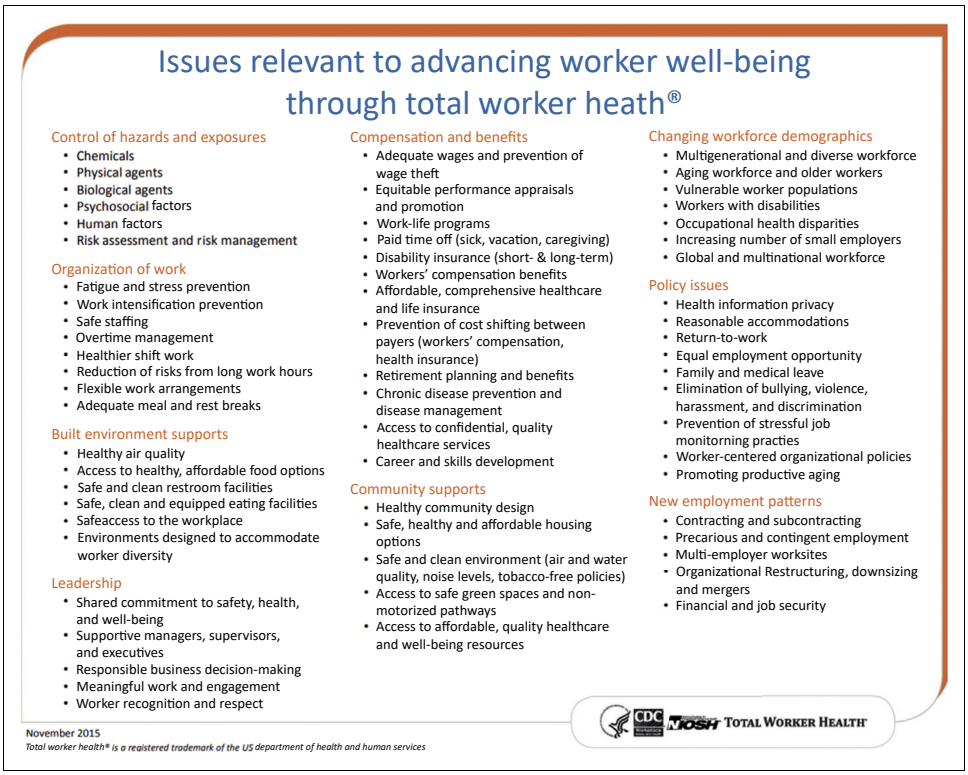

FIGURE 3

Issues that NIOSH has identified as relevant to advancing worker well-being through TWH.[14] NIOSH, National Institute for Occupational Safety and Health; TWH, Total Worker Health.

eliminate or minimize risk, providing recommendations to ED leaders. An example provided in the TWH workbook[14] includes policy implementation that gives nurses greater control and flexibility over their work schedules as an intervention to reduce work-related stress. Stress-reducing or skill-building interventions and easy access to Employee Assistance Programs or other noninstitutionalized mental health services are other examples.[14]

3. Promote and support worker engagement throughout the program design and implementation.

The third element of TWH is embedded in the very design of shared governance—a participatory model that enhances staff engagement and empowerment. ED leadership should prioritize programs of most importance for frontline workers and involve unit-based council members in the program design, planning, implementation, and evaluation phases of projects. All interventions should be created with long-term considerations for sustainability. Unit-based councils may also choose to implement initiatives to promote and support worker engagement. Interventions such as meaningful recognition, shared decision making, and increased leadership support and involvement have been implemented successfully and reported in published literature.[23] Organizational resources must be aligned to support the prioritized programs identified by frontline workers.[14]

4. Ensure confidentiality and privacy of workers.

Implementing and evaluating programs to promote the occupational health and well-being of nurses may involve employees sharing confidential information pertaining to their health. Nurse leaders should ensure confidentiality and data privacy regarding these matters, the fourth element of TWH. Unit-based councils also need to consider this when creating, implementing, monitoring, or evaluating initiatives. Frontline staff should be involved in program planning meetings and can work with leaders to develop surveys. Communication regarding how employee data will be used and protected should be transparent across all levels of the organization. At no time should data be collected in ways that could result in discrimination, stigmatization, or penalization of employees. Program evaluation data, risk assessments,

self-reported survey data, and electronic health records are examples of personal health information that may be used in a TWH initiative. Precautions such as record deidentification, third-party involvement, aggregate data use/reporting, and destroying personally identifiable information are privacy practices that can help ensure confidentiality.[14]

5. Integrate relevant systems to advance worker well-being.

When considering the fifth element of TWH, unit-based councils and nurse leaders can collaborate regarding system integration of data sources. Coordination can reduce redundancies and maximize effectiveness and resources. An initial assessment of safety and health policies, programs, and practices can reveal areas of overlap and opportunities for future coordination. Unit-based councils can expertly assess how policies and programs may or may not affect practice and worker well-being. Team meetings that convene staff and leaders with similar responsibilities can be helpful to plan and set priorities. Obtaining a multilevel perspective can assist organizations in mapping the connections between different systems and the experience of workers to design the most effective and innovative approaches to different workplace challenges.[14]

TWH provides resources to obtain a baseline unit/organizational assessment or worker health; identify steps to begin improving worker health, safety, and well-being; and measure progress over time. Few studies among the existing literature assess the impact of the work environment on nurse occupational outcomes. In a systematic review, Wei et al[1] examined the state of the science of United States nurse work environments, finding only 2 of the 54 included studies contained nurse occupational health outcome measures. This author team noted that the existing literature pertaining to nurse work environments was mostly descriptive and also observed a dearth of research studies that investigate the contribution of nurses to building/maintaining healthy work environments.[1] Interventions need to be designed and tested to advance our understanding of improving work environments and promoting nurse occupational health. Work environment measures also need to be applied consistently (some scales have been modified over time) and longitudinally to better understand the scope of normal fluctuation from a range of data.[24] Regular and consistent measurements are especially vital in the context of infectious disease surges, which strain health care workers and resources.

The long-term implications of pandemic-related increases of workplace hazards and stresses in a disaster context are evolving and have yet to be fully realized. It is undeniable that great opportunities exist regarding the research of nurse work environments and to promote worker health. The TWH framework outlines an approach to assess, implement, and evaluate programs to positively affect the occupation health of nurses and health care workers. Unit-based councils can be empowered to initiate and regulate such efforts. It has never been more important for health care organizations to prioritize the health of their workforce.[14] The TWH approach can provide ED leaders, unit-based practice councils, and frontline workers with the structure and resources to collaborate and positively affect the occupational health of nurses and other health care workers.

Author Disclosures

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COVID-19 and New Onset IgA Vasculitis: A Systematic Review of Case Reports

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Contribution to Emergency Nursing Practice

- The current literature on immunoglobulin A vasculitis indicates that it may be triggered by upper respiratory tract infections. Cases of COVID-19–mediated immunoglobulin A vasculitis are characterized by a more severe disease course because of increased renal involvement.
- This article contributes the finding that existing literature suggests immunoglobulin A vasculitis may result from COVID-19 infections and that prompt recognition and treatment are necessary to improve patient outcomes.
- Key implications for emergency nursing practice found in this manuscript are being aware that COVID-19 is a provoking factor that may lead to the development of immunoglobulin A–related disorders. In addition, the manuscript outlines management and treatment for patients diagnosed with immunoglobulin A vasculitis.

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Abstract

Introduction: Immunoglobulin A vasculitis is historically more commonly found in children after certain viral infections such as Epstein-Barr, varicella virus, and parvovirus B19. COVID-19 has not been formally established in literature as a trigger for immunoglobulin A vasculitis. However, a main pathogenetic mechanism of COVID-19 is vascular damage, which makes it likely that vasculitis associated with COVID-19 (ie, COVID-19–mediated immunoglobulin A vasculitis) could be biologically plausible, with serious implications, especially for adults. The purpose of this review is to assist emergency nurses in gaining knowledge on the pathophysiology, symptoms, and treatment of COVID-19–mediated immunoglobulin A vasculitis.

Methods: A systematic search for case reports of COVID-19–associated immunoglobulin A vasculitis was conducted in the PubMed and Scopus electronic databases. The search terms used were COVID-19, coronavirus 2019, SARS COVID-19, and IgA vasculitis, case reports. The following were the inclusion criteria: publication dates between December 1, 2019, and December 1, 2021; full-text article, clinical case studies, and letters to the editor available electronically in English. The following were exclusion criteria: a summary of reports and newspaper publications.

Results: Only 13 clinical cases met the inclusion criteria. The median age of patients described in the case reports were 38.1 years. Of them, 3 children were less than 5 years old. Twelve patients were male. In 7 of 13 cases of immunoglobulin A vasculitis, renal involvement was found.

Discussion: The analysis of published clinical cases showed that COVID-19–associated immunoglobulin A vasculitis affected mostly adults and was characterized by a more severe course because of renal involvement. COVID-19 may be a possible trigger for immunoglobulin A–related disorders. More research is needed to better understand the relationship between immunoglobulin A vasculitis and COVID-19.

Key words: IgA vasculitis; COVID-19; Dermatology; Hematology

Introduction

COVID-19 has rapidly spread worldwide, affecting 504 million people and causing more than 6.2 million deaths to date.[1] Typically, patients with COVID-19 present with fever, computed tomography signs of interstitial pneumonia, and respiratory distress; dermatological manifestations of infection have been reported in only a few publications.[2-5] The incidence rate of dermatological manifestations of COVID-19 ranges from 0.2% to 20.4%.[6,7] Immunoglobulin A vasculitis (IgAV) has been identified in previous case reports as a potentially uncommon complication of COVID-19, with no data on its prevalence.

Purpose

The purpose of this systematic review of case reports is to explore the relationship between IgAV and COVID-19 and assist emergency nurses in gaining knowledge on COVID-19–associated IgAV. In this manuscript, we discuss the symptoms and treatment of this condition and review case reports published between December 1, 2019, and December 1, 2021.

Overview of IgA vasculitis

DEFINITION

Vasculitis is a condition that occurs when swelling and inflammation occur to the walls of blood vessels. Vasculitis can occur as a result of autoimmune disorders, infections, and trauma. IgAV is a disease that causes the antibody IgA to collect in small blood vessels, which then experience inflammation and leak blood.[8] The site of vessel involvement, size of the affected vessels, extent of vascular injury, and underlying pathology determine the disease phenotype and severity. IgAV is a leukocytoclastic vasculitis of small vessels with predominant IgA deposition. The exact cause of the illness, however, is unknown. It often occurs after acute respiratory infection (Epstein-Barr, varicella virus, parvovirus B19, Mycoplasma, Campylobacter jejuni).[8,9] IgAV notably affects children between 3 and 15 years. It is estimated that approximately 10% of the affected population are adults and that this category of patients is prone to kidney involvement and malignancy.[10]

PATHOPHYSIOLOGY

The current COVID-19 pandemic has led to a small but growing body of evidence that IgAV may be caused by a viral infection. It is known that COVID-19 can affect the circulatory system and cause apoptosis, inflammation, and dysfunction of endothelial cells and thrombosis.[11] Cutaneous manifestations of COVID-19 include urticaria,[7] reticular rash,[12] red-purple papules,[13] urticarial and varicella-like exanthema,[14,15] petechiae,[16] and even ecchymosis.[17] Moreover, according to some authors, petechiae, purpura, and acral ischemia accompanied by coagulation disorders are prognostically unfavorable symptoms and may indicate a more severe course of the disease.[18] A clinical case of large vessel vasculitis after COVID-19 has been reported recently. The authors suggested that infection and endotheliitis may lead to the development of vasculitis.[19] Exaggerated immune response to COVID-19 leads to IgA accumulation in the vascular wall and renal mesangium and the development of IgAV[20] (Figure 1).

MANIFESTATIONS

Palpable nonthrombocytopenic purpura of lower extremities and buttocks is a characteristic and hallmark sign of IgAV. Other manifestations include acute enteritis, renal impairment, and arthritis. Colicky abdominal pain, abdominal tenderness, and melena are typical gastrointestinal symptoms of IgAV. Intussusception is more common in children. IgAV may occur during the course or before the diagnosis of malignant tumors, particularly with adult-onset IgAV. Adults diagnosed with IgAV are also at a greater risk of kidney involvement.

DIAGNOSTICS

The clinical classification of IgAV is based on research from the European League Against Rheumatism (EULAR), the Paediatric Rheumatology European Society (PRES), and the Paediatric Rheumatology International Trials Organization (PRINTO).[21] Purpura or petechiae must be present, as well as 1 of the other 4 criteria: abdominal discomfort, histopathological appearance, arthralgia, and renal involvement. In addition to the EULAR/PRES/PRINTO clinical criterion for IgAV, histological studies confirming leukocytoclastic vasculitis and IgA deposition in blood vessel walls can be used to confirm the diagnosis. In patients with unusual distribution of rash (extensive lesions or diffusely distributed lesions) and atypical clinical manifestation, tissue biopsy (skin or kidney)

must be done to confirm the clinical diagnosis.[22] Similarly, the absence of IgA staining on biopsy does not rule out the possibility of IgAV.[23]

IgA vasculitis is characterized as vasculitis with IgA1-dominant immune deposits that affect small vessels in the skin and gastrointestinal tract and frequently cause arthritis, according to the 2012 Chapel Hill Consensus Conference.[24] IgAV is also linked to glomerulonephritis, which is indistinguishable from IgA nephropathy (IgAN). Deposition of glomerular IgA on biopsy is characteristic of both IgAV and IgAN. While both IgA nephropathy and IgAV can cause hematuria, IgAV clinically differs from IgA nephropathy in that the pathology includes extra-renal involvement of skin (purpuric rash), joints (arthralgias), and gut (abdominal pain, melena).[24] IgAV is indicated by strong IgA deposition in the absence of other antibody deposition.

MANAGEMENT

IgAV is a self-limiting disease, especially in children. Glucocorticoids are standard treatments in IgAV and are used to reduce inflammation and prevent complications.[22] According to SHARE (Single Hub and Access point for paediatric Rheumatology in Europe) initiative, glucocorticoids should be considered in the presence of the following conditions associated with IgAV: orchitis, cerebral vasculitis, pulmonary hemorrhage and severe gastrointestinal involvement, IgA nephritis, severe abdominal pain, and/or rectal bleeding. The dose of oral glucocorticoids (prednisoLONE/predniSONE) is 1-2 mg/kg/day. In severe cases, intravenous MethylPREDNISolone (eg, 10-30 mg/kg with a maximum of 1 g/day on 3 consecutive days) may be considered.[22]

Additional immune suppressors such as azathioprine, mycophenolate mofetil, and cyclophosphamide are prescribed to patients with more severe cases, including those with renal and gastrointestinal involvement. Although the results of treatment are controversial, a retrospective study by the French Vasculitis Group,[25] as well as a prospective study by Pillebout et al,[26] showed that there is no significant difference between combined treatment of glucocorticoids with immune suppressors (cyclophosphamide) and glucocorticoid treatment alone as it relates to patient outcome and mortality. Recent studies demonstrated the efficiency of riTUXimab, a monoclonal antibody medication, in the treatment of adult-onset IgA vasculitis.[27] Colchicine and dapsone have also been reported to be effective for treating chronic IgA vasculitis. However, there are still no randomized controlled trials to determine the optimal therapeutic dose and duration of treatment.[28] Finally, plasma exchange in combination with steroids has been associated with good outcomes in adults with IgA vasculitis.

Relapses typically occur in 20% to 30% of individuals diagnosed with adult-onset IgA vasculitis. The predictor of relapse was persistent purpura, severe leucocytoclastic vasculitis, abdominal pain, hematuria, and adult onset of the disease.[29]

Method of Identification of Case Reports

We searched PubMed and Scopus databases for articles including case reports published between December 1, 2019, and December 1, 2021, using the following keywords: "COVID-19," "coronavirus 2019," "SARS COVID-2," and "IgA vasculitis." Clinical case studies and letters to the editor that were written in English and accessible in full text were included. Summary reports and newspaper publications were excluded. For inclusion, we independently reviewed the titles and abstracts of retrieved citations, and any inconsistencies were resolved by consensus. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist for writing a systematic review of case reports was used. The quality of clinical cases were evaluated by Equator network's Clinical Case Reporting Guideline Development (CARE) checklist. In total, 680 full-text publications were checked, with reference lists manually scanned for additional studies (See Figure 2).

Discussion of Case Reports

There were only 13 cases that met the requirements for inclusion. In the presented clinical cases, 5 of 13 were found in children. IgAV is more common in children, while COVID-19–associated IgAV is more common in adults (8 cases of 13). Our data are consistent with the results of other study.[30] The analysis of clinical cases showed that COVID-19–associated IgA vasculitis affects mostly adults, and concomitant diseases are characterized by a more severe course of the disease with damage of the skin, joints, and kidneys. Renal involvement was found in 7 of the 13 published clinical cases of IgAV. Renal involvement ranged from proteinuria and/or hematuria to acute renal insufficiency with elevated creatinine. Four of the patients had no respiratory symptoms. It can be assumed that asymptomatic COVID-19 infections in children and young people may cause latent vascular damage. Only 3 patients had

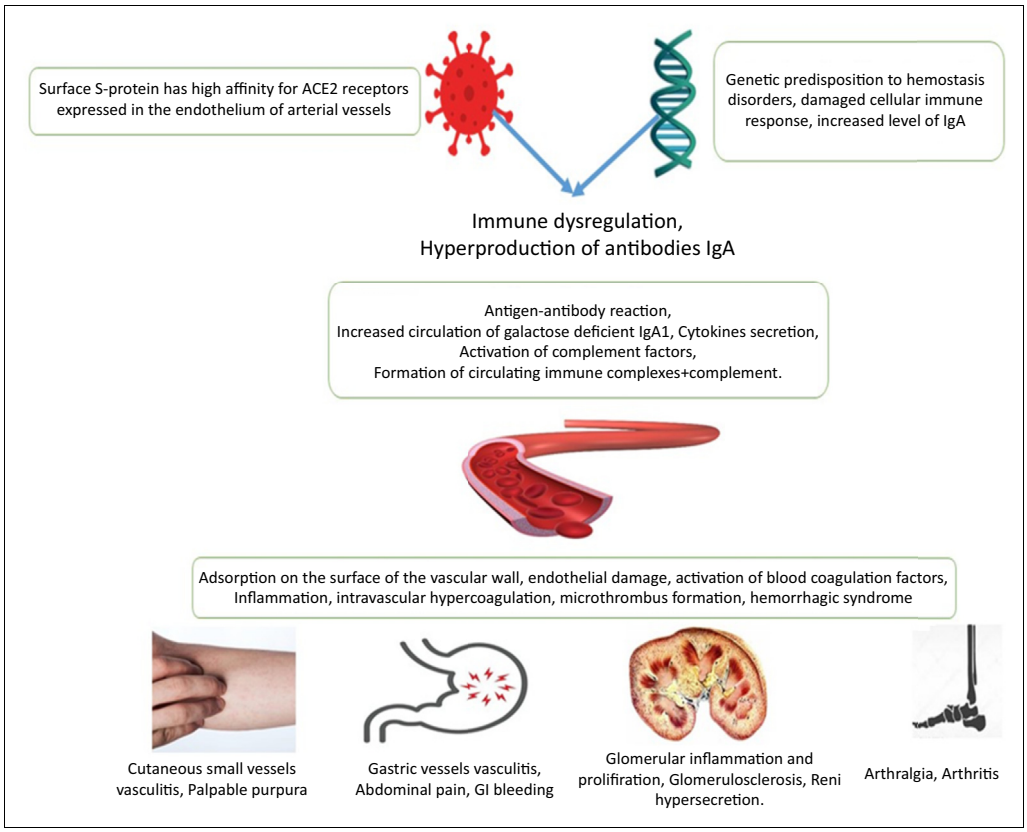

FIGURE 1

Pathogenesis of COVID-19 associated IgA vasculitis. ACE2, angiotensin-converting enzyme 2; IgA, immunoglobulin A; GI, gastrointestinal.

pneumonia. In almost all cases, a positive effect from the use of glucocorticoids was reported, which is similar to the findings of previously reported studies.[31] Only 2 pediatric cases did not require treatment with glucocorticoids.

ADULT CASES

One of the first studies that described COVID-19–related IgAV was published by Allez et al[32] in November 2020 (Tables 1 and 2). This study involved a 24-year-old man with Crohn's disease under anti-TNF therapy and showed skin, joint, and abdominal symptoms of IgAV. A similar case was also described in a 22-year-old young man but with the development of IgA nephritis.[33] Nasopharyngeal swabs for COVID-19 and polymerase chain reaction (PCR) testing were positive in both cases (Table 1). In the first case, the patient complained of a skin rash, and further examination revealed a positive PCR test. In the second case, the COVID-19 symptoms and vasculitis developed simultaneously. In both cases, a skin biopsy confirmed the diagnosis of IgAV. In the second case, a kidney biopsy was performed, as IgAN developed. The authors hypothesized that COVID-19 causes IgA-mediated diseases with the deposition of immunoglobulin A in the skin and other organs and the development of vasculitis.

A similar case was described by Li et al[34]: a 30-year-old man with clinical signs of active COVID-19 infection presented with purpuric rash, joint, and abdominal pain, proteinuria, and hematuria. COVID-19 was verified by a positive throat swab and SARS-CoV-2 nucleic acid testing. The diagnosis of IgAV was confirmed by a biopsy of the skin and kidneys. A skin biopsy showed signs of leukocytoclastic vasculitis. Given the persistence of the urinary syndrome (proteinuria, hematuria), a kidney biopsy was performed, which showed signs of IgAN. Rowley and Shulman[35] found IgA plasma cell infiltration of the coronary arteries, pancreas, and kidneys in patients who died of Kawasaki disease. They hypothesized that the virus or pathogen invades through the respiratory or digestive tract, and IgA producing plasma cells affect the coronary arteries and heart muscles, etc. Comparative characteristics of the clinical cases are presented in Tables 1 and 2.

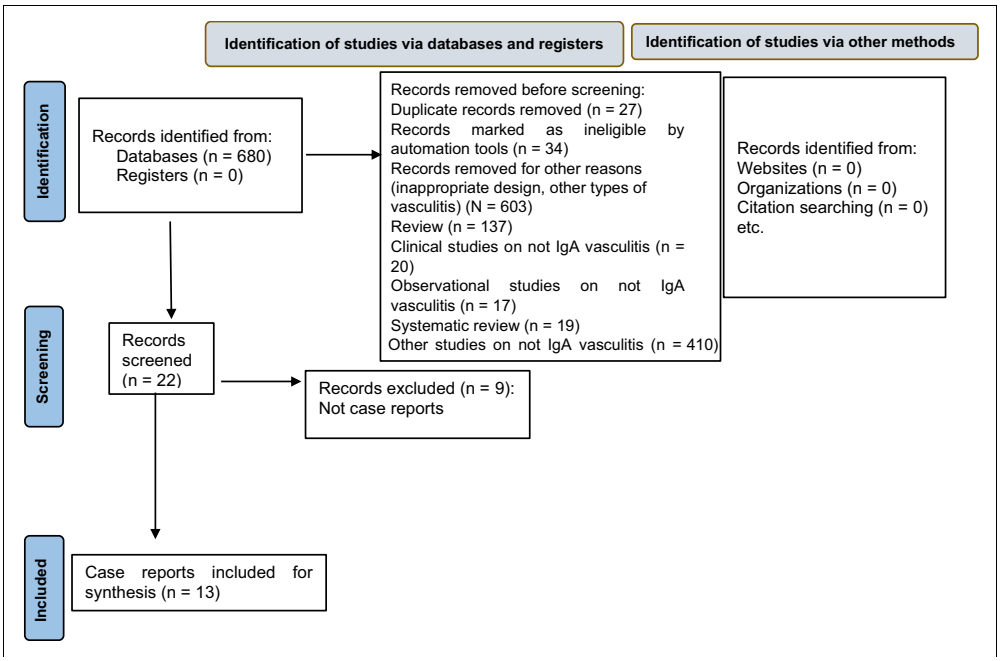

FIGURE 2
PRISMA diagram of search process.[52]

PEDIATRIC CASES

In children, IgAV most commonly affects males under 5 years of age. A 3-year-old male with palpable purpura and abdominal pain, without renal or musculoskeletal involvement, presented during an active COVID-19 infection.[36] A nasopharyngeal swab tested positive for SARS-CoV-2 using reverse transcriptase-PCR. He was diagnosed with IgAV after meeting 2 clinical criteria (palpable purpura and abdominal syndrome). AlGhoozi[37] also reported the case of a 4-year-old male with skin and joint symptoms 37 days after a COVID-19 upper respiratory infection. A PCR test performed 2 distinct times, 5 days apart, confirmed his COVID-19 positivity. The patient's clinical presentation was consistent with the EULAR/PRINTO/PRES criteria for IgAV,[21] as it met the requirement of a characteristic rash in the absence of thrombocytopenia, as well as one of the supportive criteria of acute arthralgia of the ankle joints. An additional case of a 2-year-old male positive for SARS-CoV-2 with gastrointestinal (hematochezia, vomiting streaked with blood, abdominal pain) and skin manifestation (palpable purpura and ecchymosis) without respiratory symptoms was recently published. Unlike other cases, the child had an elevated D-dimer (19.88 mg/ml) and c-reactive protein (2.5 mg/dl).[38] COVID-19 was diagnosed simultaneously with IgAV. COVID-19 was detected in a nasopharyngeal sample using PCR. A skin biopsy of the patient's right thigh revealed superficial perivascular inflammation with neutrophils and positive immunostaining for IgA.

A 16-year-old male developed a purpuric rash of his lower limbs and buttocks, severe abdominal pain, hematochezia, and hemoptysis 2 days before testing positive for SARS-CoV-2. This patient also had renal involvement, including severe proteinuria and hematuria. This patient was prescribed oral prednisoLONE for a month in combination with ramipril.[39] A similar case was described by Borocco et al[40] in a 13-year-old girl with a positive PCR for SARS-CoV-2 and Epstein-Barr virus. IgAV was diagnosed clinically according to EULAR/PRINTO/PRES criteria in both cases.

OLDER ADULT CASES

Five cases of IgAV in older adults were found in the literature. Suso et al[41] reported the case of a 78-year-old man with COVID-19 pneumonia, who developed cutaneous vasculitis, arthritis, and nephritic syndrome 5 weeks after COVID-19. The diagnosis of COVID-19 was made based

TABLE 1
Diagnostic findings of IgA vasculitis in patients with COVID-19

N	Reference	Age/sex	Diagnostic date/method for IgAV	Diagnostic date/method for COVID-19	The period from a positive PCR test to the appearance IgAV signs
1	Allez et al[32]	24 y/male	Not reported/skin biopsy H/E: perivascular and vessel wall infiltration by neutrophils and lymphocytes, leukocytoclasia DIF: C3 and IgA deposits in dermal capillaries	Not reported/ a positive PCR test for SARS-CoV-2 in a nasopharyngeal swab. Positive serology for COVID-19.	Not reported
2	Suso et al[41]	78 y/male	3 wk after discharge date 17 April 2020/kidney biopsy H/E: segmental mesangial expansion with hypercellularity in 4/7 glomeruli, epithelial crescents in 2/7 glomeruli, without tubular or interstitial defects DIF: IgA granular deposits in the glomerular mesangium	4 April 2020/a positive PCR test for SARS-CoV-2 in a nasopharyngeal swab. Positive result for anti-SARS-CoV-2 by chemiluminescent immunoassay.	5 wk
3	Sandhu et al[33]	22 y/male	Not reported/skin and kidney biopsy Skin biopsy: H/E: signs of LCV DIF: negative for IgA deposition (after 48 hours) Kidney biopsy H/E: signs of focal necrotizing, mesangial, and focal endocapillary proliferative IgA nephropathy DIF: IgA mesangial granular deposition	30 August 2020/a positive PCR test for SARS-CoV-2 in a nasopharyngeal swab	Simultaneously
4	Jacobi et al[36]	3 y/male	Not reported/ clinically (palpable purpura and abdominal pain)	Not reported/ a positive RT-PCR of a nasopharyngeal swab.	Simultaneously
5	AlGhooziand AlKhayyat[37]	4 y/male	Not reported/ clinically (palpable purpura and arthralgia)	Not reported/a positive PCR test for SARS-CoV-2 in a nasopharyngeal swab.	37 d

continued

TABLE 1
Continued

N	Reference	Age/sex	Diagnostic date/method for IgAV	Diagnostic date/method for COVID-19	The period from a positive PCR test to the appearance IgAV signs
6	Hoskins et al[38]	2 y/male	Not reported/ skin biopsy H/E: perivascular inflammation with neutrophils Immunostain: positive for IgA DIF: not performed	Not reported/ a positive PCR test for SARS-CoV-2 in a nasopharyngeal swab.	Simultaneously
7	Li et al[34]	30 y/male	Not reported/skin and kidney biopsy Skin biopsy: H/E: a neutrophil-rich small-vessel vasculitis-LCV DIF: IgA, IgG, IgM, and C3 was negative Kidney biopsy: H/E: focally crescentic and segmentally necrotizing IgAN with focal endocapillary hypercellularity DIF mesangial and segmental peripheral capillary wall staining for IgA, C3, IgM, IgG, and C1q was negative E/M: mesangial and subendothelial immune-type deposits	Not reported/ a positive throat swab and nucleic acid testing for SARS-CoV-2.	Simultaneously
8	El Hasbani et al[39]	16 y/male	Not reported/ clinically (palpable purpura, abdominal pain, proteinuria, elevated Ig A)	Not reported/ a positive PCR test for SARS-CoV-2.	2 d

continued

TABLE 1
Continued

N	Reference	Age/sex	Diagnostic date/method for IgAV	Diagnostic date/method for COVID-19	The period from a positive PCR test to the appearance IgAV signs
9	Jedlowski and Jedlowski[30]	70 y/male	Not reported/skin and kidney biopsy Skin biopsy: H/E: signs of LCV DIF: IgA, C5B-9, fibrinogen deposition Kidney biopsy: H/E: mesangial hypercellularity, tubular atrophy, interstitial fibrosis, lymphocytic tubulitis with absence of crescents DIF: granular mesangial deposition of IgA. E/M: patchy effacement of podocytes	Not reported/ a positive PCR test for SARS-CoV-2 in a nasopharyngeal swab.	Simultaneously (1 wk later after URI symptoms)
10	Borocco et al,[40]	13 y/female	April 2020/clinically (palpable purpura, arthralgia, periarticular edema, abdominal pain)	Not reported/ a positive RT-PCR of a nasopharyngeal swab.	Simultaneously
11	Barbetta et al[42]	62 y/male	Not reported/skin biopsy H/E: perivascular and interstitial lymphocytic infiltrate, with extravasated red blood cells, ectatic capillary vessels, endothelial cells with signs of swelling without atypia DIF: IgA deposition	Not reported/ a positive RT-PCR of a nasopharyngeal swab.	10 d

continued

TABLE 1
Continued

N	Reference	Age/sex	Diagnostic date/method for IgAV	Diagnostic date/method for COVID-19	The period from a positive PCR test to the appearance IgAV signs
12	Oñate et al[43]	84 y/male	Not reported/skin and kidney biopsy Skin biopsy: H/E: signs of LCV DIF: IgA, C5B-9, fibrinogen deposition Kidney biopsy: H/E: interstitial fibrosis, tubular atrophy, without crescents DIF: granular mesangial deposition of IgA. C3, IgM, IgG, C1q were negative	March 2020/ a positive PCR test for SARS-CoV-2 in a nasopharyngeal swab.	4 mo
13	Oñate et al I[43]	87 y/male	December 2020/skin biopsy H/E: signs of LCV DIF: perivascular granular IgA deposition	October 2020/ a positive serology for Ig G, negative for Ig M.	8 wk

DIF, direct immunofluorescence; EM, electron microscopy; H/E, hemoxylin-eosin; IgA, immunoglobulin A; IgAV, igA vasculitis; IgM, immunoglobulin M; 1gG, immunoglobulin G; C3, complement 3; C1q, complement 1q; c5B-9, complement 5B-9; LCV, leukocytoclastic vasculitis; RT-PCR, reverse transcriptase-polymerase chain reaction; URI, upper respiratory infection.

TABLE 2
Clinical and laboratorial characteristic of IgA vasculitis in COVID-19 patients

N	Reference/country	Age/sex	Concomitant diseases	Brief scenario	Treatment
1	Allez et al,[1] France	24 y/male	Crohn's disease	- COVID-19 symptoms: none - IgAV symptoms: skin rash, asymmetric arthralgia, periarticular swelling, and abdominal pain, palpable purpura on the legs and arms, swelling in the left hand, and pain in several joints on palpation. - Laboratory and instrumental findings: CRP, D-dimer, fibrinogen, and complement C4, IgA levels were all elevated. An enlarged ileitis on CT scan.	MethylPREDNISolone enoxaparin
2	Suso et al,[41] Spain	78 year/male	Hypertension, alcohol consumption, bladder cancer in remission	- COVID-19 symptoms: history of bilateral pneumonia with respiratory failure, treated with hydroxychloroquine, lopinavir/ritonavir, dexamethasone, ceftriaxone, azithromycin, and tocilizumab (IL-6). - IgAV symptoms: returned to the ER 3 wk later with wrist arthritis, lower limb purpura, and hypertension. - Laboratory findings: elevated creatinine, hypoalbuminemia, massive proteinuria (10 g/d), and hematuria with 60% dysmorphic red blood cells.	PrednisoLONE, methylPREDNISolone+ riTUXimab

continued

TABLE 2
Continued

N	Reference/country	Age/sex	Concomitant diseases	Brief scenario	Treatment
3	Sandhu et al,[33] India	22 y/male	No	- There was a simultaneous development of symptoms of COVID-19 and vasculitis: fever, abdominal pain, vomiting, and painful swelling of both ankle and wrist joints were the first symptoms of the illness accompanied by multiple purpura, edema of the joints 2 d later. - Laboratory findings: proteinuria, elevation of liver function test.	Dexamethasone, oral prednisoLONE, mycophenolate mofetil
4	Jacobi et al,[36] Israel	3 y/male	Hirschsprung disease	- COVID-19 symptoms: none - IgAV symptoms: a palpable purpuric rash on the buttocks and extensor surface of the lower extremities, abdominal pain and emesis. - Laboratory findings: microcytic anemia and mild thrombocytosis.	NSAIDs, predniSONE
5	AlGhoozi and AlKhayyat,[37] Bahrain	4 y/male	No	- COVID-19 symptoms: signs of upper respiratory tract infection. - IgAV symptoms: lower limb arthralgia and maculopapular rash, edema of the ankles. - Laboratory findings: normal full blood count, normal electrolytes, normal liver and renal function tests, normal coagulation profile, erythrocyte sedimentation rate and C reactive protein values.	Paracetamol

continued

TABLE 2
Continued

N	Reference/country	Age/sex	Concomitant diseases	Brief scenario	Treatment
6	Hoskins et al,[38] [d]Baltimore	2 y/male	No	- COVID-19 symptoms: none - IgAV symptoms: severe abdominal pain, purpuric rash, ecchymotic lesions, hematochezia, emesis was observed - Laboratory findings: elevated D-dimer. CRP and high inflammatory markers.	Steroids, low-molecular weight heparin
7	Li et al.[34] Canada	30 y/male	No	- There was a simultaneous development of symptoms of COVID-19 and vasculitis: fever, runny nose, cough, diarrhea, abdominal pain, painful purpuric rash to his lower extremities, distal upper extremities, and trunk. - Laboratory findings: proteinuria, mild hematuria, cholestatic liver enzymes elevated.	Steroids
8	El Hasbani et al,[39] United States	16 y/male	No	- COVID-19 symptoms: sore throat, muscle pain. - IgAV symptoms: palpable purpura both lower limbs, abdominal pain, hemoptysis, hematochezia. - Laboratory findings: elevated inflammatory markers (ESR,CRP) and serum Ig A, proteinuria, microscopic hematuria, hypogammaglobinemia, hypoalbuminemia.	PrednisoLONE, ramipril, trimethoprim/Sulfamethoxazole

continued

TABLE 2
Continued

N	Reference/country	Age/sex	Concomitant diseases	Brief scenario	Treatment
9	Jedlowski and Jedlowski,[30] United States	70 year/male	Dyslipidemia	- COVID-19 symptoms: rhinorrhea, shortness of breath, fever, chills. - IgAV symptoms: diarrhea, bilateral symmetrical arthralgia of wrists, ankles, and knees, abdominal pain, purpuric rash on the bilateral lower extremities and buttocks, hematochezia, enterocolitis, ileitis. - Laboratory findings: elevated inflammatory markers (ESR,CRP), proteinuria, gross hematuria, acute kidney injury (elevation of creatinine).	Dexamethasone, MethylPREDNISolone, predniSONE
10	Borocco et al,[40] French	13 y/female	Panhypopituitarism, suprasellar germinoma in remission	- COVID-19 symptoms: sore throat, pharyngitis. - IgAV symptoms: purpuric and ecchymosis lesion of lower limbs, buttocks. abdominal pain, arthralgia, periarticular edema. - Laboratory findings: leukocytosis with neutrophilia, lymphocytosis, elevation of CRP, Ig G and A.	Pain relievers

continued

TABLE 2
Continued

N	Reference/country	Age/sex	Concomitant diseases	Brief scenario	Treatment
11	Barbetta et al,[42] Italy	62 y/male	Diabetes mellitus, arterial hypertension	- COVID-19 symptoms: dyspnea, fever, bilateral interstitial pneumonia. - IgAV symptoms: purpuric rash of lower extremities, buttocks, abdominal pain, vomiting, hematochezia. - Laboratory findings: hematuria, proteinuria, glycosuria, hyaline cylinders.	CPAP, hydroxychloroquine, lopinavir/ritonavir, enoxaparin, MethylPREDNISolone 1 mg/kg
12	Oñate I[43] Spain	84 y/male	Arterial hypertension, dyslipidemia, atrioventricular block tricuspid endocarditis congestive liver disease, atrial flutter, chronic obstructive pulmonary disease, obstructive sleep apnea syndrome, axonal polyneuropathy	- COVID-19 symptoms: dyspnea, fever, bilateral interstitial pneumonia. - IgAV symptoms: palpable purpura, acute renal failure with increase creatinine, proteinuria - Laboratory findings: increase of creatinine, proteinuria, microhematuria, purpuric skin lesion, increase in IgA level,	Hydroxychloroquine, lopinavir/ritonavir, azithromycin, tocilizumab, anticoagulant drugs. MethylPREDNISolone, oral prednisoLONE, mycophenolate mofetil.
13	Oñate I[43] Spain	87 y/male	Hypertension, hypertensive cardiomyopathy, pulmonary hypertension, diverticulosis, prostate hyperplasia, cognitive impairment	- COVID-19 symptoms: upper respiratory tract infection, ipsilateral crackles. - IgAV symptoms: purpuric skin lesion in the lower limbs, increase in IgA levels. creatinine, proteinuria, microhematuria. - Laboratory findings: increase of creatinine, proteinuria, microhematuria, increase in Ig A level.	Amoxicillin-clavulanate, MethylPREDNISolone, oral prednisoLONE

IgA, immunoglobulin A; IgAV, IgA vasculitis; C4, component 4; CT, computed tomography; IL-6, interleukin 6; CRP, c-reactive protein; ESR, erythrocyte sedimentation rate; ER, emergency room; NSAIDS, non-steroidal anti-inflammatory drugs; CPAP, continuous positive airway pressure.

on a positive reverse transcription-PCR test for SARS-CoV-2 in a nasopharyngeal swab and a positive result for anti-SARS-CoV-2 by chemiluminescent immunoassay.

A 62-year-old patient with respiratory distress due to COVID-19 pneumonia developed cutaneous, renal, and gastrointestinal manifestations of IgAV 10 days after admission. The skin biopsy showed leukocytoclastic vasculitis and IgA deposits revealed on immunohistochemistry.[42] Similar cases of vasculitis with development of acute renal failure have been reported in patients 70, 84, and 87 years old (Tables 1 and 2).[30,43]

It should be noted that in all cases, older adults had kidney damage, and 4 of them developed acute renal failure. Thus, more severe forms with renal involvement were observed in the older adult patients.

The Link Between COVID-19 and Vasculitis

It is known that IgA levels increase in inflammatory diseases such as AIDS, IgAN, IgAV, dermatitis herpetiformis, celiac disease, inflammatory bowel disease, Sjögren's syndrome, ankylosing spondylitis, and alcoholic liver cirrhosis. It is unclear what role IgA plays in these inflammatory disorders.[44] We believe that it is critical to be aware of the potential link between COVID-19 infection and IgA vasculitis. One of the possible mechanisms of microvascular injury and thrombosis is the deposition of C5b-9, C4d complement complexes, and co-localization of COVID-19 spike glycoproteins in endothelial cells, which activate pathways of the complement system. The activation of the complement system leads to the activation of the clotting pathway and fibrin deposition with thrombus formation.[45] The main causes of death due to COVID-19 are hypercoagulability, vasculitis, cytokine storm with the development of ARDS, and multiorgan failure syndrome.[46] A recent study of Zhang et al[47] showed that treatment with anti-inflammatory medications (glucocorticoids, IL-6 antagonist, JAK inhibitors, and chloroquine/hydroxychloroquine) can prevent severe complications and mortality due to COVID-19.

BIOLOGICAL PLAUSIBILITY

SARS-COV-2, the etiological agent of coronavirus infection, is known to cause vasculitis-like diseases. Clinical data also show a higher prevalence of Kawasaki disease (KD) in pediatric patients with COVID-19.[48] The pathophysiology of KD is based on extensive endothelial dysfunction. Some scientists suggest that KD vasculitis is a type of IgA vasculitis that involves the gut-vascular system.[49] COVID-19 affects skin cells, endothelial cells across the whole body via angiotensin-converting enzyme 2, thus leading to generalized endothelial damage and inflammation, so-called endotheliitis. SARS-COV-2 virus penetrates human cells by binding to angiotensin-converting enzyme transmembrane protein receptors of vascular endothelium and can cause systemic inflammatory response with subsequent development of a cytokine storm, which may play a role in the development of IgAV.[36] In addition, medications used to treat SARS-COV-2 (ie, antibiotics, TNF-alpha blockers, immunomodulatory agents) can cause drug-induced IgAV, which can also be one of the possible mechanisms of the development of vasculitis.[50] In 7 of our reviewed cases, SARS-CoV-2 infection preceded the development of IgA vasculitis. The latency time between infection and the onset of vasculitis ranged from 2 days to 4 months. These data support the theory of immune dysregulation as the main etiopathogenic factor of IgAV. In 6 cases, there were simultaneous manifestations of symptoms of COVID-19 and IgA vasculitis. In these cases with simultaneous manifestations, we considered the simultaneous presentation may have been due to delayed COVID-19 diagnosis, delayed health care utilization, or an asymptomatic course of SARS-CoV-2 infection.

Limitations

We have some limitations in our study. The small number of clinical cases makes it challenging to draw any definitive conclusions or establish a causal relationship between COVID-19 and IgAV. The absence of exact dates and methods of the diagnosis of COVID-19 infection and IgAV in the included case reports is a notable limitation as well. Finally, published case reports may reflect clinician and publication bias. The claim that IgAV affects men is premature. There is clear and abundant literature that chronic inflammatory and autoimmune processes are more prevalent in women[51] and that women experience substantially longer diagnostic delays and have symptoms and presentations that are often dismissed, misdiagnosed, considered vague, or not taken as seriously by health care providers and scientists. A fair and balanced interpretation must include that the published reports may reflect clinician and publication bias that tend to be much more (and unjustly) sensitive and responsive to men in the health care system, science, and publishing rather than a true underlying sex difference in prevalence and pathology.

Conclusion

COVID-19 associated IgAV affects mostly adults; it is characterized by a more severe course of the disease due to renal involvement. As the number of patients with COVID-19 increases worldwide, we suspect to see more cases of IgA-related disorders, especially IgAV, and it may indicate a severe course of infection. In asymptomatic patients with SARS-CoV-2, emergency care providers should maintain an index of suspicion for vascular damage. Emergency clinicians who note the possibility of IgAV in their differential diagnosis for patients with COVID-19 infection should consider referral to hematologist and recommend the following diagnostic testing: skin and kidney biopsy with direct immunofluorescence. Anticoagulants, glucocorticoids, and intravenous immunoglobulin are used to treat COVID-19–associated IgAV.[30,31] Further studies are warranted to determine the role of SARS-CoV-2 in the pathogenesis of IgAV and further clarify these relationships. It is important for emergency clinicians to be aware of the prevalence and presentation of COVID-19–mediated IgAV to assist in timely recognition and treatment of the condition.

Data, Code, and Research Materials Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Disclosures

Conflicts of interest: none to report.

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Cross-Sectional Analysis of Burnout, Secondary Traumatic Stress, and Compassion Satisfaction Among Emergency Nurses in Southern California Working Through the COVID-19 Pandemic

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Contribution to Emergency Nursing Practice

- Emergency nurses are at risk of burnout and compassion fatigue owing to the nature of the environment. The COVID-19 pandemic created uncertainty, changes in practice, and a lack of resources for health care providers.
- The findings of this paper are that current burnout and secondary traumatic stress scores for emergency nurses are moderately high whereas compassion satisfaction is moderately low. Nurses who work the midshift scored significantly higher for burnout and secondary traumatic stress than those working the day shift, whereas those with 2 children living at home scored significantly lower for compassion satisfaction than those with 1 child.
- Emergency nurses need continued support from those in leadership positions to decrease burnout and secondary traumatic stress while continually supporting compassion satisfaction. Department heads must support efforts to decrease negative components of nurses' professional quality of life with specific interventions.

Abstract

Objective: The purpose of this study was to assess burnout, secondary traumatic stress, and compassion satisfaction scores in emergency nurses after working through the COVID-19 pandemic using the Professional Quality of Life Scale version 5 and compare those scores with similar studies conducted before the pandemic.

Methods: A cross-sectional analysis of a descriptive survey including the Professional Quality of Life Scale version 5 questionnaire was sent to nurses working in the emergency department before 2021 from urban, adult, and pediatric receiving hospitals in Southern California. Results were analyzed to provide insight into the effect of the COVID-19 pandemic on the levels of burnout, secondary traumatic stress, and compassion satisfaction compared with prepandemic studies found in the literature using the same Professional Quality of Life Scale version 5 instrument.

Results: Mean subcategory scores were in the moderate range for burnout (25.6), secondary traumatic stress (24.5), and compassion satisfaction (38.7). Burnout scores for midshift nurses were found to be significantly higher than day shift nurses (mean difference 5, $P = .02$) as were secondary traumatic stress scores (mean difference 4.6, $P = .007$). In addition, compassion satisfaction subcategory scores in nurses with 1 child living at home were significantly higher than those with 2 (mean difference 6.7, $P = .02$).

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Discussion: The unnormalized mean findings were similar to prepandemic studies conducted using the same Professional Quality of Life Scale version 5 instrument indicating nurses are at risk of compassion fatigue. In addition, the scores from midshift nurses reflect increased burnout and secondary traumatic stress whereas nurses with 2 children had lower compassion satisfaction. This implies the need for leadership to proactively seek interventions to support nurses on each shift.

Key Words: Compassion fatigue; Burnout; Secondary traumatic stress; Emergency nurses; Resilience; Professional Quality of Life Scale

Introduction

Professional quality of life, as represented by the constructs examined using the Professional Quality of Life Scale version 5 (ProQOL), is made up of both positive and negative emotions that an individual feels while engaged in their position.[1] Emergency nurses experience unique daily stressors, including a multitude of patient presentations, traumatic events, chaotic environments, and a wide range of emotional encounters.[2] Nursing is emotionally, spiritually, and physically demanding; these demands and stressful encounters can lead to compassion fatigue, burnout, secondary traumatic stress, vicarious trauma, and a decrease in compassion satisfaction.[2-6] The ProQOL is a validated tool that measures 2 negative (burnout and secondary traumatic stress) affects and 1 positive (compassion satisfaction) affect, or feelings/emotions, that are part of a worker's overall professional quality of life.[7]

The ProQOL defines burnout as one of the multiple elements in compassion fatigue.[7] Compassion fatigue and burnout have similar symptoms; however, they differ in cause. Compassion fatigue occurs because of the element of caring for people in a helping profession, whereas burnout is caused by workplace environments and is associated with the organization rather than the patients.[8] If a caregiver's stressors are caused by work conditions, scheduling conflicts, poor work environment, and leadership, this would classify as burnout.[8,9] Compassion fatigue occurs subtly and is progressive in nature. The signs may go unnoticed until the caregiver experiences a sudden onset of physical, emotional, and spiritual exhaustion.[9,10] The consequence of compassion fatigue is that the nurse's ability to show and feel compassion is decreased or absent. Nurses who are experiencing compassion fatigue may negatively affect patient outcomes and patient satisfaction owing to their emotional distress, inability to care, and low levels of efficiency. Compassion fatigue can be devastating to the nurse both personally and professionally, and early recognition and prevention are important.[8,11]

Secondary traumatic stress is a consequence of caring for people who have experienced trauma even though the nurse has not experienced the trauma personally.[8,11] Secondary traumatic stress describes various symptoms similar to those of posttraumatic stress disorder acquired through secondary exposure to trauma rather than a direct event.[12] Nurses with secondary traumatic stress experience similar symptoms of posttraumatic stress disorder, which include behavioral components such as irritability, anger, lack of sleep, and substance abuse problems.[8] Although secondary traumatic stress and vicarious trauma are often used interchangeably, they were independently developed by different research groups. Although secondary traumatic stress is defined by symptoms, vicarious trauma tends to focus on the potentially harmful changes that can occur in professionals dealing with graphic and/or traumatic material through clients and/or patients.[13]

Finally, compassion satisfaction is what nurses look to achieve by working with people. Many nurses enter the field to help people and improve patients' quality of life. Compassion satisfaction is the knowledge that the caregiver's work is making a positive impact on the patient's experience and meaningful connections are made.[14]

Immediately after the World Health Organization declared the COVID-19 a global pandemic on March 11, 2020, followed shortly after by the United States issuing a national emergency proclamation on March 13, 2020, the professional demands of emergency nurses were affected.[1-17] COVID-19, caused by the severe acute respiratory syndrome coronavirus 2, has caused additional stress, uncertainty, and fear in the health professional community, particularly including emergency nursing staff.[18-20] When nurses are exposed to unpredictable changes and stressful situations on a regular basis, they can experience anxiety and exhaustion, which can lead to decreases in job satisfaction and the quality of care they are able to provide.[21]

The concepts of compassion fatigue, burnout, secondary traumatic stress, vicarious trauma, and compassion satisfaction have been studied extensively in an array of settings including nursing departments. The overall goal of this project was to record and assess levels of burnout, secondary traumatic stress, and compassion satisfaction using the ProQOL questionnaire in emergency nurses employed in Southern California during the COVID-19 pandemic. The specific aims of this study were to:

1) Describe the sample population of emergency nurses

2) Summarize the ProQOL scores by subcategories (burnout, secondary traumatic stress, and compassion satisfaction)
3) Examine correlational relationships between the subcategory scores
4) Evaluate ProQOL subcategory scores by demographic, socio-related, and work-related characteristic compassion satisfaction

Methods

This study was designed as a descriptive observational study for emergency nurses at 3 Southern California acute care hospitals located in Torrance, Laguna Beach, and Mission Viejo where the authors of this article are employed. The registered nurses at the selected locations who met the inclusion criteria were invited to participate. The inclusion criteria were any registered nurse who was actively working on the unit and hired before January 2021. Qualified individuals were sent an anonymous survey to be completed via the organization's Research Electronic Data Capture instance.[22,23] Before the initiation of procedures, the study was reviewed by the organization's regional institutional review board and the research department and local administrative staff. Owing to the anonymous responses and a lack of intervention and follow-up, the institutional review board deemed the project exempt because it did not qualify as human subjects research; however, all system policies and procedures and good research practices were followed. Owing to the cross-sectional, hypothesis generation nature of this project, no power or sample size calculation was completed.

SURVEY TOOLS

The data collection survey included multiple demographic, socio-related, and work-related items:

i. Years of experience as a nurse
ii. Full-time employment status
iii. Current age range
iv. Marital status
v. Number of children living at home
vi. Shift worked

Participant responses to these questions would serve as points of interest in further investigation of ProQOL scores.

The ProQOL is an open access tool available to assess burnout, secondary traumatic stress, and compassion satisfaction that has been used in numerous populations, including health care professionals, since its release in 2012.[7] High scores of burnout and secondary traumatic stress with low levels of compassion satisfaction are indicative of compassion fatigue in health care workers.[7] Although areas of concern with the scale's validity and reliability in nurses have been recently reported, there is a documented lack of more adequate tools.[24,25] The scale is made up of 30 items which are "I"-statements regarding professional work that the user responds to via a 5-point Likert scale ranging from 1 = never to 5 = very often.[7] Scoring is completed by summing the values for all statements in each of the 3 subscales: compassion satisfaction (10 items), burnout (10 items), and secondary traumatic stress (10 items).[7] It is important to note that, when scoring the ProQOL, multiple burnout items are scored inversely.[7] Raw or unnormalized scores for each subcategory can be evaluated or transformed to a *t*-score where the sample mean is converted to 50 with the standard deviation set at 10.[7]

PROCEDURE

The survey was distributed via email, which included an attached flyer with a scannable QR code; the recruitment flyer was also posted in participating locations' break rooms. In the distribution phase, the nurses were informed as to why this survey was being conducted. The aims of the study were explicitly described to the nurses as an assessment of the baseline levels of burnout, compassion fatigue, compassion satisfaction, and secondary traumatic stress not only to compare the scores with prepandemic levels in similar studies but also to have knowledge for future interventions designed to help the staff and prevent burnout and compassion fatigue. Given that the ProQOL is a psychological test, it was important to inform the nurses that they were not being evaluated for any bad behavior or feelings and the responses would be anonymous.[7] Guidance for reporting the results of the study was derived from the Strengthening the Reporting of Observational Studies in Epidemiology checklist for cross-sectional studies.[26]

DATA ANALYSIS

Data were exported from Research Electronic Data Capture to Microsoft Excel for Mac version 16.5 for cleaning and coding. The results were then imported to IBM SPSS Statistics version 27 for further analysis.

For description of the study's participant population, all responding nurses were pooled and demographic, socio-related, and work-related items for the entire study population were described via frequency reporting. For analysis of each of the 3 ProQOL subcategories (burnout,

TABLE 1
Responder demographics (N = 50)

Characteristics	n	%
Hospital location		
Torrance	30	60
Mission Viejo	19	38
Laguna	1	2
Age range		
20-29 y	9	18
30-39 y	17	34
40-49 y	14	28
≥ 50 y	10	20
Years of experience, y		
≤ 2	9	18
3-5	10	20
6-10	13	26
> 10	18	36
FTE status		
Full time	44	88
Part time	4	4
Per diem	2	4
Shift worked		
Day shift	23	46
Mid-shift	10	20
Night shift	17	34
Marital status		
Single	16	32
Married	30	60
Divorced	3	6
Separated	1	2
No of children living in the home		
0	20	40
1	9	18
2	13	26
≥ 3	8	16

FTE, full time equivalent.

secondary traumatic stress, and compassion satisfaction), mean scores and standard deviations were calculated via results from all responding nurses; the mean scores were evaluated directly by the guidelines in the ProQOL manual.[7] All statistical analysis conducted had an alpha set < 0.05 as the cutoff for significance. Bivariate correlations between all of the subcategory scores were conducted and significant interactions reported using Pearson's correlation coefficient (PCC). Using demographic, socio-related, and work-related characteristics as grouping factors, mean ProQOL subcategory scores were compared using a one-way analysis of variance (ANOVA) to assess differences between all groups. Owing to the unbalanced groups and exploratory nature of this post hoc analysis, any result with an alpha of < 0.1 was further examined via a Tukey test to examine potential between-group differences in mean subcategory scores.

SETTING AND CONTEXT

According to publicly available data from the Centers for Disease Control and Prevention, although the survey was open, the daily average of newly reported COVID-19 cases in the United States was 20,338 (SD = 7374.4, range 9094-35,655) whereas the state of California saw an average of 965.6 newly reported COVID-19 cases daily (SD 247.8, range 580-1440). COVID-19–related deaths were lower during the same time frame with the United States daily average being 445.8 (SD 132.6, range 228-662) and California at 19.7 (SD 5.6, range 12-35).[27]

Results

During a 26-day period, between May 13, 2021, and June 7, 2021, the survey was open, and 55 nurses responded with 50 completing the survey from 3 hospitals within the health care system. The response rate was calculated at 25% whereas 22.7% completed the survey (total nurses 220, Torrance 90, Mission Viejo 90, Mission Laguna 40).

The survey was sent out to 3 hospitals with the concentration of responses coming from Mission Viejo and Torrance. Responders varied in age, experience, and shifts, with age (82% were 30 years or older) and experienced (82% had at least 3 years of experience), and full-time workers (88%). The reported shifts being worked were split, with day shifters being the most common responders (46%) followed by night shift (34%) and midshift (20%). The majority of the study population were married (60%) and had at least 1 child (60%). Full demographic characteristics of the responders are further detailed in Table 1.

The mean raw (unnormalized) ProQOL scores for all 3 subcategories were found to be in the "moderate" range: burnout = 25.6 (SD = 5.6); secondary traumatic stress = 24.5 (5.4); and compassion satisfaction = 38.7 (SD = 5.4). Before additional analyses, normality of all 3 subcategory results was evaluated and found to be acceptable (Table 2). Correlations among the 3 ProQOL subcategories were assessed, and responders' burnout scores were

TABLE 2
ProQOL score summary for all responders (N = 50)

Summary measure	Burnout		Secondary traumatic stress		Compassion satisfaction	
	Mean	SD	Mean	SD	Mean	SD
Raw score	25.6	5.6	24.5	5.4	38.7	5.4
Skewness	−0.08		0.39		−0.3	
Kurtosis	−0.95		−0.51		−0.3	
Raw score reference range[7]	22 or less = low 23 to 41 = moderate 42 or more = high					

Descriptive report of ProQOL results by responders including mean (measure of central tendency), SD (variability), skewness (asymmetry), and kurtosis (tailedness) of all 3 subcategories (burnout, secondary traumatic stress, and compassion satisfaction).
ProQOL, Professional Quality of Life Scale version 5.

found to be associated with both the secondary traumatic stress and compassion satisfaction scores (Supplementary Table 1). Burnout and secondary traumatic stress had a significant positive correlation indicating that as the score for one increased, the score for the other also increased (PCC 0.54, $P < .001$), whereas burnout and compassion satisfaction scores were significantly inversely correlated with one another revealing as 1 score increased the other score tended to decrease (PCC –0.64, $P < .001$). There was no significant relationship between secondary traumatic stress and compassion satisfaction found.

After grouping responders by the demographic characteristics described in Table 1 (location, age range, experience, employment status, shift, marital status, and number of children), ProQOL subcategory scores were examined by one-way ANOVA (Table 3). Based on the ANOVA results, ProQOL subcategory scores for 3 demographic characteristics warranted further examination:

1) Burnout and compassion satisfaction subcategory scores for years of experience as a nurse: examination of the post hoc Tukey test results for years of experience as a nurse revealed no significant between-group differences in the burnout or compassion satisfaction subcategory scores for any comparison.

TABLE 3
Subcategory ANOVA results for ProQOL subcategories (N = 50)

Demographic characteristic	Burnout		Secondary traumatic stress		Compassion satisfaction	
	F value	*P* value	*F* value	*P* value	*F* value	*P* value
Hospital location	0.42	.66	0.66	.52	0.52	.6
Age range	0.72	.55	1.56	.21	1.18	.33
Years of experience	2.66	.06*	1.35	.27	2.54	.07*
FTE status	0.06	.94	1.36	.27	0.86	.43
Shift worked	2.97	.06*	3.12	.05*	1.6	.21
Marital status	1.65	.19	0.68	.57	1.77	.17
No. of children living in the home	2.48	.07*	0.16	.93	3.33	.03*

ANOVA results evaluating the impact of each demographic characteristic on ProQOL.
ANOVA, analysis of variance; ProQOL, Professional Quality of Life Scale version 5; FTE, fukk-time equivalent.
* Any result with a *P* value of < .1 was further evaluated with a post hoc Tukey test to identify significant between-group differences in subcategory scores. Based on the post hoc Tukey tests, the only significant differences were as follows: (1) day shift nurses had significantly lower unnormalized mean burnout and secondary traumatic stress scores than midshift nurses, and (2) nurses with 1 child had significantly higher compassion satisfaction than those with 2 children.

TABLE 4
ProQOL burnout and secondary traumatic stress subcategory scores between day-shift and midshift nurses

Shift worked	Burnout*		Secondary traumatic stress†	
	Mean	SD	Mean	SD
Day shift (n = 23)	24.1	5.8	22.7	4.4
Midshift (n = 10)	29.1	4.9	27.3	3.7

Results of the post hoc Tukey test indicated day-shift nurses reporting significantly lower burnout and secondary traumatic stress scores than mid-shift nurses.
ProQOL, Professional Quality of Life Scale version 5.
* Mean difference = 5; $t(31) = 2.376$; $P = .02$.
† Mean difference = 4.6; $t(31) = 2.915$; $P = .007$.

2) Burnout and secondary traumatic stress subcategory scores for the shift being worked: as suggested by Tukey test results, burnout subcategory scores for day-shift nurses (n = 23) were compared with those working the midshift (n = 10). Nurses working the midshift had significantly higher burnout subcategory scores (mean 29.1, SD 4.9) than those working the day shift (mean 24.1, SD 5.8, mean difference 5, t(31) 2.376, $P = .02$). The same groups' scores for secondary traumatic stress were also examined, and midshift nurses again had significantly higher mean scores (mean 27.3, SD 3.7) then those working the day shift (mean 22.7, SD 4.4, mean difference 4.6, t(31) 2.915, $P = .007$). Results also summarized in Table 4.
3) Burnout and compassion satisfaction subcategories for the number of children: based on the results of the post hoc Tukey test, compassion satisfaction subcategory scores for nurses with 1 child (n = 9) were compared with those with 2 children (n = 13). Nurses with 1 child had a significantly higher compassion satisfaction subcategory score (mean 41.9, SD 8.2) than those with 2 children (mean 35.2, SD 4.6, mean difference 6.7, t(20) = 2.432, $P = .02$).

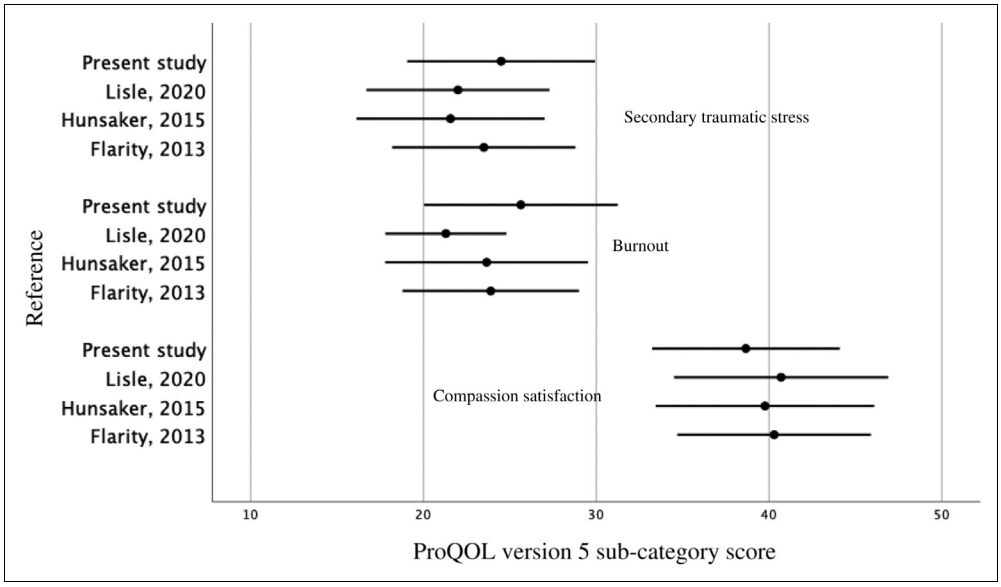

FIGURE
ProQOL subcategory scores mapped with previous findings. Black dot represents the unnormalized point estimate (measure of central tendency) with the SD indicated by the left/right arms. ProQOL, Professional Quality of Life Scale version 5.

Discussion

This study was designed to assess the burnout, secondary traumatic stress, and compassion satisfaction levels in emergency nurses working through the COVID-19 pandemic to determine whether the nurses are currently experiencing compassion fatigue. The authors then took the current scores and compared those scores with similar studies conducted before the pandemic found in the literature. The results of this research determine that the emergency nurses are experiencing compassion fatigue as indicated by the moderate levels of burnout, secondary traumatic stress, and compassion satisfaction during the COVID-19 pandemic. The mean ProQOL subcategory scores fall in the moderate level for burnout, secondary traumatic stress, and compassion satisfaction.

Comparisons of the present study's results with those conducted before the presence of the COVID-19 pandemic suggest that moderate levels of burnout and secondary traumatic stress are consistently present along with a moderate level of compassion satisfaction. The scores were not significantly different after working through the COVID-19 surge experienced in Southern California, along with short staffing, changes in practice, critically ill patients, and overcrowded departments. Figure and Supplementary Table 2 illustrate the current study's results along with those that have been previously published with an unnormalized measure of central tendency (point estimate) and variability (SD).

Although a full systematic review or meta-analysis was not conducted, a targeted literature review focusing on examining the potential impact of the COVID-19 pandemic on results was conducted using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses–like process.[28] After completion of a literature review, 3 manuscripts met all requirements and were included:

1. "The effectiveness of an educational program on preventing and treating compassion fatigue in emergency nurses,"[29]
2. "Factors that influence the development of compassion fatigue, burnout, and compassion satisfaction in emergency nurses,"[30]
3. "Differences in Compassion Satisfaction, Compassion Fatigue, and Work Environment Factors by Hospital Registered Nurse Type."[31]

Some areas of consideration for this lack of major change from prepandemic times may be that emergency nurses have always adapted to rapid changes in patient acuity and high levels of stress; thus, they are more resilient to the environment created by the pandemic. Another possibility is the increased support from the leadership, the organization, and the public during the pandemic. Nurses were recognized as heroes during the early pandemic, which may have created a sense of support that prevented severe rises in burnout and secondary traumatic stress scores. In addition, the study took place during a period when COVID-19 cases were relatively low (after public distribution of COVID-19 vaccines began and before the major wave of cases caused by the delta variant began). As of July 27, 2021, the 7-day case average was more than 60,000 per day compared to the 20,338 case per day average seen during the study period.[32]

Although the mean scores were not different from earlier studies, certain demographic characteristics seem to have an impact on subcategory scores. When day shift was compared to midshift, the midshift nurses have significantly higher levels of burnout and secondary traumatic stress. This finding provides insight for the need to support the midshift nurses and further investigate what contributes to this result. Midshift nurses start the shift during busier times and end the shift during busier times. They often miss in-services scheduled for the morning and night shifts. Their break times do not fall at usual break times, which may prevent participation in the hospital's scheduled nursing events. Working the midshift may lead to missing department gatherings, supportive interventions, and preshift informational meetings and huddles. Plus, when the midshift nurses arrive, they are often sent straight out to the unit to take over an assignment, give lunch breaks, or relieve an overwhelmed coworker.

The number of children living at home was associated with the compassion satisfaction subcategory score. Nurses with 1 child living at home had significantly higher compassion satisfaction scores than those with 2. Currently: the average compassion satisfaction score for those with 1 child nearly improved from the "moderate" range to the "high" range. Although emergency nursing leaders do not have a direct impact on the number of children an individual has, additional support, such as flexible scheduling and nonpunitive available time off to care for family, can be provided to lessen the impact of childcare stressors on their professional quality of life.

The implications of the results in this current study compared with previous studies indicate that nurses are constantly at risk of the development of compassion fatigue, and early recognition and continuous interventions are needed. When nurses experience burnout and secondary traumatic stress combined with low levels of compassion satisfaction, they will slowly and quietly develop compassion fatigue. Once the nurse is experiencing compassion fatigue, a sudden onset of physical and emotional exhaustion may occur, and the ability to recover becomes difficult.[14] Patient outcomes suffer, turnover rates increase, unit moral decreases, and the nurse's mental health declines. The consequences are devastating to the nurse, the patients, and the organization.[14]

Limitations

The study had several limitations. First, the survey was sent out in May 2021, which was a time when the COVID-19 surge in January had decreased and work life had returned to a more normal state. Second, the study's sample (N = 50) was limited to a single hospital system in Southern California. In addition, the significant findings by demographic characteristics (shift worked and number of children) were analyzed with small sample sizes indicating the need for further research. Third, the survey was sent out in an email and posted in the break room. This was a voluntary survey, which may have captured only nurses who were engaged enough to complete the survey. Nurses who were experiencing extreme burnout and compassion fatigue may have chosen not to participate. Finally, the demographics did not include sex or education level. The ProQOL manual explains that sex does not significantly impact scores; however, looking at the results obtained, these demographics may provide additional insight.[7] For example, were the nurses with 2 children who scored low on compassion satisfaction male or female? In addition, do the nurses working midshift voluntarily work those hours or are they waiting for a day-shift spot to open? Nurses with children may work midshift for childcare reasons, yet the hours make sleeping and self-care difficult. These factors may contribute to high burnout and low compassion satisfaction and not because of the organization. Further investigation into variations of the ProQOL score based on education level (ADN, BSN, MSN), certification, such as certified emergency nurse, and any education on self-care and/or emotional intelligence could be explored for its potential effect on the nurses' scores.

As with all observational studies, the risk of bias is present. The small sample size and limited locations of participants and the fact that generally motivated individuals complete optional studies all play into the risk of selection bias.[33] Owing to the potential risk, generalization of the results of this study applying to all emergency nurses throughout the United States or beyond without the application of further analysis would not be advisable.

Implications for Emergency Nurses

An important point in this study is that although the ProQOL scores of the emergency nurses are not significantly higher in burnout and secondary traumatic stress or significantly lower in compassion satisfaction from the prepandemic scores found in similar studies,[29-31] they are still in the moderate range, with the point estimate for compassion satisfaction being lower than previous findings and burnout and secondary traumatic stress point estimates being higher. Continuous work to improve these scores and the emergency nurses' quality of life is needed. Those in leadership positions need to be aware of the increased burnout and secondary traumatic stress levels in the midshift nurses and should include the midshift nurses in all supportive interventions.

Interventions to support higher compassion satisfaction levels and decrease burnout and secondary traumatic stress levels may cultivate a better work environment for our nursing professionals, increase patient satisfaction, and decrease turnover. Interventions that focus on nurse recognition have shown to be effective in reducing burnout and turnover.[34] Cost-effective interventions can be implemented as part of a unit-based improvement project. Items such as a gratitude board in the break room where staff can write a thank you message openly to one another, anonymous suggestion boxes that are addressed in unit meetings, leadership rounding where leaders show support and interest in staff, and a time and place for staff to meet, debrief, and provide feedback are shown to be effective.[34]

Compassion fatigue prevention in nurses can be targeted by interventions based on self-care and self-awareness. Activities such as meditation, mindfulness exercises, journaling, adequate sleep, healthy diet, and exercise are self-care activities that support well-being. Some hospitals have a dedicated self-renewal room where nurses can relax in times of stress. Other hospitals have used mobile carts with refreshments, journals, aroma therapy, stress reduction balls, and portable chair massagers.[35] Leadership can support nurses by implementing proactive programs targeted at improving nurses' well-being.[14] Leaders can also provide education on the concepts of burnout and compassion fatigue and the importance of self-awareness and early recognition to prevent compassion fatigue.[14] Nurses may not be aware of what compassion fatigue is and how it starts. Simple education on the concept to promote awareness is important for prevention. It is also important to not a component of compassion fatigue is burnout, which is now understood as being substantially influenced by organizational components such as unhealthy work environments, pressure from organizational policies, insufficient resources/staffing and patient care-related stress. Interventions focused on the individual nurse alone will not be sufficient; system-level solutions are needed to effectively address this occupational phenomenon.[8] Organizational and individual efforts to prevent and combat compassion fatigue promise to benefit the nurse, the patient, and the organization.

Conclusion

The results of this study show that emergency nurses had moderate levels of burnout and secondary traumatic stress with moderate levels of compassion satisfaction indicating

probable compassion fatigue while working through the COVID-19 pandemic. The present study's results were not significantly different from the prepandemic levels reported in other nursing studies. Emergency nurses are accustomed to unexpected events on a daily basis. They work in chaotic environments and adapt to changes throughout the shift based on incoming patients.

Potential areas of future research include surveying other nursing units in the hospital with the ProQOL to assess the scores by department. Comparing other units' scores with those reported in emergency nurses may provide insight on the resiliency of emergency nurses working through situations such as the COVID-19 pandemic. In addition, future research into the development of a targeted questionnaire specifically for nurses to assess the components of the ProQOL has been suggested.[25] Further assessment into what positive interventions leadership and hospital systems provided to nurses during the pandemic should be explored. The added support that nurses receive during the pandemic may have had a positive effect on preventiing burnout and improving compassion satisfaction.

The finding that midshift nurses have higher levels of burnout and secondary traumatic stress subcategory scores indicates a need for further research as does the impact of children on compassion satisfaction. Assessment of the factors that contribute to the difference in scores between day shift and midshift and tailoring specific interventions to support the midshift nurses are needed.

Finally, the prevention of compassion fatigue in nurses should be as high a priority as any other quality improvement project in the hospital setting. When the nurses experience high burnout, secondary traumatic stress, and low compassion satisfaction, the entire organization suffers.

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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.2022.03.008.

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Supplementary Data

Search methods for identifying previously published raw, unnormalized, ProQOL subcategory scores (and standard deviations) for US-based nurses:

- Searches included Ovid (Evidence-based Medicine Reviews, Embase, and MEDLINE), PubMed, and Google Scholar using key search terms in various combinations:
  a. Key search terms:
     i. "Nurse(s)","
     ii. "Professional Quality of Life," or "ProQOL,"
     iii. With and without "Scale,"
     iv. With and without "version 5," "V", or "v5."
- Articles were restricted to peer-reviewed journals, published in English, conducted using version 5 of the ProQOL (released in 2012) and conducted in the US.
- Only subcategory scores for nurses were included, rather than those pooled with other health care providers.
- Also, ProQOL subcategory means/medians and SDs must include the raw, or unnormalized because transformation to a t-score makes comparisons difficult because of the mean (or median) being set at 50 with a SD of 10.
- An additional approach to article selection included reviewing reference lists for pertinent citations.
- Studies using a pre/post-intervention were included with the pre-intervention scores being used.

SUPPLEMENTARY TABLE 1

ProQOL Subcategory correlations (N = 50)

	Secondary traumatic stress		Compassion satisfaction	
	PCC	***P* value**	**PCC**	***P* value**
Burnout	0.54	$P < .001$*	-0.64	$P < .001$*

PCC, Pearson's correlation efficient; ProQOL, Professional Quality of Life Scale version 5.

* Significant correlation.

SUPPLEMENTARY TABLE 2

ProQOL subcategory scores with previous findings.

Publication	**Burnout**		**Secondary traumatic stress**		**Compassion satisfaction**	
	PE	**SD**	**PE**	**SD**	**PE**	**SD**
Present study (N = 50)	25.6	5.6	24.5	5.4	38.7	5.4
Lisle et al[31] (N = 208)	21.3	3.5	22	5.3	40.7	6.2
Hunsaker et al[30] (N = 284)	23.7	5.9	21.6	5.4	39.8	6.3
Flarity et al[29] (N = 73)	23.9	5.1	23.5	5.3	40.3	5.6

PE, point estimate; ProQOL, Professional Quality of Life Scale version 5.

Number of participants (N).

Point estimate could be either a mean or a median.

Should Emergency Physicians and Nurses Direct Their Patients to YouTube for Heparin Self-Injection Training? A Systematic Review of Social Media Videos

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NCPD Earn Up to 9.5 Hours. See page 492.

Abstract

Background: The aim of this study was to examine the content, reliability, popularity, and quality of YouTube videos for patients learning how to self-administer subcutaneous low molecular weight heparin injections.

Methods: A systematic review of YouTube videos was conducted on August 20, 2021, using the keywords of "Low-molecular-weight heparin injection," "Enoxaparin injection," "Heparin injection," "Dalteparin injection," and "Tinzaparin injection." Two independent emergency physicians evaluated included videos separately with 5 different score systems (1- Journal of American Medical Association Score, 2-The Video Power Index, 3- Global Quality Scale, 4- Modified 5 Point DISCERN, 5- Total Comprehensiveness Score).

Results: Of 458 videos, a total of 161 unique videos were included. Of these, 94 (58.4%) were classified as useful and 67 (41.6%) as containing misleading information. The total number of views was 6,245,284 in useful information videos. DISCERN score (median 4, $P < .001$), Global Quality Score (median 4, $P < .001$), Journal of American Medical Association Score (median 4, $P < .001$), and Total Comprehensiveness Score (median 6, $P < .001$) were higher in the Useful Information Group.

Conclusions: Nurse and physician prescreening and prescoring the accuracy and quality of specific low molecular weight heparin injection self-administration videos before recommending YouTube to patients is warranted. Policies to limit the spread of health misinformation through credibility scoring and evaluation are needed on social media sites such as YouTube.

Keywords: COVID-19; LMWH injection; Heparin injection; YouTube; Online education

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Introduction

Low molecular weight heparin (LMWH) medications are widely indicated and used for patients with thrombotic and ischemic strokes, venous thrombosis, cardiovascular disorders, and inflammatory diseases.[1] As the practice of self-injection has become widespread, patients should receive appropriate self-injection training from a health care provider before self-administration.[2]

One of the main reasons of the recently increased global LMWH use is the COVID-19 pandemic. Early LMWH administration prevents thrombosis formation and causes systemic pulmonary inflammation reduction, as well as limiting viral invasion.[3] LMWH injection training is mostly given by nurses worldwide. However, during the COVID-19 pandemic, a higher level of mutual support between health workers has emerged because of workforce shortage. As a result, physicians provided additional patient discharge education.

The first SARS CoV-2 case was reported on December 31, 2019. As of August 2021, more than 230 million people were infected, and over 4.7 million people lost their lives.[4] SARS CoV-2 induces a prothrombotic state; thus, pulmonary embolism is frequently seen. These patients have a nearly 45% higher mortality rate compared with others.[5] Mortality rates decrease owing to prevention of coagulative events in patients with COVID-19; hence, patients' discharge from the hospital with LMWH was recommended by the authorities.[6]

Classical education methods are changing in tandem with technological advancements. With the emergence of multiple platforms, various methods of online learning and teaching are becoming increasingly popular.[7] Patients are more involved in their health care than ever before. Because of technological advancements and widespread internet access, the public now has access to a vast amount of health information. The number of people using the internet to search for health-related information is growing; it is estimated that 1 out of every 3 United States adults uses the internet to diagnose or learn about a health problem.[8] Simulations, e-books, licensed patient education videos, online magazines, mobile applications, and social media are used for educational purposes. Social media platforms, such as YouTube, play a significant role in our lives and are used for education.[7] Currently, YouTube is one of the most popular websites, coming right after Google Search, with over 2 billion monthly logged-in users and more than 500 hours of content added every minute.[9] YouTube is the most prevalent form of social media used by–73% of adults in the United States–and there is a growing body of literature evaluating the reliability of the medical content available to patients on YouTube.[8] Several studies investigated quality and contents of educational YouTube videos on sarcopenia videos,[10] methotrexate injection,[11] antitumor necrosis factor agent injection,[2] self-examinations of breast,[12] radiology education,[7] and basic life support and cardiopulmonary resuscitation.[13]

STUDY AIM

We found no published research on the quality of YouTube videos about the administration of LMWH injections. To address this gap in the published literature, we aimed to assess videos' accuracy, subject matter, popularity, and caliber for patients on YouTube to learn how to self-administer subcutaneous LMWH injections. For that reason, we evaluated all English language videos on the administration of LMWH injections on YouTube. With this study, we analyzed whether the patients who rely on these videos to self-administer LMWH injections were misled by the information provided in the videos.

Methods

This was a systematic review of YouTube videos using the search function at the YouTube site. The 5 following keywords were searched on YouTube on August 20, 2021; "Low-molecular-weight heparin injection," "Enoxaparin injection," "Heparin injection," "Dalteparin injection," and "Tinzaparin injection." Because search results on YouTube can change daily, screenshots of the videos were taken, and URLs of the videos were saved on August 20, 2021. These screenshots contained information about the number of comments, dislikes, likes, total views, and upload date. The exclusion criteria in the study consist of the following items:

- Non-English language videos
- Videos without audio/visual or with unclear audio
- Videos that involved the keywords "Low-molecular-weight heparin injection," "Enoxaparin injection," "Heparin injection," "Dalteparin injection," and "Tinzaparin Injection," where the keywords were mentioned but the theme of the video was not LMWH injection.

Repetitive videos (of the repetitive videos with different URLs but the same content, only 1 was included in the study) or multipart videos were condensed and considered a single video with duplicates removed from the final videos evaluated, as done in similar studies.[12,14]

ASSESSMENT OF USEFULNESS

Although according to the literature, different methods can be used to administer LMWH injections, the techniques are similar. A Professor of Emergency Medicine at our

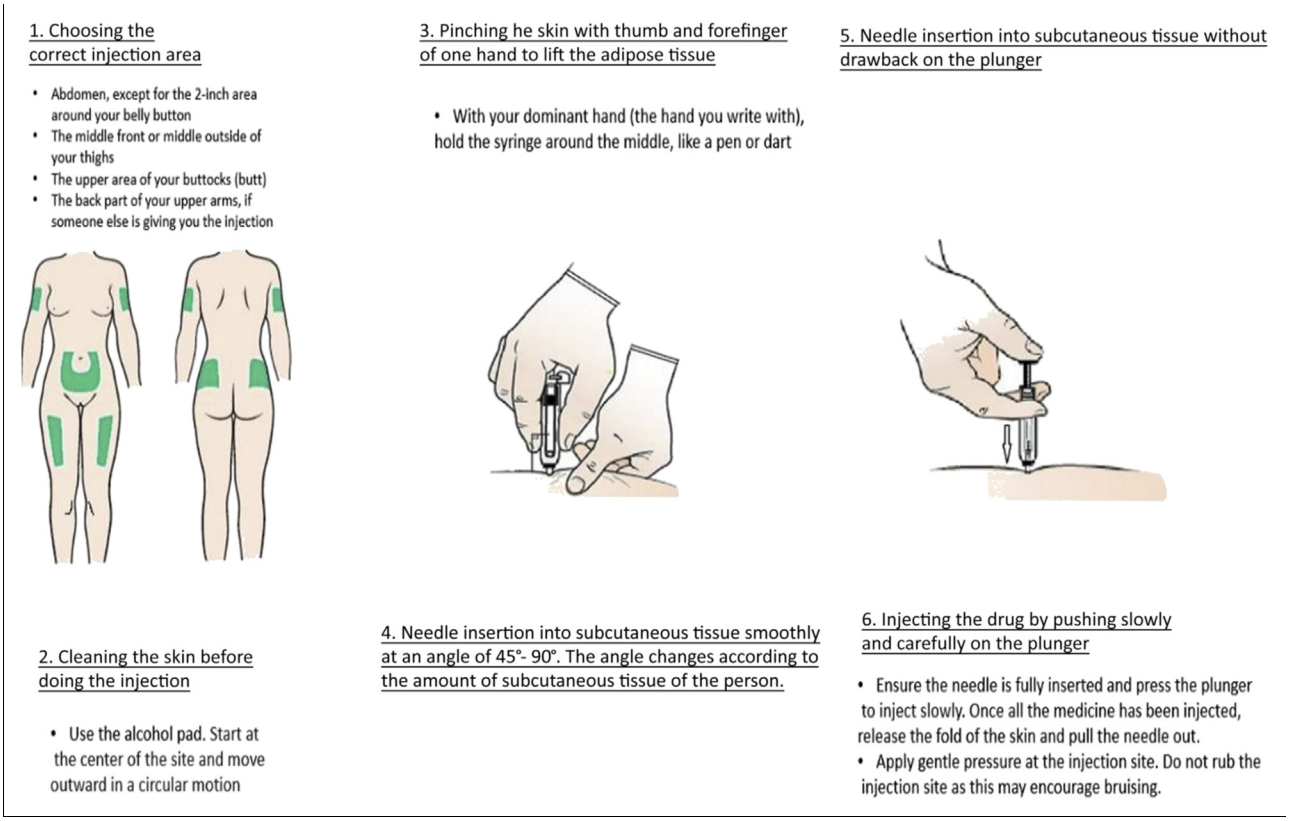

FIGURE 1
LMWH injection steps.[15,16]

university, by using "Memorial Sloan Kettering Cancer Center, Patient-Education"[15] and "Cambridge UH, 2021"[16] references, trained the authors about LMWH self-injection education procedures for standardization. According to this training, a 6-step algorithm (Total Comprehensiveness Score [TCS]) of self-injection has been adapted (Figure 1). Two independent emergency physicians evaluated included videos separately. Both physicians were blinded to the score of the other reviewer. Our rationale for physician reviewers included the need for nurse-physician mutual support during the COVID-19 pandemic, with an increasing need for physicians to provide mutual support to nurse colleagues in completing patient discharge education.

Categorization Process

These videos were categorized into 2 groups, one containing Useful Information and the other Misleading Information. Videos included in the Useful Information group were those that received a TCS of 6 when evaluated by 2 separate emergency medicine physicians. In contrast, videos that received a TCS score < 6 by one or both of the evaluating physicians were considered to be in the Misleading Information group. The usefulness/misleading information determination by each reviewer was sent to the professor who had trained the physicians. If the 2 emergency physicians disagreed on the evaluation, the professor decided the final categorization of the videos in question. The following are the classifications that were made:

- Useful Information: Videos that were judged by the reviewers here to contain helpful information were accurate and included comprehensive scientific information about LMWH injection administration according to the guidelines mentioned above.[15,16] These videos cover all the steps of LMWH injection administration.
- Misleading Information: Videos that were judged by the reviewers here to contain misleading information included inaccurate information or videos that did not contain any information on LMWH injection administration. In addition, videos that had only

relatively useful information or contained any relatively misleading information were categorized as misleading. (eg, not all steps were covered or wrong technique).

CATEGORIZATION OF THE VIDEO CHARACTERISTICS

The videos were categorized into 5 subgroups according to their sources:

- Governmental and news organizations
- Universities, professional associations, nonprofit medical groups, and individual physicians
- Medical advertisement/for-profit companies
- Online independent sites that provide medical information
- Individuals/patients

The videos were categorized into 5 groups according to the person who gave the explanation:

- Physician
- Nurse (presenter on YouTube who defines themself as a nurse regardless of nursing degrees)
- Health providers (who are not physicians/nurses)
- Patient
- Unknown

The videos were classified into 5 groups according to narrative style:

- Live patients being treated
- Realistic model users
- Texts, images (including PowerPoint presentation)
- Animations
- Audio presentations (videos without video content)

The following information was collected from the videos: video name, the time passed between upload and search, duration, total views, like and dislike counts, and number of comments. Daily views were calculated. This method has been used in many other studies related to YouTube evaluation in the published literature.[2,11,12]

SCORING SYSTEMS USED IN THE STUDY

First, the videos included for the research were separated into 2 categories: Useful Information and Misleading Information as described above. After that, the physicians who made the first evaluation also evaluated these videos with 5 different score systems separately. When these scoring systems were used, (except for Video Power Index [VPI], as it is an objective value independent of the evaluator), the scores given by the 2 evaluating physicians were compared to each other. In the case of the 2 physicians giving the same video different scores, an average value was calculated and used.

The VPI[13]

VPI was used to assess video popularity, which is calculated as "like rate × view rate/100." In this equation, the view ratio is equal to views per day, and like ratio is equal to (100 × likes)/(likes + dislikes). With VPI, assessment of the popularity of the videos through a scoring system became possible. A higher VPI score represents a more popular video.

Modified 5-point DISCERN[17]

DISCERN is a brief questionnaire that allows users to assess the quality of written information on treatment options for a health problem in a valid and reliable manner.[18] There are several reasons a modified DISCERN is required for evaluating the quality of YouTube videos. The DISCERN will enable consumers and information providers to judge the quality of written information, not videos. The instrument comprises 3 parts and 16 questions. Parts 2 and 3 are about treatment. Many of DISCERN's questions go unanswered in YouTube videos, especially if the videos are not about treatment. This information is not provided in the YouTube video, and using the DISCERN instrument results in a score of 0 for this item. When we reviewed the literature, The M-DISCERN Tool was used in similar studies to evaluate the quality of YouTube videos.[2,11,14] Therefore, we used the Modified 5-point DISCERN (M-DISCERN) Tool in our research. The M-DISCERN score (reference range: 0-5) consists of 5 questions, 1 point per question if answered YES (Table 1). It assesses the reliability of the videos. Any video receiving a Modified DISCERN score <3 was considered to have poor reliability, and videos with a score ≥ 3 were considered reliable and contained helpful information.

TCS

TCS about the LMWH injection procedure was designed in line with the information obtained from the literature.[15,16] The comprehensiveness of the LMWH injection video was assessed using a 6-point scale. The videos were awarded 1 point for each step that was demonstrated. (Table 1). The TCS score (reference range: 0-6) consists of 6 questions, 1 point per question if answered YES (Table 1). The higher the score, the better the content of the video. Only videos that received a TCS score of 6 were included in the Useful Information group.

TABLE 1
Evaluation systems of the YouTube videos

Modified 5-point DISCERN reliability tool[17] (1 point per question if answered yes)

1. Is the information in the video clear and understandable?
2. Are useful reference sources given? (Publication cited, from valid studies).
3. Is the information in the video balanced and neutral?
4. Are additional sources of information given from which the viewer can benefit?
5. Does the video evaluate areas that are controversial or uncertain?

Total Comprehensiveness Score[15,16] (1 point for each video covered)

1. Choosing the correct injection area
2. Cleaning the skin before doing the injection
3. Pinching the skin with thumb and forefinger of one hand to lift the adipose tissue
4. Needle insertion into subcutaneous tissue smoothly at an angle of 45°-90°. The angle changes according to the amount of subcutaneous tissue of the person.
5. Needle insertion into subcutaneous tissue without drawback on the plunger
6. Injecting the drug by pushing slowly and carefully on the plunger

GQS[19]

1. Poor quality, poor flow, most information missing, not helpful for patients
2. Generally poor, some information given but of limited use to patients
3. Moderate quality, some important information is adequately discussed
4. Good quality good flow, most relevant information is covered, useful for patients
5. Excellent quality and excellent flow, very useful for patients

JAMAS (1 point per each covered on video)

1. Authorship: Does the video include authors' and collaborators' names, their affiliations, and relevant credentials?
2. Attribution: Does the video frankly list all contents' sources and references and copyright information?
3. Disclosure: Does the website publicly and fully disclose any "ownership," sponsorship, advertising, commercial funding or assistance, or any conflicts of interest?
4. Currency: Does the website indicate upload and update dates of all contents?

GQS, Global Quality Scale; JAMAS, Journal of the American Medical Association Score.

Global Quality Scale[10]

Akyol et al[10] evaluated videos according to Global Quality Scale (GQS) to evaluate the quality, ease of use, and streaming quality of sarcopenia videos on YouTube. The scale has a total of 5 items. The item indicating the scale's quality was chosen. Low quality received 1 or 2 points. Those with a score of 3 were considered medium-quality videos, and the high-quality ones received 4 or 5 points (Table 1).

Journal of American Medical Association Score[19]

Journal of American Medical Association Score (JAMAS), a 4-criteria scoring system, was used to assess the reliability and accuracy of the sources of medical information that are given in the videos (Table 1). The total score was calculated by assigning 1 point for satisfying each criterion. The JAMAS (reference range: 0-4) consists of 4 questions, 1 point per question if answered YES (Table 1). Any video receiving JAMAS ≤ 2 was considered poor in accuracy and reliability, and videos with a score > 2 were considered accurate and reliable.

STATISTICAL ANALYSIS

The Shapiro–Wilk test was used to examine the normal distribution of continuous variables. Means and standard deviations of normally distributed data and medians, minimum, and maximum values of non-normally distributed data were calculated to constitute descriptive statistics. Mann–Whitney U test was applied in order to compare 2 non-normally distributed groups. Kruskal Wallis test was applied in order to compare 3 or more non-normally distributed

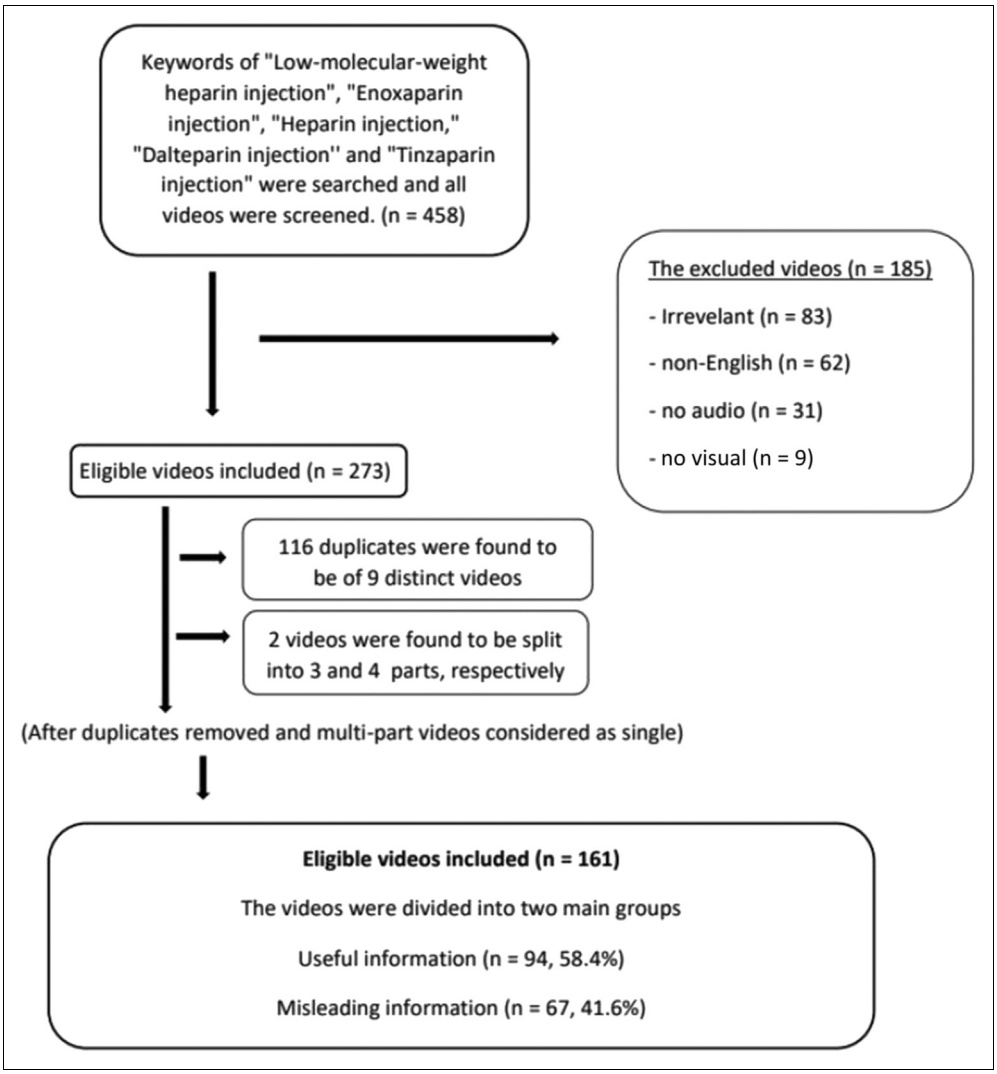

FIGURE 2
Flowchart of the selection of appropriate YouTube videos.

groups. Likelihood ratio test, Chi-square, and the Fisher exact test were applied to categorical variables, and their results were presented as observation counts and percentage values. Cohen's kappa score was applied to identify interrater reliability. Interobserver reliability was established by using the intraclass correlation coefficient. Results were regarded as statistically significant if the 2-sided *P*-value was $< .05$. MedCalc Statistical Software (version 12.7.7; MedCalc Software bvba, Ostend, Belgium) was used to perform statistical analysis of these data.

Results

With the search of mentioned keywords, 458 videos were obtained on YouTube; 46 for "Low-molecular-weight heparin injection," 226 for "Enoxaparin Injection," 157 for "Heparin Injection," 14 for "Dalteparin Injection," and 15 for "Tinzaparin Injection." A total of 185 videos were excluded because their topics were irrelevant (n = 83), did not have audio (n = 31), were in languages other than English (n = 62), or did not have any visual subject (n = 9). A

TABLE 2
Analyzed data of YouTube videos about heparin self-injection

Parameters	Misleading information n = 67		Useful information n = 94		U*	Z	P
	Total	Minimum-Maximum	Total	Minimum-Maximum			
Length (minutes)	19,843	14-1591	28,698	20-1157	2538.0	−2.095	.03
Likes	4511	0-758	19,635	0-3655	2899.5	−0.859	.39
Dislikes	623	0-99	2238	0-521	2729.5	−1.459	.14
Comments	736	0-81	1477	0-341	2983.0	−0.584	.55
Total no. of views	1,855,717	7-336309	6,245,284	1-1,501,204	3109.0	−0.137	.89
	Mean	Minimum-Maximum	Mean	Minimum-Maximum			
Uploaded date	1459	99-4573	976	4-44,429	2578.5	−1.957	.05
Views per day	2	0.5-157	3.5	0-514	2785.0	−1.271	.20
Video Power Index	1.6	0-141.21	2.75	0-449.87	2776.5	−1.280	.20
M-DISCERN	2	0-4	4	3-5	177.5	−10.427	< .001†
Total Comprehensiveness Score	3	0-6	6	6	10.5	−11.750	< .001†
GQS	3	0-4	4	2-5	782.5	−8.375	< .001†
JAMAS	1	0-3	4	2-4	114.0	–10.775	< .001†
	n	%	n	%	χ^2‡	P	
The speaker on the video							
Physician	-	-	8	8.5	6.00	.02†	
Nurse	2	2.9	48	51	42.23	< .001†	
Health provider	3	4.4	4	4.3	0.01	> .99	
Patient	56	83.7	24	25.5	52.73	< .001†	
Unknown	6	8.9	10	10.6	0.12	.72	
Live patients	49	73.1	50	53.2	6.57	.01†	
The way of presentation in video							
Realistic model	3	4.5	35	37.2	23.277	<.001†	
Textual material	4	6.0	1	1.1	3.129	.16	
Animation	1	1.5	5	5.3	1.597	.40	
Audio presentation only	10	14.9	3	3.2	7.256	.007†	

GQS, Global Quality Scale; JAMAS; Journal of American Medical Association Score.
* Mann–Whitney U test.
† Significance of $P < .05$.
‡ Pearson Chi-square test.

TABLE 3
Analysis of video features by sources

Usefulness of the source	Government/ News agencies (n = 3)		University channels/ Professional organizations/ Physician groups (n = 47)		Individuals/ Patients (n = 79)		Medical advertisement/For profit companies (n=17)		Independent informative websites about health (n = 15)		$\chi^{2\dagger}$	*P*
	N	%	n	%	n	%	n	%	n	%		
Misleading information	-	-	-	-	64	95.5	3	4.5	-	-	116.17	<.001*
Useful information	3	3.2	47	50.0	15	15.9	14	14.8	15	15.9		

Parameters	Total	Minimum-Maximum	Total	Minimum-Maximum	Total	Minimum-Maximum	Total	Minimum-Maximum	Total	Minimum-Maximum		
Length (s)	1129	272-431	16,161	62-768	22,380	14-1591	4276	75-767	4595	43-1157	11.15	.02*
Likes	293	19-165	15,667	1-3655	4843	0-758	933	0-260	2410	1-822	8.07	.08
Dislikes	39	5-19	1654	0-521	718	0-99	112	0-38	338	0-130	7.62	.10
Comments	4	1-2	806	0-341	827	0-81	89	0-34	487	0-189	6.36	.17
No. of views	127,959	6643-81,835	4,115,364	7-150,1204	2,051,337	1-336,309	882,922	1-640,531	923,419	199-347,277	6.26	.18

Parameters	Mean	Mean	Mean	Mean	Mean		
Uploaded date	2400	1024	1278	648	1106	7.43	.11
Views per day	18	2	2	18	20	8.69	.06
VPI	15.32	1.5	1.2	17.04	19.3	9.24	.055
M-DISCERN	5	5	2	5	4	98.44	< .001*
TCS	6	5	3	5	5	89.79	< .001*
GQS	4	4	3	4	4	80.50	< .001*
JAMAS	4	4	1	4	3	118.91	< .001*

GQS, Global Quality Scale; JAMAS, Journal of American Medical Association Score; TCS, Total Comprehensiveness Score; VPI, Video Power Index.
* significant of $P < .05$.
† Chi-square test.

total of 273 eligible videos were included in the initial review; 1 video consisted of 3 small video segments, and 1 video consisted of 4 smaller video segments. As a result, a total of 2 videos were included in the study instead of 7 video segments. We also found that 116 videos were duplicates of 9 distinct videos. Thus, we included them as 9 videos. After removing all duplicates and considering multipart videos as single, the final sample consisted of 161 eligible videos, which were included in our study. Of these videos, 94 (58.4%) were categorized as useful, and 67 (41.6%) of them were categorized as misleading. The flowchart is shown in Figure 2. An excellent level of inter-rater agreement in the reliability assessment of the videos was found ($\kappa = 0.987$). In terms of intraclass correlation, the M-DISCERN reliability score had a correlation coefficient of 0.86 (95% confidence interval [CI], 0.75-0.91), GQS had a correlation coefficient of 0.98 (95% CI, 0.89-0.91), TCS had a correlation coefficient of 0.98 (95% CI, 0.87-1.00), and JAMAS had a correlation coefficient of 0.87 (95% CI, 0.81-0.91). The inter-rater reliability was statistically significant in all evaluations ($P < .001$).

There was no significant difference between the 2 groups in terms of VPI or duration on YouTube in terms of total views or views per day or likes and comments, even though the Useful Information group scored considerably better on M-DISCERN, TCS, JAMAS, and GQS, and their presentation style and length were superior as well. The videos' components are available in Table 2.

Most of the videos were created by individuals/patients (49.1%); university channels/professional organizations/physician groups constituted 29.2% of the content creators, medical advertisement/for-profit companies constituted 10.6%, independent informative websites about health constituted 9.3%, and government/news agencies were 1.8%. Among the videos included in the study, 5 were created by drug manufacturer sites. When we were grouping these videos by source, videos produced by drug manufacturer sites were in the medical advertising/profit companies group. These 5 videos were in the Useful Information group. They had high scores on the JAMAS, M-DISCERN, and TCS evaluation scores. In the category of having useful information, university channels/professional organizations/physician groups generated exactly half of the videos in the group (50.0%). Individuals/patients (95.5%) were the major content makers in the category of Misleading Information. Descriptive parameters of each source's videos can be seen in Table 3.

In the current study, the total number of views was 8,101,001, the number of likes was 24,146, the number of dislikes was 2861, the number of comments was 2213, and total video duration was 48,541 seconds. When all the videos included in the study were examined, 10 (6.2%) of them contained information that may harm the person getting the injection (noncompliance with sterility rules, injection to the wrong area, and at the wrong angle). They all belonged to the Misleading Information group. Four (2.4%) of the videos included in the study had recommendations to prevent postinjection complications, such as cold compress to the injection area before and after the injection for 20 seconds.

Discussion

This is the first study on YouTube videos pertaining to LMWH injection administration. Our results show that when patients refer to YouTube to learn about LMWH self-injection, they may encounter a substantial amount of misleading information. A substantial portion of the videos (58.4%) was useful. Alternately, deceptive videos exist throughout all research, albeit the numbers varied among the works of Özsaban et al,[20] Culha et al,[21] and Chang and Park[22] (80.8%, 88.1%, 76%, respectively). Health care information on the internet is becoming more and more accessible, and many are turning to it as their primary source of information. Health care professionals and patients are adopting YouTube as a source of health care and medical knowledge and as an instructional guide.[12] There have been several investigations of the content and quality of YouTube videos.[23,24] This research revealed that patients might benefit from watching instructive videos on YouTube. It is easy to find material online on any medical issue, but because the web is mostly unfiltered, it may contain misleading and biased information.

Over 8 million people watched the videos included in this study, giving 24,126 "likes" and leaving 2213 comments. We compared our findings with those of similar studies that evaluated the content of YouTube videos teaching methotrexate self-injection technique (with 43,840 views)[11] and antitumor necrosis factor agent injections[2] with approximately 3 million views. This demonstrates the popularity and accessibility of LMWH injection videos on YouTube compared with others; obviously, there is higher audience interaction when compared with similar content. (The total number of views among the studies of Tolu et al,[2] Rittberg et al,[11] and Esen et al[12] were 2,888,196, 161,028, and 164,044, respectively.) There may be several reasons for this. In our study, all LMWH injection videos on YouTube were evaluated, yet other studies included a certain number of the most-watched videos, but not all the videos on YouTube. Thus, because our

systematic methods and inclusion criteria resulted in more videos being screened, the number of interactions is expected to be higher. Another factor could be that, as previously mentioned, the majority of the patients were treated with LMWH in the COVID-19 pandemic, including those admitted to the hospital, treated at outpatient clinics, or discharged home after being treated. Patients with COVID-19, especially those treated at home, have to follow the worldwide accepted 10-day isolation protocol.[25] Thus, they may have had to find a way to learn self-injecting LMWH. The patient might need to see a visual step-by-step demonstration of this procedure under the COVID-19 context. Because of the COVID-19 pandemic, the internet and social media had become a popular arena for distance-learning activities and communication.[26] Thus, patients might have considered YouTube a free, easily accessible educational tool. In addition, YouTube has grown to be a global information source in tandem with these changes.[27,28] There are also patient groups that benefit from watching videos via subscription or licensed content provided by the health care system.[29] Although e-based learning programs provide a flexible teaching method, evidence shows that e-based learning alone does not surpass face-to-face education.[30,31] However, because of the limitations caused by the COVID-19 pandemic, people began looking for online training options. Considering this current research on the validity, reliability, and popularity of the videos on YouTube after the pandemic, it is plausible that the pandemic context resulted in higher numbers of views and audience reactions.

There are various scoring systems used to assess videos' quality and scientific accuracy online.[13] In terms of substance, dependability, and quality, there is no standard way to evaluate online health care videos because there is a lot of variation. Similar instruments (M-DISCERN score, GQS) were used in our study, just like in previous studies.[10,12-14] When it came to M-DISCERN scores, GQS, and other test scores, there were substantial variations between the groups of videos that presented useful and misleading information. JAMAS and TCS scores indicate that videos in the Useful Information group are more consistent and had higher overall quality. When we compared these findings with those of other studies, we observed that our findings generally corroborated previous research.[22,23] Unlike in the study by Yilmaz Ferhatoglu and Kudsioglu,[13] in our research, there was no significant difference in VPI between the 2 groups.

In previous studies that investigated the standards and themes of the YouTube videos, clinical skills education videos included antitumor necrosis factor agent injections,[2] gonadotropin self-injections,[23] methotrexate self-injection,[11] and ventrogluteal injections.[20] In these studies, videos containing useful information are significantly dominant among all the videos included in the studies. However, when we look at the results of these studies, the number of views of useful and misleading videos is different from our results. Total views were higher in the Useful Information videos group. Somehow, patients or students viewed the useful information videos more often than those with misinformation, except for Özsaban et al.[20] Even though Özsaban et al's[20] research found the difference to be insignificant, the overall number of views of misleading videos was greater than that of useful videos. An unfavorable conclusion is that misleading videos attracted more viewers. Among the misleading videos, there were ones that could harm the patients. This ratio was not reported in other studies; however, our study found that 10 videos (14.9%) of the misleading group could put one's health at risk. Past research has indicated that YouTube videos on a variety of medical issues were untrustworthy sources of information.[12,13] This reveals a need to evaluate videos before letting them get uploaded on YouTube, to spot and publicly label misleading ones, and to avoid the spread of incorrect information.

We found that videos created by nurses and physicians were statistically significantly more useful to patients: 56 videos were in the Useful Information group, and 2 videos were in the Misleading Information group ($P < .001$). A total of 59.5% of the videos in the Useful Information group had nurses or physicians as presenters, whereas they created just 2.9% of videos in the Misleading Information group. When we compared our findings to studies of evaluated breast self-examination videos[12] or gonadotropin self-injections videos[23] on YouTube, the results were similar: the number of videos narrated by health professionals was higher in the Useful Information group. Although YouTube LMWH injection videos narrated by health care providers may be deemed as trustworthy by the audience,[32] in terms of getting meaningful information, we discovered that the source of the uploads was more important than the presenter narrating the video.

One-half of all the useful videos evaluated here on LMWH injection were created and released by several university channels, professional organizations, or teams consisting of physicians (50.0%) in this study. The videos uploaded by patients have low GQS, and videos uploaded by patients constituted 95% of the videos in the Misleading Information group. It can be harmful to their health if patients access sources that have not been checked by health care professionals or that are not licensed. Therefore, when uploading health-related information to social media, peer patient educators need to partner with a knowledgeable health care provider and/or content expert to enhance

TABLE 4
Ten highest ranked videos about LMWH self-injection

Uploader	Views	Likes	Length(s)	VPI	JAMAS	Upload date
Pharmacist Online[36]	10,291	44	166	41.0	3	May 21, 2021
Tacoma Community College[37]	71,564	1117	210	26.3	3	November 16, 2014
Thrombosis Canada[38]	827	7	517	2.6	4	February 16, 2021
About Kids Health[39]	4007	6	170	0.75	3	June 22, 2015
CIMS Hospital[40]	282,082	1775	204	209.2	3	February 6, 2018
DIS farmasi Hospital[41]	732	8	269	2.0	4	May 2, 2021
University of Manitoba Nursing Skills[42]	25,493	158	768	22.7	3	November 2, 2018
O and G Department Sarawak General Hospital[43]	39,481	165	426	24.7	4	September 22, 2017
Autry Learn Now[44]	13,820	25	91	11.2	2	November 12, 2018
Pharm Project[45]	20,187	53	243	20.0	4	March 5, 2019

JAMAS, Journal of American Medical Association Score; VPI, Video Power Index.

credibility and combat health misinformation. The number of videos created by government/news agencies found in our study was scarce, as in similar studies. Although the videos created by government agencies or news agencies were of the highest quality, they received relatively few monthly views, but all of them (n = 3) were in the Useful Information group.[33] In order to give accurate and unbiased material, universities and governments should actively participate in online video education by developing and posting educational and informative videos on YouTube or other open-access social media sites. For the viewer, this might result in higher levels of dependability and content quality.

Patients believe that YouTube is a helpful way to find answers to health issues.[34] If accurate and credible sources are used, health education information online could improve the health awareness of the audience and improve patient satisfaction. Emergency nurses and physicians should be familiar with specialized tools to assist and educate their patients toward optimal self-care outcomes, even if it means using online videos. According to the findings of another systematic review, several YouTube videos provide misleading or unreliable information on health care.[35] Because the quality and reliability of online information are unregulated, this could mislead viewers, particularly patients, and damage the balance between information and understanding in the clinician-patient interaction. For these reasons, we recommend that social media operators develop policies, regulations, standards, and rules for preventing the submission of misleading information to YouTube and similar platforms by utilizing the expert evaluations from unbiased health professionals.

Limitations

We aimed to comprehensively analyze the sources and independently review the listed videos. However, there are several limitations to the study's conclusions that must be taken into account. First, the systematic review protocol and strategy were not preregistered. Other limitations include the following: we would have preferred to scan the videos in all languages on YouTube, but we were limited to scanning only English language videos. We chose the search phrases "Low-molecular-weight heparin injection," "Enoxaparin injection," "Heparin injection," "Dalteparin injection," and "Tinzaparin injection." Video indexing on sites such as YouTube may not be as useful or accurate as informatics and librarian-developed peer-reviewed journal databases and indexing platforms. Despite this, there is a possibility that we overlooked any useful or misleading videos. Because of the limited scope of the study, the findings may not be applicable to open-access social media platforms other than YouTube that feature educational videos. It is possible that the results of this study may have been influenced by the fact that both of the reviewers were physicians rather than an interdisciplinary team of reviewers.

Implications for Emergency Nurses

On the basis of the findings of our study, we recommend that health care providers increase their awareness of the reliability of health education videos available on social media platforms such as YouTube to familiarize themselves with information that their patients are accessing outside of the clinical

environment. In order to accomplish this, nurses and physicians can benefit from applying the methods we used to evaluate the videos in this study (M-DISCERN, JAMAS, GQS). Table 4 includes low molecular weight heparin self-injection education YouTube videos with the highest scores from our study for consideration as an adjunct to clinical practice patient education.

Because of the large number of videos on YouTube and the growth that the platform is experiencing, it is not feasible for clinicians to independently monitor the quality and credibility of all relevant videos. We recommend that collective efforts through professional organizations be considered to regularly review social media platforms and certify or recommend specific videos on the basis of the measures we presented here. Health care professionals must support multilevel efforts to combat health misinformation. We suggest clinician advocacy to and partnership with social media and video hosting services, such as YouTube, in order to enact a credibility and accuracy score for health information to avoid spreading misinformation.

We recommend social media policies to license, endorse, or certify a video only after it has been reviewed and determined to meet the required professional criteria. Leaders of health care institutions can combat misinformation by budgeting for patient access to credible patient education videos after discharge and from the patient's home.

Conclusion

As a result of our research, we can conclude that over half of the videos contained useful information. Among the videos examined in our study, 10 videos that are in the Useful Information group possess the highest TCS, GQS, and M-DISCERN scores. These videos are shown in Table 4. However, 41.6% of the LMWH self-injection videos reviewed in the study contained misleading information. Thus, there is a substantial risk of patients reaching incorrect or inadequate information if they are directed to general YouTube videos to learn the LMWH self-injection technique. We recommend that nurses and physicians prescreen and score the accuracy and usefulness of videos from credible sources before recommending them to patients. We suggest that social media and video hosting services, such as YouTube, enact a credibility and accuracy score for health information to avoid spreading misinformation.

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.2022.03.007.

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Role and Training of Emergency Department Charge Nurses: A Mixed Methods Analysis of Processes, Needs, and Expectations

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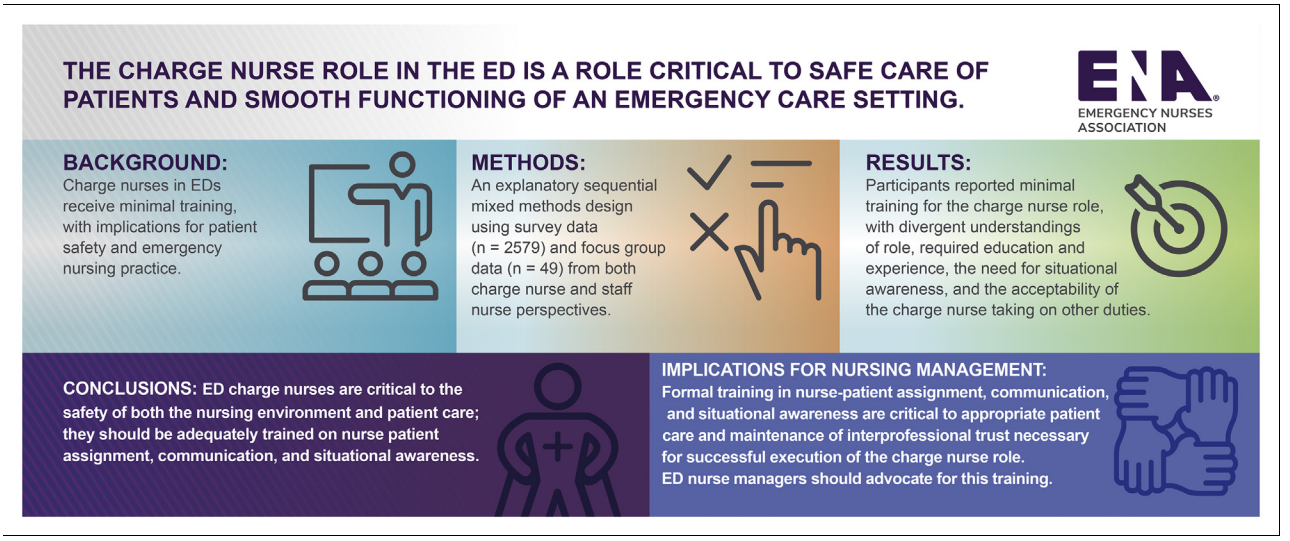

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Role and Training of Emergency Department Charge Nurses: A Mixed Methods Analysis of Processes, Needs, and Expectations

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NCPD Earn Up to 9.5 Hours. See page 492.

Contribution to Emergency Nursing Practice

- CN role in the emergency department is a role critical to safe care of patients and smooth functioning of an emergency care setting. There is a paucity of information on the training of ED CNs.
- The role of the CN is understood differently by ED CNs and staff nurses. Preparation and training are very minimal and contribute to role confusion, inconsistent execution of duties, and variable success.
- Recommendations for translating study findings into emergency clinical practice include identification of ED CN competencies and implementation of formal training.

Abstract

Introduction: Charge nurses (CNs) are shift leaders who manage resources and facilitate patient care, yet CNs in EDs receive minimal training, with implications for patient safety and emergency nursing practice. The purpose of the study was to describe the experiences of emergency nurses related to training, preparation, and function of the CN role.

Methods: An explanatory sequential mixed methods design using survey data (n = 2579) and focus group data (n = 49) from both CN and staff nurse perspectives.

Results: Participants reported minimal training for the CN role, with divergent understandings of role, required education and experience, the need for situational awareness, and the acceptability of the CN taking on other duties.

Conclusions: The ED CN is critical to the safety of both nursing environment and patient care. Nurses in this pivotal role do not receive adequate leadership orientation or formal training in the key areas of nurse patient assignment, communication, and situational awareness. Formal training in nurse-patient assignment, communication, and situational awareness are critical to appropriate patient care and maintenance of interprofessional trust necessary for successful execution of the CN role. ED nurse managers should advocate for this training.

Key words: Emergency department; Charge nurse; Nurse manager; Training; Mixed methods research

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Introduction

Charge nurses (CNs) are shift leaders whose role includes managing nursing resources and facilitating appropriate patient flow and care.[1-5] As clinical leaders, CNs ideally use knowledge, expertise, and experience to guide the flow of patients in a way that maximizes resources while ensuring safety.[5,6] The leadership of CNs has been examined in the literature with seminal research pointing to 2 main categories: transactional and transformational. Transactional leadership works as an exchange of staff compliance for praise, rewards, and resources or the avoidance of disciplinary action and clarifies expectations and offers recognition when goals are achieved.[7] It works reasonably well in pulling a team together when expectations are clear. Transformational leadership is a more individualized approach, with the elements of idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration.[7] Although more recent literature related to CN development focuses on improvements in transformational and transactional leadership, resiliency,[8] and observed behaviors of clinical leadership,[9] this literature is descriptive, situated in the inpatient unit, focused on assessment of education, and does not provide evidence for specific training modalities.[1] There is a decided lack of research findings centered on the problem of leadership development in the ED CN role.

CNs play a pivotal role in the socioclinical dynamics of an emergency department[10] because they manage interdisciplinary communication, patient flow, and patient assignments. Allen[11] described the process of nurse-patient assignment (NPA) as crucial to safe care, nurse satisfaction, and hospital costs. NPA decision-making is focused on elements particular to the nurse (competence, ability), the patient (acuity), and the environment (the layout of the unit and the rooms, the ability to cluster patients together in an assignment) to balance the abilities of the nurse and the needs of the patient.[11] Well-performed NPA that aligns nurse capacity with patient need is critical to a healthy, supportive nursing environment. When NPA is not in alignment, the environment of care suffers commensurately.

CNs have been identified as potential facilitators of bullying dynamics in the emergency care environment,[10] specifically, in their role in deciding NPAs that are misaligned with nurses' experience and skills. This may be related to the lack of leadership preparation and training for the role and the intermediary leadership status of CNs.[12] There is a dearth of literature on both the processes by which ED CNs are oriented to the role and on the specific NPA training that impacts nursing and patient outcomes. The aim of this study was to explore both the clinical and social aspects of the training process and leadership orientation to the CN role in emergency departments in the United States.

Methods

This mixed methods study utilized an explanatory sequential design to examine both charge and staff nurses' perspectives of United States CNs training, practices, and lived experiences. A mixed methods approach was chosen because research on the CN role has largely focused on inpatient settings and there is an identified gap in understanding the role, function, and preparation in emergency departments. In addition, a tangential area of interest was the further exploration of previous research regarding CNs influence on emergency nurse bullying.[10] Survey items were developed in a twofold process that included constructs based on the literature examining the process of NPA[11] CN development,[1] competencies,[5] and social dynamics,[10] along with question items generated from earlier studies by the authors (see Supplementary Appendix). The sequential design provided triangulation and validation of quantitative results through qualitative data that incorporated both charge and staff nurse perspectives of necessary preparation, expected duties, and experiences of trust in the charge/staff nurse relationship.

SAMPLE

A purposive sample was recruited for both quantitative survey data collection (n = 2579) and qualitative focus group participants (n = 49) from a demographically diverse population of emergency nurses who were members of the Emergency Nurses Association. (see Figure, Tables 1 and 2). Inclusion criteria consisted of English-speaking emergency nurses over the age of 18 years practicing in United States emergency departments as staff nurses or permanent or intermittent CNs.

Institutional Review Board approval was obtained from Advarra, Inc (Columbia, MD), before recruitment of study participants. All participants were given a summary of the study and assurance of confidentiality via a Certificate of Confidentiality provided by the National Institutes of Health. This information was provided again to focus group participants before the beginning of the focus group discussion.

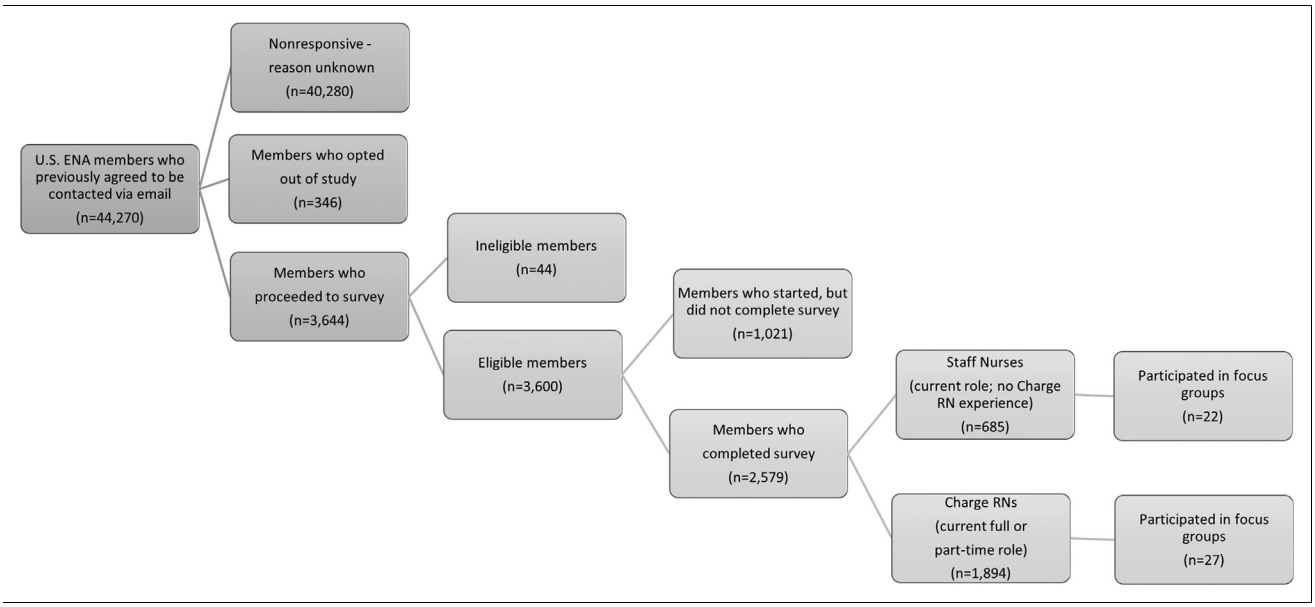


FIGURE
Sampling flow diagram.

QUANTITATIVE DATA COLLECTION

Qualtrics survey software was used to collect personal and facility demographics, work experience, education and training requirements, and role expectations and responsibilities specifically for the CN role. The 32-item survey was disseminated online from March 15 through April 15, 2021.

QUALITATIVE DATA COLLECTION

Focus groups were conducted online; the Zoom (San Jose, CA) "waiting room" feature allowed for verification of participants into the focus group sessions.[13] Participants were asked to identify themselves online using only their first names.

A total of 49 participants (27 charge, 22 staff) attended 1 of a series of 6 1-hour focus groups held via Zoom with 6 to 11 participants per session. Session recordings were transcribed by the Zoom software and verified by a transcriptionist. The research team facilitated sessions using a structured interview agenda that was theoretically derived[1,10,12,14] tailored to staff or CN groups and vetted by the team.

DATA ANALYSIS

Quantitative survey data were exported to SPSS (Armonk, NY), and 3 members of the research team (L.W., A.D., and C.P.) analyzed results of descriptive statistics. Qualitative focus group transcripts and session notes were compiled in a secure data site that was accessible to the team for analysis. Mayring's content analysis process[15] provided a framework for investigator's data coding and analysis. Mayring's content analysis process comprises a step-by-step formulation of inductive categories derived from the interview transcripts, followed by a review of categories after 10% to 50% of material (formative check of reliability), revision, and collective comparison among coinvestigators including frequencies of key elements (summative check of reliability) to arrive at the final determination of themes and categories and interpretation of results. The theoretical underpinning for these analyses is based on extant literature pointing to role discrepancies between CNs leadership skills, preparation, and increasing administrative responsibilities vs organizational expectations, supports, and authority delegated to these frontline nurse leaders.[1,6]

TABLE 1
Demographic characteristics of survey participants and emergency departments where they work

Nurse demographics (n = 2579)			Facility demographics (n = 2579)		
Years of experience	**Mean**	**SD**	**Facility size (n = 2579)**	**Mean**	**SD**
As a nurse in all areas	14.9	11.1	Average daily volume	131	85.6
As an emergency nurse only	11.5	9.2	No. of ED beds	32.9	21.6
As a nurse in your current emergency department	7.4	7.5			
All other roles in emergency care, excluding nursing	6.2	9.2			
Age (y)	42.5	11.0			
Sex	%		Geographic location	%	
Female	83.0		Urban	42.0	
Male	16.6		Suburban	37.3	
Nonbinary	0.1		Rural	20.7	
Prefer not to say	0.3				
Education	%		ED patient population	%	
Nursing diploma	1.7		General emergency department	83.8	
Associate	17.7		Adult-only emergency department	10.7	
Bachelor	62.3		Pediatric-only emergency department	5.5	
Master	17.0		Geriatric-only emergency department	0	
Doctorate	1.4				
One or more EN specialty certification (eg, CEN, CPEN)	52.2				
Primary ED role	%		Facility type	%	
Staff nurse	21.4		Nongovernment/not for profit	71.0	
Different primary role, occasionally staff	5.1		Investor-owned/for profit	17.3	
Charge nurse	7.1		State/local government	7.2	
			Federal government/military	42	
				%	
Primarily charge, occasionally staff	23.7		Academic medical center	47.5	
Primarily staff, occasionally charge	34.5		Community hospital	70.7	
Different primary role, occasionally charge	8.2		Critical access hospital	41.3	
			Freestanding emergency department	11.7	
			Trauma center	46.8	

EN, emergency nurse; CEN, certified emergency nurse; CPEN, certified pediatric emergency nurse.

DATA INTEGRATION

Results from both datasets were separately analyzed and interpreted sequentially. Quantitative findings were evaluated first and informed the interview guide and moderation of focus group sessions, allowing for interpretive data integration during qualitative data collection. Results are presented in thematic categories both narratively and using a side-by-side format that incorporates major themes, statistics, and meta inferences from integrated results.[16,17]

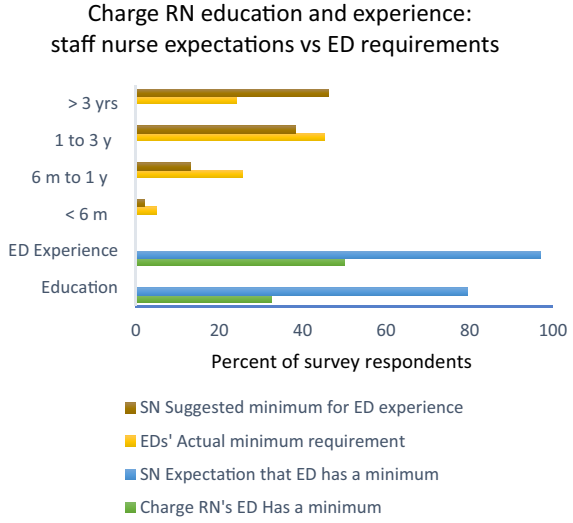
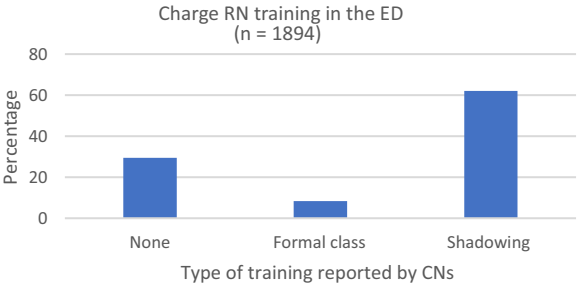
TABLE 2
Demographic characteristics of focus group participants and their emergency departments

Nurse demographics (n = 49)							
Years of experience	**Staff RNs (n = 22)**		**Charge RNs (n = 27)**		**Combined demographics (n = 49)**		
	Mean	**SD**	**Mean**	**SD**	**Years of experience**	**Mean**	**SD**
In all areas of nursing	12.9	11.6	13.6	10.0	In all areas of nursing	13.3	10.7
Emergency nursing only	6.8	5.7	10.8	7.4	Emergency nursing	9.0	6.9
In current emergency department	5.2	5.0	7.3	5.6	In current emergency department	6.4	5.4
All other emergency care roles, excluding nursing	6.3	7.8	5.3	7.8	All other emergency care roles	5.8	7.3
Age (y)	41.4	10.9	40.7	9.1	Age (y)	41.0	9.8
Sex	Staff RNs		Charge RNs		Sex	%	
Female	77.3		85.2		Female	81.6	
Male	22.7		14.8		Male	18.4	
Education	Staff RNs		Charge RNs		Education		
Nursing diploma	4.5		3.7		Nursing diploma	4.1	
Associate	4.5		3.7		Associate	4.1	
Bachelor	81.8		51.9		Bachelor	65.3	
Master	9.1		33.3		Master	22.4	
Doctorate	0		7.4		Doctorate	4.1	

Combined facility demographics (n = 47)					
Facility size (n = 47)		**Mean**	**SD**		
Average ED daily volume		158.0	68.5		
Geographic location	% (n = 47)	ED patient population	% (n = 47)	Facility type	% (n = 47)
Urban	44.9	General emergency department	79.6	Nongovernment/nonprofit	75.5
Suburban	42.9	Adult-only emergency department	12.2	Investor-owned/for profit	10.2
Rural	12.2	Pediatric-only emergency department	8.2	State/local government	10.2
				Federal government/military/VA	4.1
				Academic medical center	53.1
				Community hospital	59.2
				Critical access hospital	36.7
				Freestanding emergency department	4.1
				Trauma center	42.9

VA, Veterans Administration; RNs, registered nurses.

TABLE 3
Integrated findings: education, experience, and preparation for the CN role (Q1)

Domain: education and experience Quantitative results (n = 1894 CNs; n = 685 SNs)	Qualitative results (n = 49)	Interpretation of mixed results
 • SN expectation for education requirement (79.4%) and ED experience (97.1%); recommended minimum >3y (46.9%) • CN's ED experience minimum <3 y (75.8%); No education requirement (67.4%)	Theme: "Tag, you're it" (CN) Theme: "Charge nurse personality" (CN, SN)	Confirmatory: CNs are not adequately prepared and often assume the role out of necessity or opportunity rather than expertise. Discordant: Expectations for minimum requirements in CN education and experience were higher among SNs compared with the actual ED minimums reported by CNs. Expanded: More research is required to ascertain minimum competencies necessary for CNs to function successfully in their role.
 One-third (29.4%) of CNs reported no training for the role, while 62.1% reported training primarily by shadowing.	Theme: "Tag, you're it" (CN) Theme: "Charge nurse personality" (CN, SN)	Confirmatory: There is a significant lack of formal CN training. Discordant: CNs and SNs describe a culture where CNs are chosen by virtue of personality; they described individual CNs as having either "negative" or "positive" personality traits. Expanded: "Shadowing" has limited efficacy because its brief and is focused on "learning" tasks rather than leadership skills.

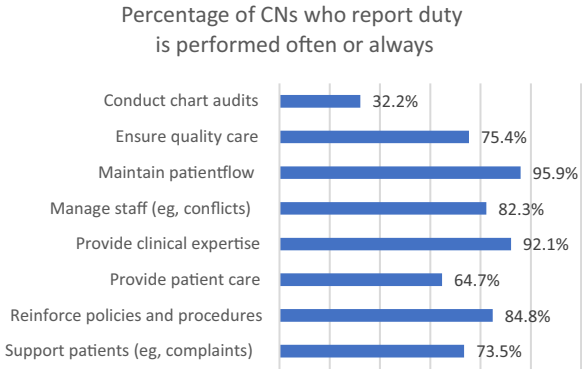
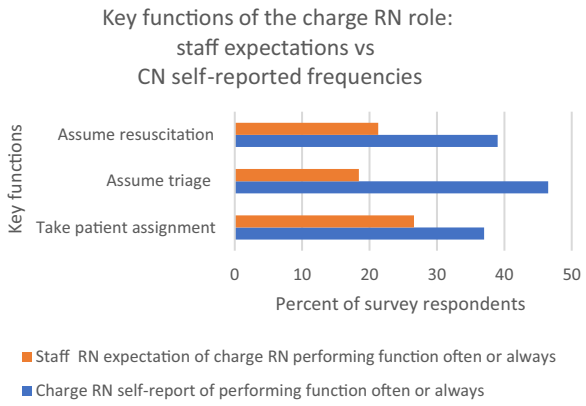
CN, charge nurse; SN, staff nurse.

Results

The final quantitative sample comprised 2579 emergency nurses, with 685 self-identifying their primary role as staff, and the remainder identified as either permanent or occasional CNs (Figure). Qualitative focus group participants consisted of 49 participants evenly distributed between charge (44.9%) and staff nurses (55.1%). Twenty of 49 participants (41%) responded to the member checking request and verified the interpretation of qualitative data.

Findings from both datasets are presented along with the interpretive results of integrated data (see Tables 3-6).

TABLE 4
Integrated findings: function and purpose of the CN role (Q2)

Domain: role expectations and responsibilities Quantitative results (n = 1894 CNs; n = 685 SNs)	**Qualitative results (n = 49)**	**Interpretation of mixed results.**
	Theme: Logistical management (CN) Theme: Situational awareness (SN)	Confirmatory: The CN role is challenging and demanding, yet often ill-defined. Discordant: CNs focused on logistical considerations, primarily patient flow. SNs recognized the need for CNs to account for changing conditions (eg, crowding, staffing, patient acuity) and managing accordingly. Expansive: SN perspectives are valuable for facilitating the success of CNs.
	Theme: It's a handful (CN, SN)	Confirmatory: CNs report frequently assuming nonmanagerial functions such as resuscitation, triage, and taking patient assignments. Discordant: SNs report that they do not believe that CNs should have to assume additional duties so that they can focus on managing the department. Expansive: Expectations of the CN role are often ambiguous and unrealistic, resulting in role confusion for both CNs and SNs.

CN, charge nurse; SN, staff nurse.

Q1: WHAT PREPARATION SHOULD CNS HAVE IN TERMS OF EDUCATION, EXPERIENCE, AND TRAINING FOR THE ROLE?

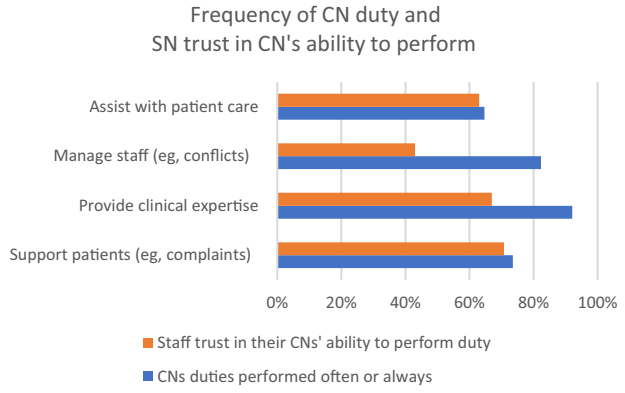
This question was answered using both survey and focus group data, with differences between the 2 groups of nurse respondents (see Table 3).

Survey Results

Most CN survey respondents (n = 1894) indicated that their emergency departments had no expectation for education or certification before assuming the role (67.4%), but there was some expectation for having had experience in the emergency department (50.1%). CN participants reported the expectation for ED experience was from 1 to 3 years (45.3%) to more than 3 years (24.2%).

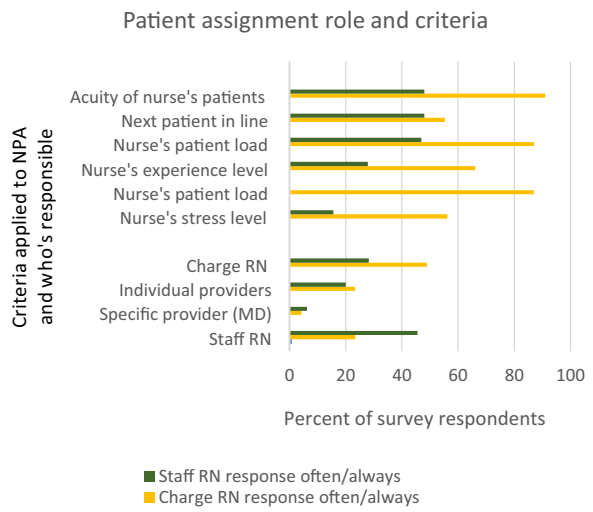
Two-thirds of the CN sample (62.1%) reported training primarily by shadowing other nurses; 29.5% of respondents reported that they had no training at all for the role. Only 8.4% reported any kind of formal class to orient them to the role. About one-third of the CNs who received training identified learning about NPAs, clinical practice and decision-making, policy implementation, and communication skills management of patient complaints and violence prevention. In contrast, staff nurse survey respondents (n = 685) overwhelmingly reported a need for CNs to have a minimum expectation for education and

TABLE 5
Integrated findings: relationships with other staff and management (Q3-Q6)

Domain: Social dynamics and trust **Quantitative results (n = 1894 CNs; n = 685 SNs)**	**Qualitative results (n = 49)**	**Interpretation of mixed results**
	Theme: CN sets the tone (CN, SN) Theme: They [staff] have to trust you (CN)	Confirmatory: CN sets the tone for the shift, both in terms of management of challenges, positivity, and teamwork. Discordant: SN trust in the CN's ability to perform in the role varies across duties and is lowest for managing staff conflicts even though CNs frequently perform this duty. Expansive: SNs trust in CN ability is critical for CN success. However, CN inexperience can impact their ability to function successfully and maintain cohesion within the health care team, potentially contributing to a culture in which bullying is permissive.

CN, charge nurse; SN, staff nurse.

TABLE 6
Integrated findings: nurse-patient assignment (Q7)

Domain: nurse-patient-assignment Quantitative results (n = 1894 CNs; n = 685 SNs)	Qualitative results (n = 49)	Interpretation of mixed results
	Theme: It's a chess game (CN) Theme: Throwing them on back (SN).	Confirmatory: CNs lack training in NPA decision-making and apply different strategies depending on conditions in the emergency department and nurse's capabilities. Discordant: CNs more often reported being responsible for, and applying specific criteria to, NPA decisions. SNs reported making NPA decisions more frequently, and that CNs lack consistency in their NPA decisions. They reported that CNs consider a nurse's experience or stress level less often than CNs reported applying those criteria. Expanded: NPA is a critical function of the CN role and can support or inhibit nurse performance at the bedside, but there is no standard process or criteria.

CN, charge nurse; NPA, nurse-patient-assignment; SN, staff nurse.

experience, with almost half indicating that more than 3 years should be the minimum requirement for ED experience before assuming the role.

Focus Group Findings

Qualitative themes emerging from focus group respondents about preparation included "Tag, you're it" and "charge nurse personality." A third theme, "situational awareness as the ideal state," described the optimal result of training. Both staff and CNs in this sample report that CNs have a broad role, significant responsibility without commensurate training, and reported deficiencies in skills, education, and ED experience, expressed by the theme "Tag, you're it," which described how nurses were often placed in the role without warning or adequate preparation.

> "Well kind of I, I started out in an ER in Montana, and it was kind of like 'Hey you're charge tonight' and I'd been there for maybe 2 years." (CN1)

> "Zero training at my facility." (SN1)

A second theme, that of the "charge nurse personality," arose from both groups. Staff nurses reported the "charge nurse personality" as describing desirable traits such as good communication skills, clinical knowledge, and situational awareness. In contrast, among CN participants there was a sense of having acquired the role by way of personal attributes.

> "I've 'been there/done that' before already and I had the attitude they thought that would get things done on the mid shift." (CN2)

> "Yeah, I think mainly it's kind of like whoever doesn't fight it just is charge." (SN2)

Finally, the staff nurse participants reported a need for education and training that would give CNs situational awareness as an ideal state. Their concerns reflected the broad scope of the role, which is further discussed in our analysis of research question 2.

Q2: WHAT IS THE FUNCTION AND PURPOSE OF THIS ROLE?

This question was answered using both survey and focus group data with differing results between the 2 groups of survey respondents. We asked how often CNs should be expected to take patient assignments or serve as the triage or resuscitation nurse and asked them to expand on the actual and expected responsibilities of the role (see Table 4).

Survey results

CN survey respondents reported that their responsibilities primarily included maintaining patient flow and throughput often (18.0%) or always (77.9%) but also included ensuring quality patient care often (32.6%) or always (42.8%), providing clinical expertise often (37.1%) or always (55.0%), reinforcing policies and procedures often (32.0%) or always (52.8%), supporting staff (eg, managing conflicts) often (29.3%) or always (53.0%), and supporting patients' experience (eg, handling complaints) often (34.7%) or always (38.8%).

They reported that they were expected to take a patient assignment often (21.0%) or always (16.0%), assume the triage nurse function often (32.4%) or always (13.9%), and assume the resuscitation nurse function often (27.9%) or always (11.1%). In contrast, staff nurse respondents reported that the CN should be expected to take a patient assignment often (12.4%) or always (4.2%), to assume the triage nurse function often (15.0%) or always (3.4%), or assume the resuscitation nurse function often (16.8%) or always (4.5%).

Focus Group Findings

Three themes arose from qualitative data on function and purpose of the CN role: "logistical management," "it's a handful," and "situational awareness to see where help is needed and give it," and describe the work of flow management, the addition of other responsibilities without warning, and the need to have a high-level view of the conditions in the emergency department. Focus group participants discussed "logistical management" overall as part of the function and purpose of the role, and CN participants reported more narrowly on the logistical aspects of patient throughput.

> So, I coordinate the flow of our department, don't do any administrative type of work, so I don't do timecards, I don't do disciplinary action, but I do work closely with our management team and giving feedback. I will do some coaching with employees. Yeah, that's all. (CN3)

> The flow that department, basically, you must overlook the people walking through the department,

> patient registration and how that's going, worry about staffing, scheduling, and the admissions or the orders correct. So, the patients go upstairs currently if your patients have COVID testing–that's what the holdup is legally, so you just make sure that's all done. (CN4)

CNs also report taking on additional roles, including triage and patient care assignments for at least part of the day. This was reported as manageable in small hospitals but stressful and challenging in larger emergency departments. Participants described the education and training needed to manage these complicated elements, uncovering the theme of "it's a handful."

> … the charge nurse also has for 6 hours every day, a patient load, so we carry 3 rooms on top of everything else that we're doing with throughput of the department, any issues that arise, EMS, service recovery, coordinating with physicians and nurses, and any concerns that anybody has. And then also dealing with the House Supervisors and admissions and all of that… You know when you're doing all of that and trying to take care of 3 rooms at the same time, you know, it's kind of a handful. (CN5)

> …as you know, working in that smaller type facility, there can be just 3 of us and we've got 15 rooms and we've had to open up fast track to run ER because we're holding everything. So, the charge nurse is very important in those smaller institutions and to have somebody who is not afraid to stand up for patient rights is very important and the proper education that backs that. (CN6)

In contrast to the CN group, the staff nurse participants reported a deeper appreciation for the nuances of understanding changing conditions and managing accordingly, uncovering the theme of "situational awareness to see where help is needed and give it."

> The charge nurse has to know what's going on, so that they can distribute the patients and distribute the workload. People don't like to work with people who are, who are not keeping aware of the whole environment. (SN1)

> I think it's really important that the charge nurse is also a staff advocate and walk around and, of course, it can be crazy and busy and cold and everything and, but when they have a chance to walk around, not just stay at the charge nurse desk, but walk around and actually see how the staff is doing. (SN3)

Q3 TO Q6: RELATIONSHIPS WITH OTHER STAFF, ANCILLARY STAFF, PROVIDERS, AND MANAGEMENT (SOCIAL DYNAMICS AND TRUST)

This area of inquiry highlighted the management of social dynamics (specifically, CN-SN trust) and teamwork that is required of CNs. (see Table 5)

Survey Results

CN survey respondents reported minimal formal training in communication skills (31.4%) and conflict resolution (29.5%) to help navigate professional relationships. The aspect of "trust in the charge nurse" was included as a survey measure among staff nurse respondents who reported that they trust their CNs often or always to assist with a patient complaint (70.8%), to have the necessary clinical expertise (67%), to assist with clinical care of a difficult patient (63%), to make fair assignments (54.5%), and to help manage conflict with colleagues (43%).

Focus Group Findings

Both charge and staff nurses described the skill associated with social dynamics and relationships with colleagues as "bridging the gap."

> They actually bridge that gap for us by kind of like saying like, okay, Where are you coming from? Because there's a lot of patients, not just the one you're admitting right now. And actually, our ER doctor is concerned about with [whether] you're admitting this patient, are refusing to admit this patient, where they have to be admitted. The service to bridging [that] gap to defend nurses as well in our department and backed up by management to defend us nurses. (SN6)

Another critical element in social relationships was the attitude of the CN and how that affected ED function. This was reflected in the theme "The charge nurse sets the tone," which emerged from both charge and staff nurse focus group data.

> But you know, if the charge nurse comes in and she's got a bad attitude and she's griping, complaining about housekeeping because they haven't done this

> room yet, it's going to spread down to the rest of us down and who are not in charge, you know because we may or may not know what's going on. And that you know, starts leading to more of a toxic environment which we're trying to avoid. (SN7)

The importance of trust in the CN was reiterated in all focus group discussions.

> It's [trust] vital, absolutely vital when you've got certain people in charge, I would know when I walk in and oh, so and so is in charge - alright no problem. I can handle whatever walks through the door because they have my back. (SN8)

> Trust is very huge and that charge role - there are people that want to be a charge nurse, and you know, the providers have input and they're telling management: "You know what, I know that person's been a nurse for, you know, 10 years, but they just don't have those skills, they just don't have that." (CN7)

Q7: WHAT IS THE PROCESS BY WHICH CNS ASSIGN PATIENTS?

This question was answered using survey data and focus group data from both CNs and staff nurses. (see Table 6)

Survey Results

There were stark differences between the 2 groups of survey respondents, with about half in each group reporting that they decide the order in which patients would be seen.

When asked, "How do you assign patients?" CNs reported that they assigned patients often or always based on the patient's acuity as compared with other patients being cared for by that nurse (91.0%), the number of patients being cared for by the nurse (87.0%), the experience level of the nurse (66.1%), the stress level of the nurse (56.2%), and which nurse or pod is next in line (55.3%).

Staff nurses perceived patients were assigned often or always based on which nurse or pod is next in line (49.2%), the number of patients being cared for by the nurse (46%), the patient's acuity as compared with other patients being cared for by that nurse (46%), the experience level of the nurse (27%), and the stress level of the nurse (15 %).

Focus Group Findings

In focus groups, CN participants reported no formal training in patient assignment decision-making strategies. They described different strategies accounting for the strength of the nurses and the volume of the emergency department and reported that "bad" CNs make patient assignments that leave nurses feeling abandoned and unsupported. A few staff nurse participants reported that some CNs make assignments based on friendships, giving the "good" assignments to nurses they favor. The discussion highlighted aspects of the ED environment that influence appropriate assignment of patients, which relies on a choice of where to place patients. CNs reported that when ED volume or patient acuity spiked, they put patients into open beds. The theme that arose was "it's a chess game."

> …if I can shuffle a couple of rooms to another nurse and a nurse that doesn't have much experience or try to put them with that more experienced nurse, so eventually they can also be an experienced nurse, that I can, you know, trust to take those heavier loads of patients. So, it's very flexible and fluid depending upon what walks in the door, at that time and at that moment; there is no standard, more of experience. (CN5)

> When you assign patients, you have to look at who you're assigning it to, like if you know it's somebody with no experience… But I always tell everybody when I'm orienting them, it's a checker game or chess game - if you don't make the right move that affects your whole day. And you just gotta know what piece to move because if not, you're going to get screwed later on. (CN4)

Another theme, reported by staff nurses, was "throwing them on back," a description of a seemingly random NPA process.

> All at one time and with no rhyme or reason, they don't look at the acuity level, they just throw them on back... It is very tough when you're given 3 critical at one time out of 4 patients and so you're ignoring 1 and you're trying to take care of the rest of them to the best of your ability and it's just impossible. (SN9)

> It doesn't matter if they need a cardiac monitor, they just put them in a bed. If there's not a nurse there, then they must put them in the bed. So that's how they're running it lately and it's very unsafe. (SN10)

Discussion

The purpose of this study was to explore both the clinical and social aspects of the CN role as well as the training and orientation process in United States emergency departments. Participants in both charge and staff nurse roles reported actual and ideal training and orientation states and processes by which the charge role is optimized.

CLINICAL ASPECTS OF THE ROLE

Competencies for the CN role have been identified in the literature as including self-management, management of others, clinical competency, conceptual-cognitive competencies, professional-legal competency, communication, and team leadership.[5] Our staff nurse participants focused on these elements as important attributes of CN success. In contrast, our CN participants' understanding of their role was more in alignment with the prosaic, logistical aspects of the role described by Husebø and Olsen,[9] including receiving an overview of the team and patients and planning the shift, ensuring resources, monitoring and ensuring appropriate patient flow, monitoring and securing information flow, and securing patient care and treatment. This difference in perspective speaks to a need for a more thorough grounding in the socioclinical aspects of the role, allowing for effective communication and management of others within a clinical context.

Research findings suggest that health care organizations pay little attention to the training of nurses in the charge role, and this has consequences for nurses who assume the CN position as well as for staff and patients. Inadequate preparation can result in deficits in the confidence and leadership skills necessary for successful execution of the role.[1-5] Integrated findings from this study confirm that most training for the role stems from a process of exposure to the role via short-term shadowing. Similar research also pointed to this lack of training as a source of role ambiguity that may influence CNs confidence, impacting both overall success[18] and performance metrics for patient outcomes.[6]

SOCIAL ASPECTS OF THE CN ROLE

Examination of key elements of the role sheds light on how those elements promote or inhibit functional social dynamics within the ED setting. Both charge and staff nurse participants reported that it is the CN who sets the tone for the shift, a harbinger of a functional or nonfunctional shift. How the CN manages the elements of NPAs can create an environment where nurses feel either supported or overwhelmed, but there are no standard criteria for making those decisions. Allen[11] and Wolf et al[10] suggest that NPAs made in alignment with nurses' capabilities are more effective for managing patient care as well as optimizing staff performance, job satisfaction, and nurse retention. In our study, integrated data analyses revealed a discord between charge and staff nurse participants' views of NPA processes in terms of responsibility and criteria for making NPA decisions. Mismanagement of NPA (eg, a heavy workload, mismatch between nurse's skill level and patient care requirements) has also been identified as a manifestation of bullying in emergency departments[14] and, thus, is critical to the quality of patient care and a healthy work environment.

CN ROLE IN NURSE BULLYING

The management of the ED socioclinical environment is a compelling place to begin more formal training for the role, given that the CN can be instrumental in the presence or absence of bullying behaviors in emergency departments.[10,14] Longo et al[12] reported that CNs may experience bullying themselves, interfering with the CN's ability to establish rapport and cohesion within the health care team. This may also impede the interprofessional trust necessary for success in the role.[9,19] CN inexperience and micromanagement can impact the CN's ability to function successfully and maintain cohesion within the health care team, potentially contributing to a culture in which bullying is permissive.

Our study supports recommendations for CN leadership training, including clarification of authority, responsibilities, and expectations[18]; ongoing mentoring and coaching[20]; communication, conflict, and team management[1,6]; fostering interprofessional trust[9,19]; and prevention of workplace bullying and aggression.[10,12]

Limitations

Limitations include use of a convenience sample drawn from Emergency Nurses Association members leading to potential for selection bias. In addition, those who

voluntarily participated in a study about CNs may have different thoughts and feelings than nonresponders. A large and diverse survey sample and further corroboration from focus group findings allows some generalizability. However, because both samples were recruited from the Emergency Nurses Association member database, there may be response bias that does not reflect unknown differences between members and nonmembers.

Implications for Emergency Nurses

The role of the CN is an under-recognized driver of both nurse and patient outcomes, rooted in role responsibilities comprising patient assignment and flow management, interdisciplinary communication, and socioclinical support necessary to effective ED operations. Nurse directors and managers should consider minimum education, experience, and training for CNs. Specific training in social management and in NPA may be useful for creating and maintaining a successfully functioning, emotionally supportive, and clinically safe emergency department.

Conclusions

The role of the ED CN is critical to the smooth functioning of a chaotic, clinically challenging, and resource-limited environment of care. Findings from this study suggest that the perception of the role is different from the perspectives of CNs and the staff nurses they work with. This study highlights a gap in role understanding, including organizational expectations and assigned responsibilities that are incommensurate with leadership training opportunities and requirements. Both staff and CN participants agreed that emergency nurses in this critical role do not receive adequate training in the areas of NPA, communication, or situational awareness and advocate for improvements in these leadership domains. Further research should focus on identifying competency requirements and designing interventions to improve education and training, particularly in the areas of communication, leadership, management of sociocultural interactions, development and maintenance of interprofessional trust, and evaluation of the CN role on nursing and patient outcomes.

Author Disclosures

Conflicts of interest: none to report.

Ethical approval from Advarra, Inc Institutional Review Board (IRB) (Columbia, MD) # Pro00049333.

Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jen.2022.03.009.

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Outcomes From a Nursing-Driven Acute Stroke Care Protocol for Telehealth Encounters

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Contribution to Emergency Nursing Practice

- What is already known on this topic? Telestroke systems can be useful and efficient for providing care in the emergency department.
- What does this paper add to the currently published literature? This study provides additional feasibility information about a nurse led telestroke protocol in the emergency department to reduce door to treatment times for stroke patients.
- What is the most important clinical implication for practice? Important clinical implications include that a nurse-driven acute care protocol was feasible to implement for improved nurse sentive door-to-provider and door-to-computed tomography time metrics when using telestroke in the emergency department. However, the feasibility evidence indicated door-to-ready, door-to-specialist, and door-to-needle times may not improve using this protocol.

Abstract

Introduction: Nursing care is widely recognized to be a vital element in stroke care delivery. However, no publications examining clinical education and optimal workflow practices as predictors of acute ischemic stroke care metrics exist. This study aimed to explore the impact of a nurse-led workflow to improve patient care that included telestroke encounters in the emergency department.

Methods: A nonrandomized prospective pre- and postintervention unit-level feasibility study design was used to explore how implementing nurse-driven acute stroke care affects the efficiency and quality of telestroke encounters in the

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emergency department. Nurses and providers in the emergency department received education/training, and then the Nursing-Driven Acute Ischemic Stroke Care protocol was implemented.

Results: There were 180 acute ischemic stroke encounters (40.3%) in the control phase and 267 (59.7%) in the postintervention phase with similar demographic characteristics. Comparing the control with intervention times directly affected by the nurse-driven protocol, there was a significant reduction in median door-to-provider times (5 [interquartile range 12] vs 2 [interquartile range 9] minutes, $P < .001$) and in median door-to–computed tomography scan times (9 [interquartile range 18] vs 5 [interquartile range 11] minutes, $P < .001$); however, the metrics potentially affected by extraneous variables outside of the nurse-driven protocol demonstrated longer median door-to-ready times (21 [interquartile range 24] vs 25 [interquartile range 25] minutes, $P < .001$). Door-to-specialist and door-to-needle times were not significantly different.

Discussion: In this sample, implementation of the nurse-driven acute stroke care protocol is associated with improved nurse-sensitive stroke time metrics but did not translate to faster delivery of thrombolytic agents for acute ischemic stroke, emphasizing the importance of well-outlined workflows and standardized stroke code protocols at every point in acute ischemic stroke care.

Key words: Stroke; Nursing; Telehealth; Emergency medicine; Time to treatment

Introduction

The past decade has seen a steady increase in the number of successful telestroke networks,[1] and the rate of adoption has rapidly increased during the 2020 coronavirus disease 2019 pandemic.[2] A telestroke system of care uses 2-way audio-video technology to bring stroke expertise to remote populations. Unfortunately, available evidence supports that the responsiveness of telestroke systems falls short,[3] with door-to-telestroke notifications of more than 15 minutes being associated with an 8-fold increase in likelihood of door-to-needle (DTN) time exceeding 60 minutes.[4] Delayed responsiveness also negatively affects the target treatment time for mechanical thrombectomy in eligible patients with acute ischemic stroke (AIS).[5] To date, there are no large studies that fully examine how clinical education and optimal workflow practices affect AIS care delivery within a telestroke setting. Meanwhile, nursing care is widely recognized to be a vital element in AIS care delivery.[6,7]

BACKGROUND

Treatment of stroke is time based, with alteplase being the only Food and Drug Administration–approved pharmaceutical treatment for AIS, and tenecteplase has only been recommended but is not yet Food and Drug Administration approved.[8-11] Both alteplase and tenecteplase been have shown to reduce patient mortality and morbidity if given within the time window of 3 hours since last known normal.[8,12] Although the benchmark DTN time was initially set at 60 minutes,[13] newer best practice recommendations have pushed the goals to 45 and 30 minutes.[14] Unfortunately, recent analysis has shown that less than one-half of patients treated with alteplase received the treatment in the recommended 60-minute DTN time window.[15] Time to treatment must be improved to allow more patients to receive the improved outcomes that AIS therapies can deliver.[16]

STROKE IN RURAL POPULATIONS

Rural health populations will benefit from receiving stroke care similar to the stroke care received in urban populations.[17] To address the need for timely treatment in rural populations, which have traditionally not had access to expert stroke specialty care, the use of telehealth for AIS has burgeoned in the last decade. Thus, telehealth has enabled many patients living in rural areas the opportunity to receive AIS care.[18,19] This resonates with early findings from the Telestroke for Comprehensive Stroke Care in Acute Stroke Ready Hospitals (TELECAST)[20] study that demonstrates clinical benefit to individuals treated with telehealth. Despite the successful institution of these telestroke networks, there are limited data examining clinical education and optimal workflow practices establishing target benchmarks. However, a study by Lees et al[21] showed that the responsiveness of telestroke systems falls short with a mean door-to-physician time of 76.3 minutes, which consequently affects the target treatment time.[15]

NURSE-DRIVEN ACUTE STROKE CARE

Interdisciplinary collaboration between nurses and physicians has increased dramatically over the past decade.[22] Nurse-driven protocols are one product of this collaboration and are becoming increasingly popular. Research has shown

TABLE 1
Demographics for the 180 control and 267 intervention subjects

Variable	n	Control		Intervention		*P* value
		Mean	SD or %	Mean	SD or %	
Age in y	445	65.5	15.9	67.4	15.5	.22*
Sex (% Female)	444	99	55.3%	140.0	52.8%	.61†

Point Estimate in Supplementary Data.
* *t* test.
† Chi-square.

that nurse-driven care protocols are associated with a reduction in time-sensitive stroke quality metrics.[23,24] One study showed improvement in door-to–computed tomography (CT) scan (DTCT) time, door-to-physician time, and door-to-decision times with a nurse-driven stroke ED protocol.[25] Fowler et al[5] added to this knowledge by finding an association between faster door-to-decision times when nurse-driven protocols are coupled with telehealth. Others have shown that incorporating a stroke nurse into ED management of patient care improved DTN times and patient outcomes at 90-days.[7,26] These studies showed the insight and need for incorporating the nurse, as a leader, into the acute care phase for patients in the emergency department, but evidence is lacking in the regularization of these protocols.[27]

SPECIFIC AIM

Standardized protocols are supported by multiple national associations, yet there are slight discrepancies regarding how these protocols should be implemented. One solution takes inspiration from stock-car racing and postulates a "pit stop" model of care with a "nurse driver" pushing the process to completion.[25] *The AHA Target: Stroke Initiative*[10] has several recommended target treatment times for AIS therapies, yet they do not specifically address the special constraints and considerations of a telestroke clinical encounter. We developed the Nursing-Driven Acute Ischemic Stroke Care (NAS-Care) protocol to optimize the performance of telestroke encounters by emphasizing the rapid and coordinated completion of the stroke workup by nursing personnel during a stroke code activation. This study explored the impact of a nurse-led workflow to improve patient care in a telestroke model in the emergency department.

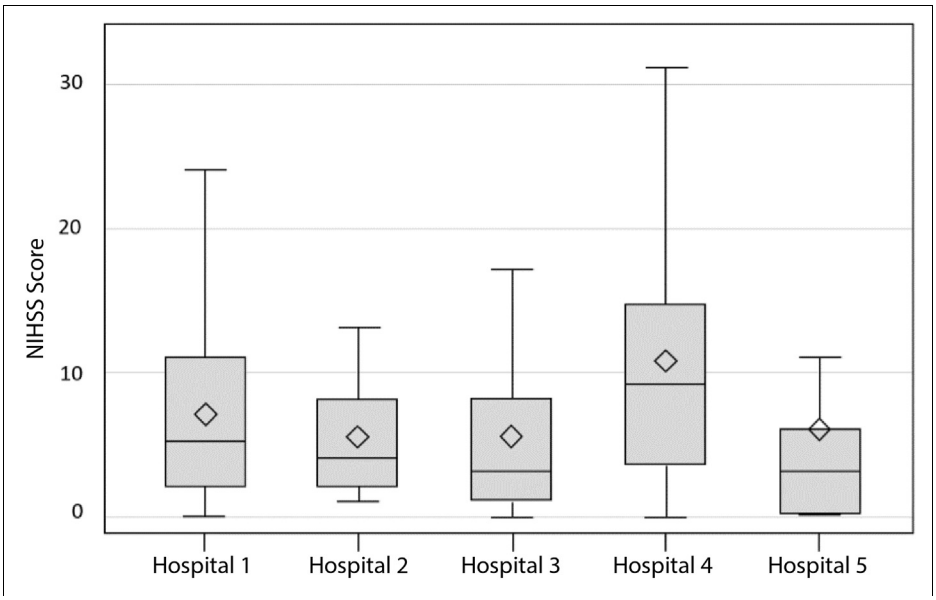
Methods

his feasibility study of a unit-level protocol used a prospective pretest and post-test design, in which the pretest cohort served as the control group, and the intervention was implementing the NAS-Care protocol. The primary aim was to examine whether the nurse-driven protocol was associated with improved efficiency of the telestroke encounter. The primary outcome was the impact on telestroke-encounter efficiency measured as DTN times. The study was completed in 3 phases: (1) baseline data collection (baseline group), (2) education and implementation of the NAS-Care protocol, and (3) postimplementation data collection (intervention group). All patients presenting to a partner institution's emergency department with identified acute neurological deficits that began within the institution's stroke code activation timeframe (commonly 4.5 hours) were enrolled in this study. The study received institutional review board approval (UT Southwestern Medical Center #112014-039). The timeline for study procedures can be found in Supplementary Material 1.

The baseline group consisted of patient data recorded before implementing the NAS-Care protocol. During the baseline phase, data were collected from each of the 5 enrolling sites for 3 months. The sites were selected based on previous and new telestroke relationships with the team that was providing the training and were not required to be a part of a single health system. Enrolling sites ranged from small quaternary hospitals to large urban primary stroke care centers. The baseline data were collected as soon as possible after the site agreed to participate in the project. No additional training was provided during the baseline data collection phase. To reduce the risk of pretrial novelty bias, a nonclinical data abstractor was appointed at each recruiting site. This data abstractor completed the data collection baseline form and the demographics form during the baseline phase. The data collection and demographics form was reviewed with the primary principal investigator and/or research manager of the trial.

INTERVENTION

The intervention group consisted of time-stamped data recorded after implementing the NAS-Care protocol. During the intervention phase, education was provided to



FIGURE

Box plot showing distribution of National Institutes of Health Stroke Scale scores by site. Box [upper and lower quartiles for interquartile range]; central lines [median]; diamond [mean]; Whiskers [minimum and maximum].

nurses and providers in the emergency department at each enrolling site. Education was based on 5 principles: identification of shared goals, organized urgency with the removal of gatekeepers, multipersonnel, nonsequential processes, focus on defined staged roles and tasks, and empowered engagement/empowered responsibility. There was an additional focus on delineation of nursing roles while seeing these patients. For example, a pit-stop model was used with the leader being the pit master (nurse in charge of the code). This nurse would lead other nurses in what to do during the stroke code in the emergency department. The pit master would record the timing of events that occurred on the NAS-Care run sheet (Appendix 1) so that data could be analyzed by the site stroke coordinator to identify lags in time with more aggregate data. This allowed for changes in the process to occur at each specific site while taking into consideration site-specific needs. The focus of this training was the change in workflow, specifically adding role delineation.

In addition, all staff were National Institutes of Health Stroke Scale (NIHSS) certified within the last 2 years. Two in-person lectures were provided to the recruiting site to ensure knowledge of research protocols, understanding of AHA guidelines, role/responsibilities during the stroke code under the study guidelines, order sets, and the study data collection form. The protocol was then implemented and the data collection, via the run sheet, commenced; this phase lasted 6 months. The postimplementation data collection phase involved the central site collecting all the data for analysis. All run sheets were completed by the pit master, during the stroke code. The data abstractor also checked the data as a measure of data quality at each enrolling site. A closeout visit occurred with each site that involved sharing their data and information regarding outcomes of the nurse-driven telehealth protocol. All materials were provided to the site for optional future use. An exit survey was also collected. See Appendix 2 for a detailed logic model.

NAS-Care implementation was facilitated at participating centers by first providing a series of planned didactic educational activities for ED personnel. Education focused on teaching that the protocol was designed to empower bedside nurses to rapidly gather the data needed for a provider to make a decision regarding alteplase administration. This protocol is mediated via the "NAS-Care run sheet" (Appendix 1). The run sheet is a detailed, single-page printed reference that serves as a workflow template during actual patient encounters and helps to organize clinical data efficiently.

MEASURES

Each case in this study reflects a stroke code activation, and the primary outcome variables reflect time metrics related to stroke codes: door-to-provider (DTP), DTCT, door-to-ready (DTR),

door-to-specialist (DTS), and DTN times. DTP is the time from patient arrival in the emergency department to when the patient is first assessed by a provider (physician or advanced practice provider). DTCT is the time from patient arrival in the emergency department to the start of the CT scan. DTR is a unique parameter to telestroke clinical encounters and reflects the earliest time point at which all of the necessary data for a telespecialist or ED provider to make a decision regarding thrombolytic (alteplase) treatment have been collected. DTS is the time point at which the telespecialist first logs on to the telestroke machine to assess the patient or a stroke specialist assesses the patient in person. DTN is the time from patient arrival in the emergency department to the start of alteplase administration. All stroke codes were assessed using the NAS-Care run sheet, regardless of stroke diagnosis. There were no time windows (eg, alteplase treatment window) imposed on data collection.

STATISTICAL ANALYSIS PLAN

Sample size estimates are based on preliminary data.[25] Assuming β is set at 0.80 and a 2-sided α of 0.05, the effect size of 0.20 (conservative estimate from above) results in a sample size estimate of 375 subjects per group.[28] The primary outcome variables were DTP, DTCT, DTR, DTS, and DTN. Data analyses were completed using SAS v9.4 for Windows. Data are reported as mean (standard deviation) for interval and ratio data, as frequency (percent) for nominal data, and as median (interquartile range) for ordinal data. Wilcoxon rank sum test was used for comparison of median times. $P < .05$ was considered statistically significant.

Results

Data were available from 447 patient encounters including 180 (40.3%) in the baseline phase and 267 (59.7%) in the postintervention phase. Of 83 patients receiving alteplase, 34 (41.0%) were in the baseline group, and 49 (59.0%) in the intervention group. As noted in Table 1, there were no statistically significant differences in demographic data by group assignment. Figure provides an example of box plots constructed to examine the difference of variables by site (see Supplementary Data). As shown in Table 2, the DTP metric was significantly lower in the intervention group, with a median of 2.0 (9.0) minutes, than the baseline group 5.0 (12.0) minutes ($P < .001$). The median DTCT time was also significantly lower in the intervention group, 5.0 (11.0), than the baseline group, 9.0 (18.0) minutes ($P < .001$). A statistically significant increase in median DTR time was observed comparing the intervention group 25.0 (25.0) with the baseline group 21.0 (24.0) minutes ($P < .001$). No statistically significant differences in median time were observed for DTS 30.0 (30.0) minutes to 34.0 (32.5) minutes ($P = .33$) nor DTN 56.0 (25.0) minutes to 55.5 (30.0) minutes ($P = .66$). See Supplementary Data for point estimates.

Discussion

The findings support that the primary mechanics of the stroke workup, the gathering of stroke patient data and driving of early AIS care can be delegated to and efficiently completed by nurses. The NAS-Care protocol was associated with reduced DTP and DTCT times but no corresponding reduction in times to ready, specialist, or needle was observed. Moreover, there was a broad standard deviation in DTS and DTN, which indicates a wide variance in actual times. This supports previous authors who have identified that increasing stroke care efficiency requires multidisciplinary-care coordination.[7,22] Similar to highly efficient, functional groups, role designation allows stroke team members to provide unique and vital contributions to stroke care.[29] Each member of the stroke team should be assigned designated tasks (roles)[30] to ensure that all tasks are accounted for and also to avoid duplication of efforts (eg, avoid both the nurse and the physician each obtaining a blood sugar).[7]

In particular, the role of the nurse is to assess, plan, implement, and evaluate patients whereas physicians and advanced practice providers are tasked with the decision to prescribe a thrombolytic agent and initiate mechanical thrombectomy.[31] Efficient ED care requires that nurses and physicians/advanced practice providers respect each team member and trust that roles are fulfilled in an accurate and timely manner.[29] Thus, it is reasonable to assume that the stroke workup can be completed by a nurse without additional medical order or prescription through a parallel processing model.[25,32] Within the NAS-Care protocol used in this study, nurses were assigned roles using the pit-crew model, which supported a nurse-led pit master to run the process of the stroke code and ensure all aspects of the stroke code were completed in a timely fashion.

In contrast to sequential interdependence, teamwork that occurs under a parallel processing framework has benefits to AIS care.[25] In the sequential model, each task must be completed before starting the next. For example, the nurse must obtain intravenous access before the physician can begin an NIHSS assessment. In reality, most tasks can be completed in a parallel manner. The nurse can perform the NIHSS while the patient is being prepped for CT scan and the physician can review the CT scan while

the pharmacist is preparing the thrombolytic dose. Consequently, as popularity for parallel processing continues to grow, greater attention is required. The NAS-Care protocol also supports parallel processing, and the pit master can assign and delegate several tasks at once.

The increase in DTR times is concerning and worthy of additional investigation. The NAS-Care program was associated with a reduction in DTP and DTCT, whereas the DTR times were increased by nearly 10 minutes. The NAS-Care program did adopt key interventions identified to improve overall DTN times such as Emergency Medical Services Prenotification, Stroke Clock, and Single Notification.[3,33] Identifying a stroke nurse (or other lead person) and using a designated run sheet have been associated with reduced DTN times.[34] Increasing familiarity (eg, using simulation of stroke code events) reduces barriers to interdisciplinary engagement.[35] Future iterations of NAS-Care style programs may benefit from simulation before deployment and thereby reduce DTR times.[36]

Although the existence of a single intervention to resolve all AIS care delays is improbable, previous work has consistently identified the necessity of cooperation to improve acute stroke ED care.[7] As noted previously, one element is to identify the role of individual team members while simultaneously coordinating care.[22,25,31,37] In our study, we used the term "nurse driver" to indicate that the stroke nurse is empowered to drive (run) an established protocol. As documented by others, the role and positive impact of the stroke coordinator are well defined.[38-40] However, this is not to say the nurse is superior, but rather that there is an advantage to having one person take charge.[41] Thus, it seems that NAS-Care is ready for adoption.

LIMITATIONS

Although each study site conducted a retrospective chart review to collect as much baseline data as possible, many variables were not documented as a standard of care, which resulted in some missing data. Patient adverse events were not included in this feasibility study and should be taken into consideration for future studies. In addition, DTR was a new variable that encompassed a particular subset of patients, ultimately inhibiting pre- and postcomparisons of study data given that the fidelity of time measurements for this variable has not been fully established. Furthermore, the variances in hospitals that have administered alteplase in DTN times were fairly significant, which limits the generalizability of study results to hospitals with varying alteplase administration rates. Recent literature suggests the use of control charts for quality improvement data,[42] and these were not derived because of the small sample size and differences in recruitment rates and times by site.

IMPLICATIONS FOR FUTURE STUDIES

Our experience demonstrates the feasibility of introducing a complex new stroke research protocol to emergency departments in diverse settings, many of which had little experience as research sites. The pit-stop model and NAS-Care run sheet were well received by unit staff. This protocol included the provision of in-person training on stroke recognition and the pit-stop model. New research models may develop approaches to remote training, which may be even more effective if continued on a regular basis beyond the initial intervention period. Future studies of unit-based emergency stroke protocols, which require larger sample sizes, would be amenable to cluster-based randomized clinical trial designs.

TABLE 2
Outcomes for the 180 control and 267 intervention subjects

Variable	n	Control		Intervention		*P* value*
		Median	IQR	Median	IQR	
NIHSS	409	5.0	8.5	5.0	8.0	.96
Door to ED provider	441	5.0	12.0	2.0	9.0	<.001
Door to CT scan	442	9.0	18.0	5.0	11.0	<.001
Door-to-ready	405	21.0	24.0	25.0	25.0	<.001
Door to specialist	347	34.0	32.5	30.0	30.0	.33
Door-to-needle	83	55.5	30.0	56.0	25.0	.66

CT, computed tomography; IQR, interquartile range; NIHSS, National Institutes of Health Stroke Scale.
* Wilcoxon rank sum test *P* values.

Implications for Emergency Nurses

The study protocol provides evidence that nurses can lead the protocol and procedure of ushering the patient through care and treatment teams in an ED setting. Telestroke is still an evolving paradigm of care; this study may have significant implications regarding clinical standards of what may constitute "best practice" care.

Conclusion

The NAS-Care protocol, in which an ED stroke nurse is the driver for AIS care, is associated with improved nurse-sensitive stroke time metrics but does not translate to lower DTN times. Additional ED workflows, possibly including mock stroke codes in partnership with telestroke physicians, may be required to further optimize alteplase administration metrics. The success of this study will be followed by a study to explore nursing-driven methods to improve identification of large vessel stroke.

Author Disclosures

Conflicts of interest: none to report.

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Supplementary Data

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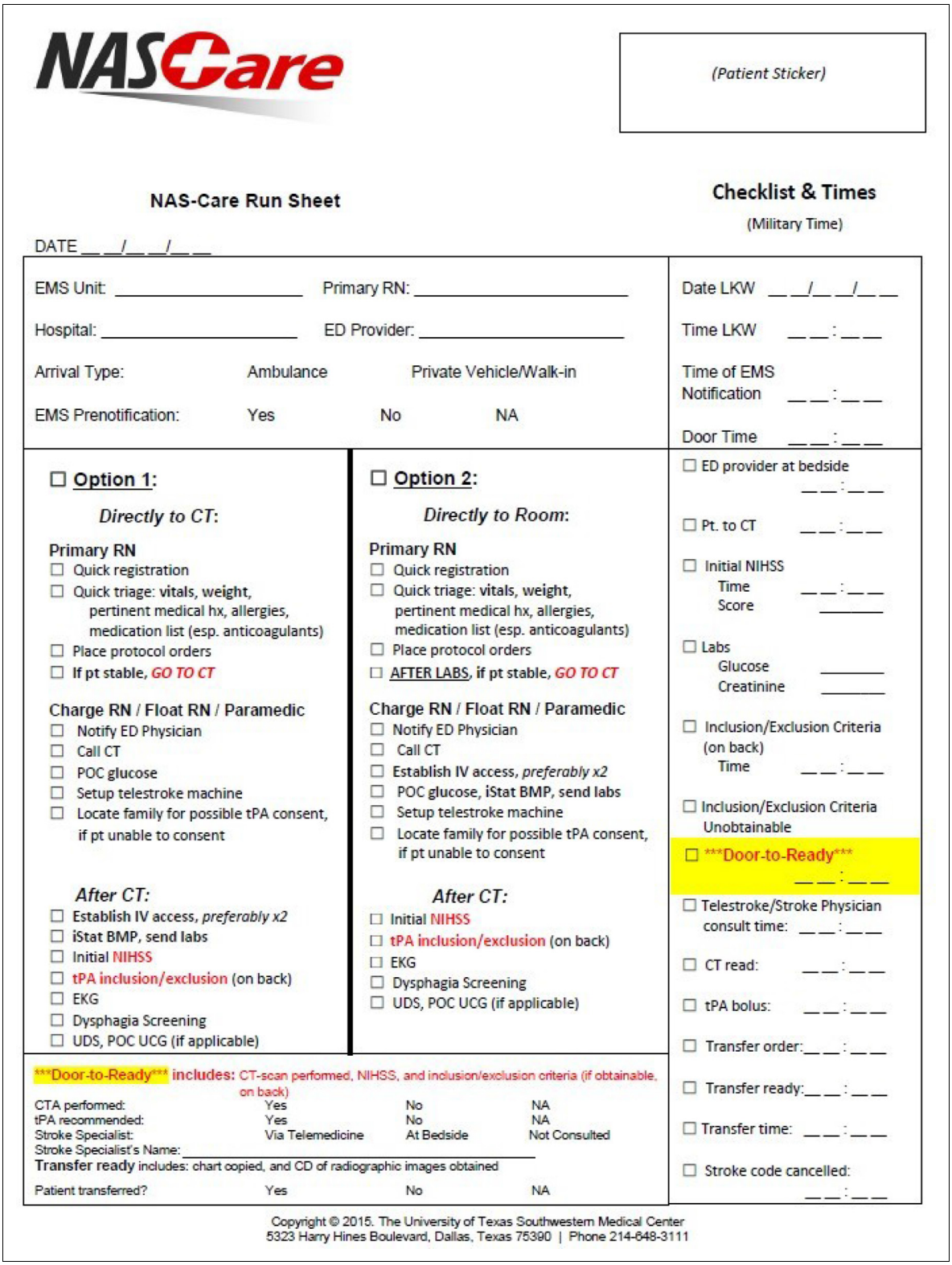
Appendix



NAS-Care

(Patient Sticker)

NAS-Care Run Sheet

Checklist & Times

(Military Time)

DATE __ __/__ __/__ __

EMS Unit: _____ Primary RN: _____

Hospital: _____ ED Provider: _____

Arrival Type: Ambulance Private Vehicle/Walk-in

EMS Prenotification: Yes No NA

Date LKW __ __/__ __/__ __

Time LKW __ __ : __ __

Time of EMS Notification __ __ : __ __

Door Time __ __ : __ __

☐ **Option 1:**

Directly to CT:

Primary RN
- ☐ Quick registration
- ☐ Quick triage: vitals, weight, pertinent medical hx, allergies, medication list (esp. anticoagulants)
- ☐ Place protocol orders
- ☐ If pt stable, *GO TO CT*

Charge RN / Float RN / Paramedic
- ☐ Notify ED Physician
- ☐ Call CT
- ☐ POC glucose
- ☐ Setup telestroke machine
- ☐ Locate family for possible tPA consent, if pt unable to consent

After CT:
- ☐ Establish IV access, *preferably x2*
- ☐ iStat BMP, send labs
- ☐ Initial NIHSS
- ☐ tPA inclusion/exclusion (on back)
- ☐ EKG
- ☐ Dysphagia Screening
- ☐ UDS, POC UCG (if applicable)

☐ **Option 2:**

Directly to Room:

Primary RN
- ☐ Quick registration
- ☐ Quick triage: vitals, weight, pertinent medical hx, allergies, medication list (esp. anticoagulants)
- ☐ Place protocol orders
- ☐ AFTER LABS, if pt stable, *GO TO CT*

Charge RN / Float RN / Paramedic
- ☐ Notify ED Physician
- ☐ Call CT
- ☐ Establish IV access, *preferably x2*
- ☐ POC glucose, iStat BMP, send labs
- ☐ Setup telestroke machine
- ☐ Locate family for possible tPA consent, if pt unable to consent

After CT:
- ☐ Initial NIHSS
- ☐ tPA inclusion/exclusion (on back)
- ☐ EKG
- ☐ Dysphagia Screening
- ☐ UDS, POC UCG (if applicable)

- ☐ ED provider at bedside __ __ : __ __
- ☐ Pt. to CT __ __ : __ __
- ☐ Initial NIHSS
  - Time __ __ : __ __
  - Score _____
- ☐ Labs
  - Glucose _____
  - Creatinine _____
- ☐ Inclusion/Exclusion Criteria (on back)
  - Time __ __ : __ __
- ☐ Inclusion/Exclusion Criteria Unobtainable
- ☐ ***Door-to-Ready*** __ __ : __ __
- ☐ Telestroke/Stroke Physician consult time: __ __ : __ __
- ☐ CT read: __ __ : __ __
- ☐ tPA bolus: __ __ : __ __
- ☐ Transfer order: __ __ : __ __
- ☐ Transfer ready: __ __ : __ __
- ☐ Transfer time: __ __ : __ __
- ☐ Stroke code cancelled: __ __ : __ __

Door-to-Ready includes: CT-scan performed, NIHSS, and inclusion/exclusion criteria (if obtainable, on back)

CTA performed:	Yes	No	NA
tPA recommended:	Yes	No	NA
Stroke Specialist:	Via Telemedicine	At Bedside	Not Consulted

Stroke Specialist's Name: _____

Transfer ready includes: chart copied, and CD of radiographic images obtained

Patient transferred?	Yes	No	NA

APPENDIX 1

NAS-Care Data Collection Sheet. NAS-Care, Nursing-Driven Acute Ischemic Stroke Care.

NASCare

(Patient Sticker)

IV tPA Inclusion/Exclusion Criteria

INCLUSION CRITERIA: For IV t-PA 0-4.5 hours

☐ Yes ☐ No Last Known Well < 4.5 hours

LKW information provided by ☐ Patient ☐ Family ☐ EMS ☐ Other: _____

EXCLUSION CRITERIA:
Absolute Contraindications

☐ Yes ☐ No History of intracranial hemorrhage.
☐ Yes ☐ No History of neoplasm, AVM, or aneurysm.
☐ Yes ☐ No Major surgeries and/or major trauma < 15 days.
☐ Yes ☐ No Recent intra-spinal or intracranial surgery and/or trauma within past 3 months.

Relative Contraindications/ Warnings:

☐ Yes ☐ No Pregnancy.
☐ Yes ☐ No Previous stroke within the past 3 months.
☐ Yes ☐ No Current use of anticoagulants*.

***Most common anticoagulant include:** Coumadin (warfarin)
Xarelto (rivaroxaban)
Eliquis (apixaban)
Pradaxa (dabigatran)

If a CTA was not performed on this patient, please check all that apply:

☐ Patient was unstable
☐ No baseline creatinine
☐ Creatinine was too high
☐ Inadequate/no IV access
☐ CT staff was unable to perform a CTA
☐ A CTA was not ordered
☐ MD stated not clinically indicated
☐ Patient had a hemorrhagic stroke
☐ Pt was transferred before a CTA was obtained

If this patient was transferred, please check all that apply:

☐ Patient/Family request
☐ ERT candidate
☐ Our hospital does not have neuro coverage
☐ Higher level of care

POST STROKE CODE SURVEY
(Primary RN)

Please answer the following survey by indicating how much you agree with statements below.

1. "When the patient arrived in the ED I was 100% sure it was a stroke within the first minute."

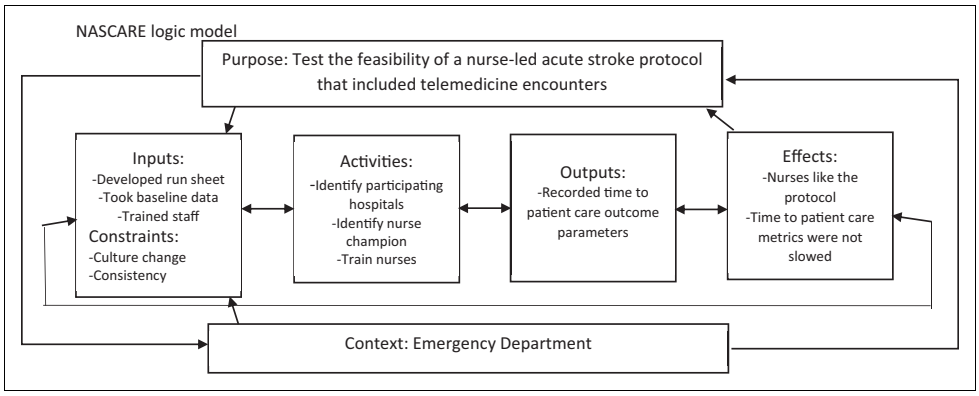
   1 2 3 4 5 6 7 8 9 10
   Strongly Disagree — Strongly Agree

2. "I felt like this stroke code was *nursing-driven*."

   1 2 3 4 5 6 7 8 9 10
   Strongly Disagree — Strongly Agree

3. "I felt that this stroke code was completed as efficiently as possible."

   1 2 3 4 5 6 7 8 9 10
   Strongly Disagree — Strongly Agree



APPENDIX 2

NASCare Logic Model.

COVID-19 Seroprevalence in ED Health Care Professionals Study: A Cross-Sectional Study

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NCPD Earn Up to 9.5 Hours. See page 492.

Contribution to Emergency Nursing Practice

- ED health care professionals are often the first point of hospital contact for patients with an acute illness. There were concerns that ED health care professionals may have been at increased risk of exposure to SARS-CoV-2.
- At a single institution, there was a seroprevalence of 2.9% for SARS-CoV-2 antibodies among ED health care professionals who had never been formally diagnosed with COVID-19.
- Adherence to infection control protocols, including implementation of universal masking and use of appropriate personal protective equipment for patients with suspected or confirmed COVID-19 or confirmed exposures, can effectively mitigate risk of transmission in health care settings.

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Abstract

Introduction: ED health care professionals are at the frontline of evaluation and management of patients with acute, and often undifferentiated, illness. During the initial phase of the SARS-CoV-2 outbreak, there were concerns that ED health care professionals may have been at increased risk of exposure to SARS-CoV-2 due to difficulty in early identification of patients. This study assessed the seroprevalence of SARS-CoV-2 antibodies among ED health care professionals without confirmed history of COVID-19 infection at a quaternary academic medical center.

Methods: This study used a cross-sectional design. An ED health care professional was deemed eligible if they had worked at least 4 shifts in the adult emergency department from April 1, 2020, through May 31, 2020, were asymptomatic on the day of blood draw, and were not known to have had prior documented COVID-19 infection. The study period was December 17, 2020, to January 27, 2021. Eligible participants completed a questionnaire and had a blood sample drawn. Samples were run on the Roche Cobas Elecsys Anti-SARS-CoV-2 antibody assay.

Results: Of 103 health care professionals (16 attending physicians, 4 emergency residents, 16 advanced practice professionals, and 67 full-time emergency nurses), only 3 (2.9%; exact 95% CI, 0.6%-8.3%) were seropositive for SARS-CoV-2 antibodies.

Discussion: At this quaternary academic medical center, among those who volunteered to take an antibody test, there was a low seroprevalence of SARS-CoV-2 antibodies among ED clinicians who were asymptomatic at the time of blood draw and not known to have had prior COVID-19 infection.

Key words: COVID-19 seroprevalence; COVID-19 antibody; SARS-CoV-2 antibody; SARS-CoV-2 seroprevalence

Introduction

ED health care professionals (HCPs) are often the first point of hospital contact for patients with an acute illness. Because of this, ED HCPs may encounter patients with communicable diseases before identification and isolation and in environments of care where effective patient isolation may be more challenging owing to ED capacity constraints and rapid turnover of patients.[1-4]

Early reports in 2020 documented elevated risk to HCPs, including in Italy, where nearly 2 in 10 people infected with COVID-19 were HCPs and in China, where health care workers constituted 14% of initial COVID-19 infections.[5] However, more recent larger studies have demonstrated that the risk of occupational exposure and acquisition is low, and that SARS-CoV-2 infection in HCPs is associated with community and demographic risk factors and not occupational risks.[6,7] In 2020, in a multistate hospital network study involving 13 academic medical centers, the authors found that seroprevalence among HCPs correlated with community COVID-19 incidence.[6] Moreover, in 2020, in a hospital-wide screening study at a Tertiary Center in Belgium, researchers found that having a household contact with COVID-19 was associated with seropositivity when compared with having no household exposure. They did not find a correlation with a health care worker being involved in the clinical care of patients with COVID-19.[7]

Understanding the prevalence of COVID-19 antibodies among ED HCPs without prior infection knowledge sheds light on occult infection rates among ED professionals and could further guide efforts to protect health care coworkers and patients.

Methods

STUDY DESIGN

We performed a prospective, cross-sectional study to estimate SARS-CoV-2 seroprevalence among ED HCPs, defined as attending physician, emergency resident physician, advanced practice provider, or full-time emergency nurse. An ED HCP was deemed eligible for the study if they had worked at least 4 shifts in the adult emergency department within and including the dates of April 1, 2020, and May 31, 2020. This period corresponded with the initial surge of COVID-19 in Massachusetts with a peak of 2988 confirmed COVID-19 cases on April 17, 2020.[8] The HCP also needed to be asymptomatic on the day of the blood draw and not known to have had a prior documented COVID-19 infection. Blood was drawn from December 17, 2020, until January 27, 2021.

ED HCPs were sent an email inviting them to participate and were assessed for eligibility on the basis of study inclusion criteria. Eligible participants were then invited to enroll in the study and verbally consented. Participants

completed a questionnaire in REDCap (Research Electronic Data Capture; https://projectredcap.org/resources/citations/), which is a secure, web-based software platform designed to support data capture for research studies, and scheduled a blood draw.[9] Samples were analyzed using the Roche Cobas Elecsys (Roche Diagnostics, Indianapolis, IN) Anti-SARS-CoV-2 total antibody assay. This assay has emergency use authorization from the Food and Drug Administration for the qualitative detection of SARS-CoV-2 antibodies. It detects IgM, IgA, and IgG antibodies to the SARS-CoV-2 nucleocapsid antigen with reported specificity of >99% and analytic sensitivity of >90%.[10,11] When the test is performed more than 2 weeks after symptom onset in patients infected with COVID-19, the analytical sensitivity approaches 100%.[10-12] This particular antibody test was chosen as it met the specificity guidance from the Infectious Diseases Society of America when performing seroprevalence studies to avoid false positives.[13] If the antibody test was positive, the subject subsequently underwent SARS-CoV-2 nucleic acid amplification testing (NAAT) from a nasopharyngeal swab to assess for active infection. Of note, vaccination for SARS-CoV-2 at our study site had just started in late December of 2020. However, the Cobas Elecsys Anti-SARS-CoV-2 total antibody assay only detects antibodies to the SARS-CoV-2 nucleocapsid antigen, which indicates infection by exposure rather than immunization by vaccination.[14]

In addition, using the electronic health record, we identified each subject's number of encounters with ED patients with confirmed COVID-19 (diagnosed before ED arrival or diagnosed based on NAAT performed in the emergency department) from April 1, 2020, to the day before the blood draw date. The participant must have either assigned themselves to the patient's treatment team or written a note in the patient's chart for the encounter to be included in the analysis.

SETTING

The study was performed in Boston at an emergency department of an urban, 1043-bed quaternary care academic center with level I trauma center designation and an Accreditation Council for Graduate Medical Education–accredited 4-year emergency medicine residency program. At this institution, patients are cared for by resident physicians or advanced practice providers (physician assistants and nurse practitioners), attending emergency physicians, and emergency nurses. Before March 6, 2020, the personal protective equipment (PPE) required for HCPs interacting with patients with suspected or confirmed COVID-19 or confirmed COVID-19 exposures included gowns, gloves, eye protection, and N95 respirator. Between March 6 and March 21, 2020, the PPE requirement for respiratory protection changed from an N95 respirator to a surgical or procedural mask, with N95 respirators reserved for aerosol-generating procedures. On March 22, 2020, universal masking was implemented for all HCPs; universal masking for all patients and visitors was instituted on April 6, 2020. On April 10, 2020, the PPE policy for HCPs changed to gown, gloves, eye protection, and N95 respirator for all patients with suspected or confirmed COVID and confirmed COVID-19 exposures. Recommended PPE was consistently available at this institution.

This study was approved by our institutional review board (Protocol# 2020P002587).

Results

Of the 446 ED HCPs invited to participate, 163 (37%) completed the eligibility questionnaire. Of the 163 HCPs, 60 (37%) did not schedule a blood draw. Subsequently, a total of 103 (23%) HCPs (16 attendings, 4 emergency residents, 16 advanced practice providers, and 67 nurses) had blood samples drawn and completed the survey. Eighty-one (79%) of 103 HCPs were female. Of the 103 HCPs, 3 (2.9%; 95% CI, 0.6%-8.3%) were seropositive for SARS-CoV-2 antibodies. One was an attending physician, one was an advanced practice provider, and one was an emergency nurse. All 3 had subsequent negative SARS-CoV-2 NAAT results. Additional characteristics of the seronegative and seropositive participants are summarized in the Table.

When asked whether coworkers wore the recommended PPE when caring for patients with confirmed or suspected COVID-19, 47% of respondents strongly agreed, 48% agreed, and 3% disagreed with the statement. When asked whether the study participant wore the recommended PPE when caring for patients with confirmed or suspected COVID-19, 68% strongly agreed, 33% agreed, and 1% disagreed with the statement.

Discussion

At a single quaternary academic medical center among those who volunteered to take an antibody test, we found a seroprevalence of 2.9% for SARS-CoV-2 antibodies among our ED HCPs who had never been formally diagnosed with COVID-19. In 2020, Wang et al[15] reported the same seroprevalence rate of 2.9% at their academic medical center in San Francisco, CA, but lower than that reported by Madsen

TABLE
Seroprevalence of SARS-CoV-2 antibody and exposure characteristics

Characteristics	Reported responses among seronegative HCPs (n = 100)				Reported responses among seropositive HCPs (n = 3)			
	Yes		No		Yes		No	
1. Between and including the dates of April 1, 2020, and May 30, 2020, I participated in aerosol-generating procedures (eg, intubation/extubation, chest compressions, nebulization, non-invasive positive pressure ventilation, high flow nasal cannula at >15L, etc.)	74	74%	26	26%	3	100%	0	0%
2. Were you notified by Occupational Health Services that you were exposed to an individual with COVID-19 (ie, notified of confirmed exposure)?	52	52%	48	48%	1	33%	2	66%
Who was the individual with confirmed COVID-19?								
Fellow employee	2	4%	-	-	0	0%	-	-
Patient	48	92%	-	-	1	100%	-	-
Do not know	2	4%	-	-	0	0%	-	-
3. Since April 1, 2020, I have clinically worked outside of the study site emergency department to care for patients with confirmed or suspected COVID-19 (ie, other hospital emergency departments, other floors/ICUs at or outside of study site, etc.)	24	24%	76	76%	1	33%	2	66%
4. I have had household contact with persons with diagnosed COVID-19	5	5%	95	95%	0	0%	3	100%
5. Outside the hospital, I have had non-household contact with persons with diagnosed COVID-19 (ie, community exposure)	6	6%	94	94%	0	0%	3	100%
6. Since April 1, 2020, I have attended a social function or gathering with 2 or more people outside of my household	73	73%	27	27%	2	66%	1	33%
Did you adhere to social distancing and/or mask guidelines?								
Yes (social distancing)	13	18%	-	-	1	50%	-	-
Yes (masking)	5	7%	-	-	0	0%	-	-
Yes (social distancing and masking)	38	52%	-	-	1	50%	-	-
No	17	23%	-	-	0	0%	-	-
7. I think I have had COVID-19 infection	17	17%	83	83%	2	66%	1	33%
8. Median number (interquartile) of COVID-19 encounters	39 (43)				68 (31)			

HCP, health care professional; ICU, intensive care unit.

et al,[16] which was 5.9% at their academic medical center in Salt Lake City, UT. However, both of these studies included participants with known prior COVID-19 infection or active symptoms of COVID-19. Moreover, in 2020, Stubblefield et al,[17] assessing seropositivity in ED and intensive care unit HCPs, found a seroprevalence rate of 7.6% among frontline health care personnel during the first month of caring for patients with COVID-19. The seroprevalence rate among personnel who recalled no symptoms was 3.2%.[17]

A substantial proportion of enrolled HCPs (19 of 103) suspected that they had been infected previously and were anticipating positive SARS-CoV-2 titers. Our results, however, suggest that the frequency of COVID-19 infection was lower than what our frontline HCPs predicted. Of the 19 participants believing that they had prior COVID-19 infection, only 2 (11%) of them were seropositive. This could be due to the nonspecific symptoms of COVID-19 and the similarities to other respiratory viral infections. This could also be due to waning immunity.[18] These results may also indicate concerns among participants about contracting SARS-CoV-2 after reflecting on their own behaviors and baseline risk. For example, among seronegative HCPs, 73% had attended a social function. While 68% of HCPs strongly agreed that they wore the recommended proper PPE, only 47% strongly agreed that their colleagues wore the recommended proper PPE. On the basis of the survey results, adherence to proper PPE was likely high. Of note, a quarter of respondents practiced at another site. Although this study is unable to ascertain risk of contracting COVID-19 in clinicians working at multiple facilities, staff working in multiple facilities may be associated with the interfacility spread of COVID-19.[19]

Limitations

The primary limitation of the study is selection bias, and the results should be interpreted with caution. It is possible that those who did not respond were more or less likely to have contracted COVID-19 than our sample population. It is plausible that those who enrolled in our study would be more likely to believe that they had previously contracted COVID-19, making it unlikely that the true seroprevalence is significantly higher than our results. A second limitation is the time elapsed between the first pandemic surge and the study period. Some subjects may have been SARS-CoV-2 seropositive and over time converted to seronegative. A third limitation is that we were precluded from doing an analysis of potential risk factors for having antibodies because we did not collect demographic information, and there was a low number of subjects with a positive antibody test. Finally, our results may not be generalizable to hospitals that were unable to secure sufficient quantities of PPE or were unable to implement infection prevention and control strategies recommended by public health.

Implications for Emergency Nurses

Adherence to infection control protocols, including implementation of universal masking and use of appropriate PPE for patients with suspected or confirmed COVID-19 or confirmed exposures appears to mitigate risk of transmission in health care settings. Health care leaders should ensure that staff have access to and use recommended PPE.

Conclusion

At a single quaternary academic medical center among those who volunteered to take an antibody test, there was a low seroprevalence of SARS-CoV-2 antibodies among ED HCPs who were asymptomatic at the time of blood sampling and not known to have had prior documented COVID-19 infection. Seropositivity was considerably lower than participants themselves anticipated, suggesting that PPE and other infection control protocols were more effective than HCPs believed. While there have been concerns about asymptomatic infections in health care workers—and the downstream consequences—it appears this was in fact a rare occurrence in our ED setting.

Author Disclosures

Conflicts of interest: none to report.

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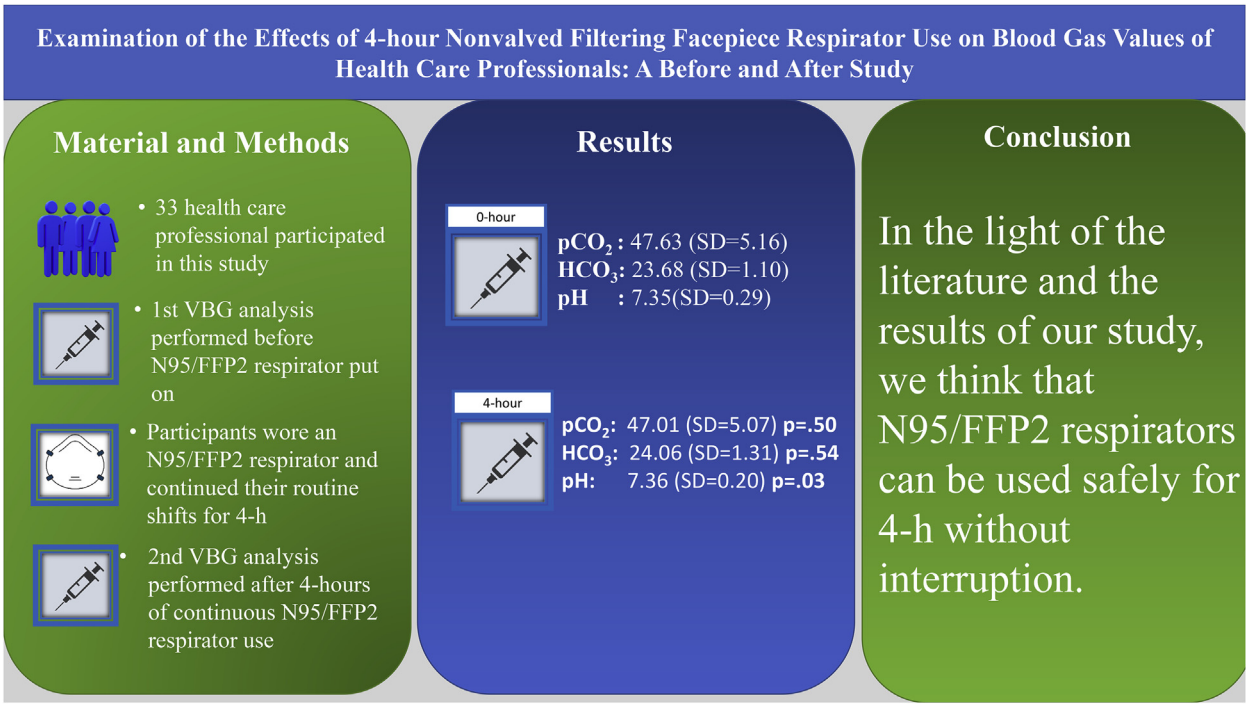
Examination of the Effects of 4-Hour Nonvalved Filtering Facepiece Respirator Use on Blood Gas Values of Health Care Professionals: A Before and After Study

Authors: Sinan Pasli, MD, Melih Imamoglu, MD, Muhammet Fatih Beser, MD, Abdul Samet Sahin, MD, Engin Ilhan, MD, and Metin Yadigaroglu, MD, Trabzon and Samsun, Turkey



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Examination of the Effects of 4-Hour Nonvalved Filtering Facepiece Respirator Use on Blood Gas Values of Health Care Professionals: A Before and After Study

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Contribution to Emergency Nursing Practice

- Nonvalved filtering facepiece respirators are frequently used by nurses, paramedics, and other health care personnel who intervene in suspected and diagnosed patients with COVID-19, especially during the pandemic with high respiratory transmission.
- The main finding of this article is that continuous nonvalved filtering facepiece respirator use for 4 hours was not associated with impairment in blood gas and peripheral SpO_2 levels during nonexertional clinical work in the emergency department. A statistically significant increase was observed in pH values, which remained within physiological limits and may not have clinical significance.
- Recommendations for translating the findings of this paper into emergency clinical practice include the following: continuous 4-hour use of nonvalved filtering facepiece respirators does not appear to have a negative impact on clinician respiratory physiology.

Abstract

Introduction: The use of personal protective equipment increased rapidly during the COVID-19 pandemic that began in 2019. The purpose of this study was to examine the effects of uninterrupted 4-hour use of internationally certified nonvalved filtering facepiece respirators on venous blood gas in health care workers during the COVID-19 pandemic.

Methods: A before-after design included venous blood gas analyses collected at the beginning of shifts before nonvalved filtering facepiece respirator had been put on and after 4-hour uninterrupted use of nonvalved filtering facepiece respirator.

Results: In this study, 33 volunteer health care workers took part. In terms of blood gas values, mean pCO_2 values were 47.63 (SD = 5.16) before and 47.01 (SD = 5.07) after nonvalved filtering facepiece respirator use, mean HCO_3 values were 23.68 (SD = 1.10) in first blood gas analysis and 24.06 (SD = 1.31) in second blood gas analysis, and no significant difference was observed between before and after the use of nonvalved filtering facepiece respirator ($t = 0.67$, $P = .50$, $t = -2.0$, $P = .054$,

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respectively). The only significant difference in parameters investigated between the groups was in pH levels, at pH = 7.35 (SD = 0.29) before and pH = 7.36 (SD = 0.20) after nonvalved filtering facepiece respirator use ($t = -2.26$, $P = .03$).

Conclusion: Continuous nonvalved filtering facepiece respirator use for 4 hours was not associated with clinician impairment in blood gas and peripheral SpO_2 levels during nonexertional clinical ED work.

Key words: FFP2; N95 mask; Respirator; Venous blood analysis

Introduction

Diseases transmitted by respiration can cause epidemics and pandemics. Health care workers adopted a series of measures to protect themselves during the severe acute respiratory syndrome (SARS) epidemic caused by the SARS coronavirus originating in Hong Kong in 2002 and during the influenza A H1N1 swine flu epidemic originating in Mexico in 2009. The most important of these measures was the use of surgical masks and nonvalved filtering facepiece (N95/FFP2) respirators.[1] The use of personal protective equipment (PPE) increased rapidly during the COVID-19 pandemic that began spreading across the world from the Chinese city of Wuhan in 2019. Studies have also emphasized the importance of PPE use.[2] Studies performed during the SARS outbreak have also revealed significant findings regarding the protective nature of PPE.[3]

Health care professionals serving patients with probable and confirmed COVID-19 were advised to use respirators (N95, FFP2, or equivalent standard), especially for aerosol-generating procedures.[4] It may be reasonable to consider European FFP2 as "equivalent" to US NIOSH N95 respirators, for filtering at least 94% of non–oil-based particles such as virus bio-aerosols.[5]

We hypothesized that the pCO_2 value in the blood gas might increase, and the pH and SpO_2 values may decrease after the continuous use of N95/FFP2 respirators. The purpose of this study was to examine the effects of uninterrupted 4-hour N95/FFP2 respirator use on venous blood gas in health care professionals.

Methods

STUDY DESIGN AND PARTICIPANTS

We used a before-after design. The study population consisted of health care professionals (emergency nurses and physicians) working in the emergency department of a tertiary hospital between March 1, 2021, and April 1, 2021. Inclusion criteria were age 18 or over, voluntary participation with written consent, being clean-shaven, and receiving training in the use of PPE. Exclusion criteria were the presence of severe chronic pulmonary disease or mask use being medically contraindicated and participants who removed their N95/FFP2 respirator for any reason during the study period. No incentive was provided.

ETHICAL CONSIDERATIONS

This study was conducted under the approval of the local ethics committee (approval number: 2021/12).

STUDY PROCEDURES

Venous blood gas measurements were performed at the beginning of shifts before the N95/FFP2 respirator had been put on and after 4-hour uninterrupted use of internationally certified N95/FFP2 (3M VFlex 9152E) respirators. Participants continued with their routine activities for 4 hours. They did not engage in high-effort interventions such as providing cardiopulmonary resuscitation and did not leave the emergency department for any reason. An average of 2 volunteers participated in the study each weekday, and the participants were observed by an author working in the same field.

MEASURES

Demographic Information

Age, sex, smoking, and medical history were recorded on a research form for each participant (see Supplementary Appendix).

Questionnaire for Side Effects

Major symptoms such as headache, nausea, palpitations, shortness of breath, or anxiety were questioned. At the end of 4-hour respirator use, participants were verbally asked whether they had any of these symptoms during the 4-hour period, and the results were recorded on a research form (see Supplementary Appendix).

Blood Gas Analysis

Blood gas analyses were performed on a bench analyzer (Rapidlab 1265, Bayer Health Care LLC, Pittsburgh, PA). The device was calibrated at regular intervals (1-point calibration

TABLE 1
Participants' demographic characteristics (N = 33)

Sex	n	%
Male	17	51.5
Female	16	48.5
Smoking		
Yes	7	21.2
No	26	78.8
Past medical history		
Asthma	2	6.1

Age (y)	Median	Min-Max	t*	P
Male	28	24-47	1.93	.06
Female	27	24-29		

* Independent sample *t* test.

TABLE 2
A comparison of prerespirator and postrespirator use parameters

Variable	Median	Min-Max	z*	P
$SpO_{2\ before}$	98	95-99	−1.48	.13
$SpO_{2\ after}$	98	92-100		

	$\bar{x}$	SD	t†	P
$pCO_{2\ before}$	47.63	5.16	0,67	.50
$pCO_{2\ after}$	47.01	5.07		
$pH_{\ before}$	7.35	0.29	−2,26	.03
$pH_{\ after}$	7.36	0.20		
$HCO_{3\ before}$	23.68	1.10	−2.0	.054
$HCO_{3\ after}$	24.06	1.31		

* Wilcoxon test.
† Paired sample *t* test.

every 4 hours, 2-point calibration every 8 hours). The pH (reference range: 7.35-7.45), pCO_2 (reference range: 35-45 mmHg), and standard-HCO_3 (reference range: 21.2-27 mmol/L) levels were measured. The results were printed on a paper and stored.

STATISTICAL METHODS

The study data were recorded onto Microsoft Excel software (Microsoft Corporation, Redmond, WA) and analyzed using Statistical Package of Social Sciences version 24.0 (IBM Corp, Armonk, NY) and MedCalc software (MedCalc Software Ltd, Oostende, Belgium). Compatibility with normal distribution was evaluated using the Shapiro Wilk or Kolmogorov Smirnov tests. Normally distributed numerical variables were expressed as mean and standard deviation and 95% confidence interval. Non-normally distributed numerical variables were expressed as median (minimum-maximum) and 95% confidence interval. Categorical variables were defined as n (number) and %. The matched pairs *t* test was used to compare before and after values of normally distributed numerical variables. Wilcoxon's test was employed to compare non-normally distributed numerical variables. The independent samples *t* test was used to compare normally distributed numerical demographic variables between independent groups, and numerical data not exhibiting normal distribution were compared using the Mann-Whitney U test. $P < .05$ were regarded as statistically significant for all analyses. When the effect size was expected as d = 0.5, alpha error = 0.05, statistical power = 0.85 for the *t* test in 2 dependent groups (matched pairs) using the GPower 3.1.9.7. program (Heinrich-Heine-University, Düsseldorf, Germany), we calculated that the sample size of the study should be at least 31.

Results

Thirty-three volunteer health care professionals (emergency nurses and physicians) participated in the study. No participants were excluded from the study, and no data were missing. Men constituted n = 17 (51.5%) of the participants and women n = 16 (48.5%). Median ages were 28 years (24-47) among men and 27 years (24-29) among women. Nonsmokers (tobacco) were n = 26 (78.8%) while n = 7 (21.2%) smoked tobacco. Intermittent asthma was present in 2 participants (Table 1). Median fingertip oxygen saturation values in room air were SpO_2 = 98 (95-99) before N95/FFP2 use and SpO_2 = 98 (92-100) after N95/FFP2 use, and the difference was not statistically significant (z = −1.48, $P = .13$). Mean pCO_2 values were 47.63 (SD = 5.16) before N95/FFP2 use and 47.01 (SD = 5.07) after N95/FFP2 use, and no significant difference was observed between these groups ($t = 0.67$, $P = .50$). The mean HCO3 levels were 23.68 (SD = 1.10) and 24.06 (SD = 1.3) before and after N95/FFP2 use, respectively, and no significant difference was observed ($t = -2.0$, $P = .054$). The only significant difference in parameters investigated between the groups was at pH levels. Mean pH levels were found at 7.35 (SD = 0.29) before N95/FFP2 use and pH = 7.36 (SD = 0.20) after N95/FFP2 use ($t = -2.26$, $P = .03$) (Table 2). No major side effects (headache, nausea, palpitations, dyspnea, or anxiety) were reported by the participants.

Discussion

The new global threat SARS-CoV-2 is transmitted by droplets and aerosols. Health care workers were advised to use PPE to prevent transmission of the disease during the COVID-19 pandemic.[4] One recent meta-analysis showed that surgical masks provided a degree of protection comparable to that of N95/FFP2 respirators for aerosol-free procedures.[6] However, in aerosol-generating procedures, the use of N95, FFP2, or FFP3 respirators may be appropriate.[4]

Although their findings vary, several studies have investigated the effects of N95/FFP2 and FFP3 respirators on metabolic and respiratory parameters. The present study examined the effect of 4-hour continuous N95/FFP2 respirator use on venous blood gas and peripheral oxygen saturation values. While a significant difference was observed in pH values, there was no significant difference between PCO_2, HCO_3, and peripheral SpO_2 values. Despite the significant difference in pH values, both groups remained within physiological limits. Although the reason could not be determined through measurements, this might be related to increased respiration rates. A study showed that the use of N95/FFP2 for 1 hour was associated with increases in respiratory rate (range, 1.4-2.4 breaths per minute).[7] Kao et al[8] performed a blood gas study on 39 patients receiving dialysis during the SARS epidemic. They reported that 4-hour use of an N95/FFP2 respirator significantly reduced PaO_2 in patients with end-stage kidney disease and increased respiratory side effects in those patients. These findings need to be confirmed in studies with a contemporaneous comparison or control group to address the unmeasured confounding of the work shift itself.

Ong et al[9] and Lim et al[10] both reported that N95/FFP2 caused a significant increase in headaches among health care workers. In a study performed during the COVID-19 pandemic, Ong et al[9] reported headaches associated with PPE use in 82% of health care workers. In another study carried out during the SARS epidemic, Lim et al[10] reported that 37.3% of participants had a headache after N95/FFP2 use. These authors interpreted that this headache finding might be related to increased inhaled CO_2 levels, but blood gas measurements were not performed in their study. There was no difference between pCO_2 levels before and after N95/FFP2 respirator use in our study, and the participants did not report any side effects. Coca et al[11] recommended establishment of appropriate working and rest periods to avoid undesirable side effects of PPE. When using respirators for extended periods of time during the COVID-19 pandemic, health care professionals may have developed physiological and behavioral adaptations or ignored side effects with extended PPE wear. Changes in nutrition, hydration, and resting habits, and adjustment of work tempo may be some of these adaptation mechanisms. Further studies targeting pulmonary function tests or behavioral changes can be beneficial to clarify possible clinician adaptations.

Bharatendu et al[12] examined the effect of N95/FFP2 use on end-tidal CO_2 ($ETCO_2$), and no significant increase in $ETCO_2$ values was observed in participants using N95/FFP2. A recent study found that the use of N95/FFP2 for 1 hour in 10 healthy emergency residents did not cause a significant difference in the pH and pCO_2 values measured at 20, 40, and 60 minutes.[13] A study conducted with 57 nurses and 47 paramedics working in the SARS coronavirus-2 intensive care unit showed that the use of FFP2 and FFP3 respirators did not cause deterioration in blood gas values in a median time of 240 minutes.[14] The results of these 2 studies are similar to our findings.

Yalciner et al[15] reported that using an FFP3 respirator for at least 4 hours caused no significant change in blood gas parameters in 15 health care workers. None of the participants removed the respirator for any reason during the study period, and this is interpreted as it being well tolerated by participants.[14] The methodology and results of our study are similar to those of Yalciner et al,[15] although we used N95/FFP2 respirators in our research. In their study of 43 health care workers, Nafisah et al[16] reported that continuous N95/FFP2 use significantly reduced pO_2 levels and increased pCO_2. The results of our study are not consistent with this research, suggesting that respiratory parameters can be affected differently by the use of different brands of respirators. In a study with the participation of 154 health care professionals, the effect of using only the N95 and combined use of the N95+Powered Air Purifying Respirator (PAPR) on cerebral hemodynamics and blood gas parameters was examined. They found a significant increase in $ETCO_2$ values after using only the N95 respirator for 5 minutes. After the combination of N95+PAPR at 5 minutes, the $ETCO_2$ values measured at 10 minutes returned to their basal values. These N95+PAPR results are not corroborated by our study. The reasons for this difference may be that clinician adaptations to extended PPE wear had not yet developed in the early pandemic period, or it may be related to the measurement method (capnometer). In addition, it is not clear whether the $ETCO_2$ values returning to basal levels in that study is due to the combination of N95+PAPR or due to the adaptation that may occur over time. We did not perform a respirator fit test for the participants; therefore, air leaking from around the respirator may have affected the results and differences in our findings from those of other studies.[12]

Currently, the evidence in the published literature does not provide consistent results, especially regarding changes in pCO_2 levels.[13,16] Most studies have shown that respirator use does not lead to significant changes in pCO_2

levels.[12-14] The fact that pCO_2 levels were not impaired in our current study corroborates evidence in the published literature. However, our study contradicts other evidence in the published literature regarding side effects related to mask use.[9,10] Headache associated with respirator use has been reported frequently in the published literature, but in our study, the participants did not report any side effects. Respirator type, duration of use, age groups, sample size, or different working conditions may be the reason for different results. We recommend that determining the duration of PPE use, respirator change frequency, and respirator reuse be aligned with current World Health Organization recommendations, health care administrator recommendations, and manufacturer recommendations.[4]

Limitations

The relatively low number of participants may be regarded as a limitation of this study, and the average age of study participants was young, which may not be generalizable to the typical health care setting. In addition, the results were based on venous blood gas tests, and arterial blood gas samples might have yielded more accurate results. Another limitation may be that we were unable to show the effects of respirator use in participants with chronic disease or with exertion during the clinical shift. A history of intermittent asthma was present in only 2 members of the study population, and no statistical comparison was possible. As another limitation the pre-4-hour and post-4-hour measurements reflect values only at that immediate time and do not give an indication of short-term excursions that may have occurred during the 4-hour period. We did not perform a respirator fit test for the participants before the study; therefore, we cannot comment on whether there was air leakage around the mask that affected our results. The N95/FFP2 respirator was fixed to the dorsum of the nose with a tape to support a mask seal to the face.

Implications for Emergency Nurses

In light of evidence from the previously published literature with the findings of our study, using N95 respirators continuously for 4 hours by nurses and physicians working in nonexertional tasks in the emergency department who do not have pulmonary disease and have no contraindications for mask use is not associated with major side effects or blood gas deterioration. Our findings should be interpreted with caution and may not apply to older workers or those with characteristics markedly different from our study participants. We also think that it would be appropriate for other health care personnel working under similar conditions to use respirators for the same period of time.

Since the COVID 19 pandemic began, the use of PPE has been of the most significant importance for health care professionals' self-protection. The importance of using proper PPE cannot be underestimated. It is important to consult with the respirator manufacturer regarding the maximum number of uses they recommend for the N95/FFP2 respirator. If no manufacturer guidance is available, data suggest limiting the number of reuses to no more than 5 total uses per device to ensure an adequate respirator performance.[17] In a survey of 27 countries overall, 17 countries (63%) provide no information on their websites about the long-term use or reuse of N95/FFP2 respirators. Some countries have proposed specific methods for decontamination of N95/FFP2 respirators, and some countries have left the decision to health care administrators. The maximum extended use time ranged from 4 hours to 40 hours.[18] World Health Organization recommends that wearing a respirator longer than 4 hours can cause discomfort and should be avoided.[4]

Conclusion

Contrary to our initial concerns, continuous N95/FFP2 respirator use for 4 hours was not associated with any impairment in blood gas and peripheral SpO2 levels. At the same time, a statistically significant increase was observed in pH values, although these remained within physiological limits and may not be clinically significant. In light of the evidence in the published literature and the results of our study, we conclude that N95/FFP2 respirators can be used safely for 4 hours without interruption for nonexertional clinical tasks in the emergency department. More research is needed on the impact of extended PPE wear during exertional activities, such as chest compressions in cardiopulmonary resuscitation.

Data, Code, and Research Materials Availability

Patient consent statement: written consent of the participants was obtained.

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.2022.03.006.

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Supplementary Appendix

Form 1. Examination of the effects of 4-hour n95/FFP2 respirator use on blood gas values of health care professionals

DATA COLLECTION FORM
Age:
Gender:
Chronic Disease:
Smoking (tobacco):
Occupation:
Fingertip $Sp0_2$, Before N95/FFP2 use …….. **After N95/FFP use** …….

	1ST BLOOD GAS SAMPLE (Before N95/FFP2 use)	2ND BLOOD GAS SAMPLE (After N95/FFP2 use)
BARCODE NUMBER		

SIDE EFFECTS OCCURED DURING RESPIRATOR USE

☐ Headache
☐ Nausea
☐ Palpitations
☐ Shortness of breath
☐ Anxiety
☐ Other (……)

Hospital Access Block: A Scoping Review

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NCPD Earn Up to 9.5 Hours. See page 492.

Contribution to Emergency Nursing Practice

- Some researchers have looked at inputs, throughputs, and outputs, and others at patient-centered, clinical, and hospital system factors.
- The main finding of this paper is to explore blockages within Access, Care, and Community.
- Recommendations for translating the findings of this paper into emergency clinical practice include addressing hospital capacities and issues regarding backend exit block.

Abstract

Introduction: The overarching objective of this scoping review was to explore the breadth of health care literature in attempts to identify current strategies that hospitals adopt to improve patient bed flow, reduce access and exit block while optimizing patient care.

Methods: PubMed, CINAHL, Embase, Proquest, and Cochrane electronic library databases supported literature search in March 2021. Scholarly articles that met the 3 eligibility criteria—access block causes, effects, and solutions—were considered. Joanna Briggs Institute Guidelines supported first- and second-level literary screening processes.

Results: The synthesis included 43 references. Most initiatives addressed access (n = 15), followed by care (n = 16) and then community (n = 9), with a further 3 articles providing commentary across all 3 domains (n = 3). Evidence supported Lean principles in both emergency department and inpatient sector. Lean principles addressing access included physician-led ED triage models, point-of-care testing, overcapacity protocols, mental health team collocation models, and fast-track services. Inpatient care Lean concepts validated gains in multidisciplinary rounds, appropriate allocation of allied health services with a 7-days-a-week model, staggering of elective surgeries, journey boards usage, transit lounges, and lateral transfers. Most literature addressing the backend was narrative in nature, theorized, and advocating for solutions and policy reform.

Discussion: This study addressed aims and identified current strategies that hospitals adopt to tackle access block while guaranteeing patient care. Government-supported research to map out evidence-based models of care that address exit block and demonstrate efficiencies is required to optimize access to care in the community.

Key words: Access; Care; Community; Hospital; Emergency

Introduction

Access block, "the situation where patients are unable to gain access to appropriate hospital beds within a reasonable amount of time" as defined by the Australian College for Emergency Medicine, can lead to crowding with patients boarding in emergency departments.[1] Scholars have spent the past 30 years exploring the concept of access block in hospitals and defining the problem; they have identified multimodal interactions that contribute to improved access to critical services. To mitigate access block, hospitals rely on efficient inputs: triage and registration systems; throughputs with timely patient assessment and management; and outputs through judicious patient discharges, transfers, or hospital admissions.[2] Health services have done well to embrace

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Lean concepts and thus efficiencies; however, the reality is that at any given point in time one-third of all Australians continue to experience access block despite these improvements.[3] Demands on Australian emergency departments have increased by 5% to 10%, accounting for approximately 1500 deaths annually.[3-5] Mental health ED presentations have increased up to 38%.[5] Furthermore, our aged population growth rates have risen by 1.5% to 2%.[4] Yet, total hospital bed numbers have reduced by 15% to 30%—a universal contradictory conundrum.[2,4]

Logic would support lack of hospitals beds as the fundamental drawback; research would suggest otherwise. A historical national survey completed by the Royal College of Physicians London would suggest that access block is complicated, with 45% of patients in hospital without reason.[6] What are health services doing wrong, and what can they do to address access block? This scoping literature review explores the research question: What current strategies can health services adopt to improve patient bed flow, reduce access and exit block while optimizing patient care? While some researchers have looked at inputs, throughputs, and outputs, and others at patient-centered, clinical, and hospital system factors, this review explores blockages within access, care, and community.[2,7] This study aims to lead one through the patient journey and explore scholarly solutions from a diverse body of literature and methodologies to address bottlenecks in access and care delivery. Finally, the role of community, the government, and accountability is discussed, identifying the need for further research and legislation to address access block influencers, which lie beyond the remit of health service regulation.

Methods

This review followed the Joanna Briggs Institute Guidelines to inform methodology.[8] The Preferred Reporting Items for Systematic Reviews and Meta-analysis Extensions for Scoping Reviews (PRISMA-ScR) provided a template to support format of final assessment.[9]

INCLUSION CRITERIA

Eligibility criteria included papers written in English sourced between 2015 and 2021 either from the primary data or synthesis of secondary data. Literature identifying probable causes and effects of access block, with a solution focus to improve bed flow while ensuring quality of patient care, were investigated. Advanced search functionalities were then applied using key words and phrases within text, "improve bed flow, bed block, reduced length of stay (LOS), access block" and exact word "inpatient." A manual research of reference lists of included papers was undertaken for extra papers missed in the initial searches. A search in Google and other web-based repositories was also conducted in addition to manual searching of reference lists of retrieved papers to identify additional relevant papers that were not captured in the selected electronic database searches.

SEARCH OUTCOME

The initial advanced search identified a total of 365 papers including papers identified through hand and manual searching. These papers were then cross referenced with 310 articles sourced using the same search engines from CINAHL, Embase, Proquest, PubMed, and Cochrane libraries. There were 122 duplicates.

Applying level-1 screening of titles, abstracts, and discussions, a further 127 articles were eliminated as not directly related to eligibility criteria. In total, 61 full texts were then screened; 36 met eligibility criteria and identified core themes of access, care, and community. Once themes were charted, a further scanning of reference lists was completed to progress each theme. The outcome of the literature search identified a total of 43 key references to inform this scoping assessment (Figure 1).

DATA EXTRACTION

The extraction form was developed using Joanna Briggs Institute manual for each paper. The extraction form was divided into 3 sections. The first section was related to the citation of the study, which included the authors and date of publication. The second section included the objective and methodology of the study, including study design, study methods, study procedures, and study participants. The third documented the findings, relevant additional information, and recommendations. Data were extracted by the first author from the included studies using the data extraction form, which was confirmed by the second author.

Results

The data search supported 43 scholarly articles (Figure 1). Most articles were quantitative (n = 23),[5,10-31] several were mixed-methods studies (n = 5),[7,32-35] and other designs (narrative literature review, scoping review, discussion papers) (n = 14),[2-4,36-46] with a single

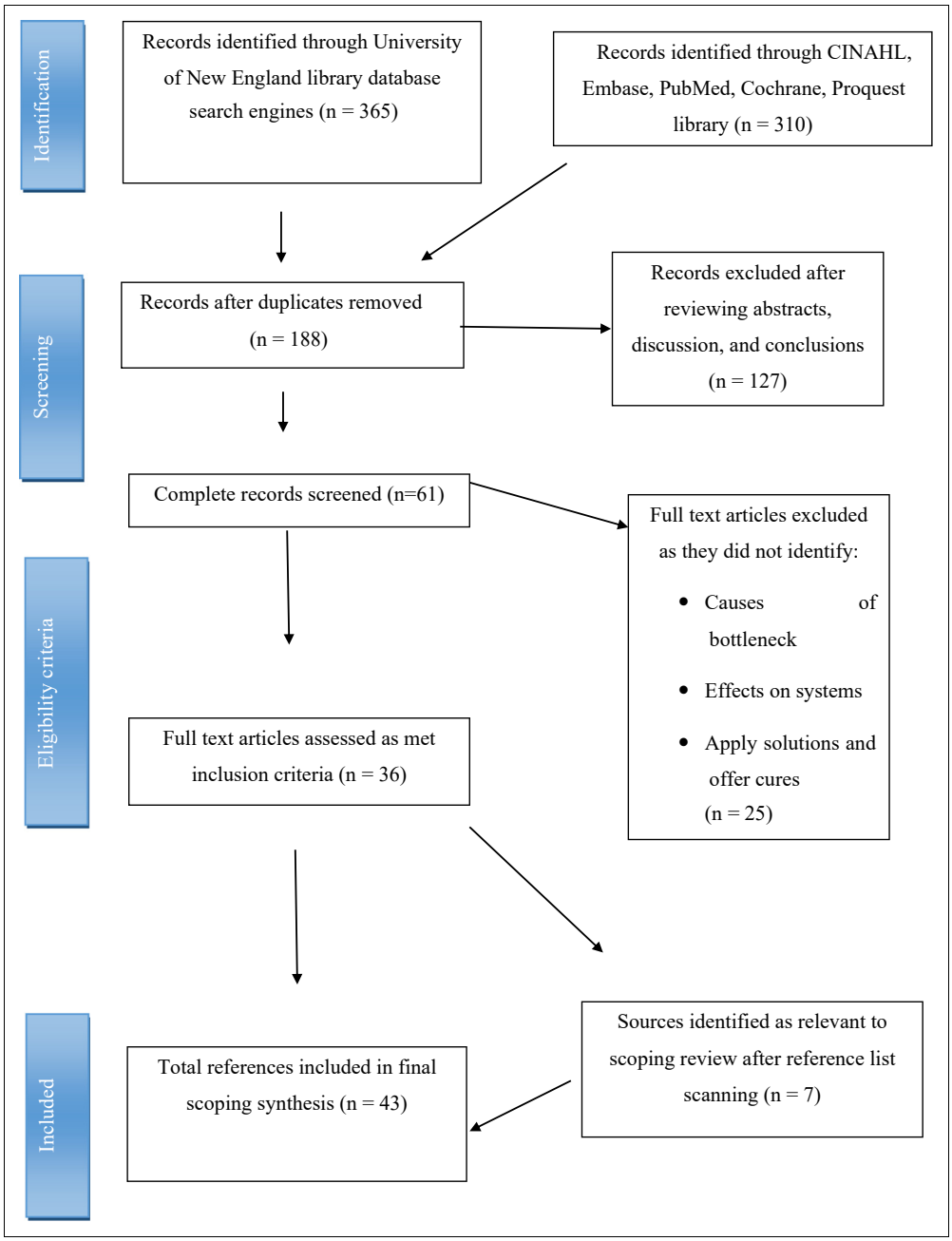

FIGURE 1

PRISMA flow diagram of included references to inform scoping review.[9] PRISMA, The Preferred Reporting Items for Systematic Reviews and Meta-analysis.

qualitative paper (n = 1).[47] Publications were universal, with studies in Trinidad, Kuwait, Iran, Canada, United States, Australia, New Zealand, Europe, France, China, Sweden, and the United Kingdom. The majority of the quantitative studies explored effects of access block on key performance indicators such as ED and inpatient LOS, the 4-hour rule, and wait times. Mixed-methods studies attempted to qualify effects of access block and interventions on patients and staff. Most initiatives targeted the adult inpatient population, although pediatric cohorts were explored. The term access block was standardized across studies; however, maintenance-type care, affecting

TABLE 1
Three key themes

Category name	Description	Example
Access	Strategies adopted to address access block at the front end of hospital care	Infrastructure Lean principles applied in emergency department: ○ Triage ○ Staffing models ○ Point of care testing ○ Fast track ○ Co-location of mental health teams ○ Overcapacity protocols ○ Short stay units ○ After hours GP or nurse service
Care	Inpatient care strategies to improve throughputs	Interdisciplinary care and information sharing Discharge times 7 days per week service Elective admissions Discharge lounges Electric journey boards Lateral transfers and flexible beds
Community	Improve exit block by addressing community care	Epidemiology Infrastructure and residential aged care facilities Funding Families and care givers

GP, general practitioner.

backend exit block, was not well defined. The scoping review identified 3 key themes in support of addressing the research question: Access, Care, and Community (Table 1).

Characteristics of included studies and their initiatives contained in this review are captured in Table 2 and Figure 2

ACCESS

This category explores themes related to front end ED access block including enhancing hospital infrastructures and applying Lean concepts.[1,3-5,10,11,13,36]

INFRASTRUCTURE

Because of advancements in medical and surgical efficiencies eventuating in reduced hospital LOS, hospital bed numbers in Australia reduced by approximately 18% over a 10-year window.[3,4] Over the years, there has been a 5% to 10% increased demand on Australian emergency departments, with annual patient presentation growth rates between 1% and 7% globally.[4,5] Therefore, it may be logical to infer that increasing ED bed numbers reduces access block and boarding; however, this is not the case.

An Australian trial whereby 3 hospitals increased ED bed numbers from 81 to 122 beds demonstrated improvements in reduced inpatient mortality rates but no effect on ED access block or LOS.[1] Similarly, increasing ED beds in a level I trauma center from 28 to 53 did not affect time between ambulance diversions and access to care.[10] This sentiment is reiterated by other authors recognizing that "the addition of new beds does not guarantee improved access to care."[11] Likewise, the principles of "elasticity in demand,"[1] —if one makes more beds, more demand will come—support research findings that simply increasing ED bed numbers does not mitigate risk of access block but rather adds to overall congestion.[12,36]

LEAN PRINCIPLES

Emergency departments across the world have embraced Lean principles to improve efficiencies in attempts to mitigate access block. These philosophies include minimizing

TABLE 2
Summary of the selected studies

Authors	Aim	Method	Participants	Major findings	Limitations
Theme - Access					
Cameron et al[4]	To explore possible solutions to hospital access block	NR	Relevant studies addressing access block between 1999 and 2009	NR discussing strategies to mitigate access block: • Reduce demand on care services by addressing patient goals of care, chronic conditions coordination in community, mental health care, expand hospital and rehabilitation in the home models, and social service supports. • Increase capacity by increasing inpatient beds, not ED beds. Increase hospital throughput processes. • Improve exit strategies by increasing discharge processes to 7-days-a-week process, introduce transit lounges, DBN concepts, and community services. Strategies that do not work according to research: • After-hours GP clinics • After-hours telephone triage • Ambulance bypass	NR, prone to bias
Mason et al[2]	To clarify the cause and effects of exit block and explore possible solutions	NR evidence sourced between 2008 and 2014	Relevant studies between 2003 and 2014	Exit block is more likely to occur in populated areas, less likely in pediatric populations. Bed occupancy correlates with exit block, and ED boarding is directly correlated with backend block. Patients prefer to wait for inpatient bed in ED cubicle rather than a corridor. Increasing no. of ED beds does not affect ED LOS. Solutions proposed, a whole of systems-wide approach	Gray literature not reviewed; only English language articles sourced. Single reviewer to screen articles

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
Bahall[11]	Explore whether improving throughputs in emergency department will reduce crowding	Quantitative descriptive, observational study	Patients presenting to single-site emergency department in Trinidad September 2010 to March 2011	Significant issues regarding throughputs in Trinidad including timeliness and access to pharmacy, laboratory, and electrocardiogram testing, physiotherapy, and social work services. Introducing multimodal throughputs for 6 months in 2011, improved efficiencies. Once throughput interventions were ceased again, ED crowding increased by 87%, despite increase in inpatient bed no. from 209 to 227 and reduced medical admissions from 58 to 52 peoples per d.	Single-center study. Secondary data. Possible observational bias
Chrusciel et al[10]	To evaluate the effects of fast-track services on ED LOS and quality of care	Quantitative adjusted before-after analysis	Patients presenting to emergency department between 2015 and 2017	In intervention hospital, ED mean intervention times reduced from 215 to 186 min; patients leaving without being seen reduced from 10.0% to 5.4%. There was an increase in 30-d readmission rates from 11.4% to 12.3%; however, improved access to critical services with decrease NEAT ≥ 4 h. Overall, there was no change in admitted patient ED LOS and so, no effect on admitted patient access block	Single-site study. Data integrity could be questioned owing to multimodal interventions
Fitzgerald et al[17]	To assess the effects of implementing a fast-track system on patient wait times and staff resourcing	Quantitative simulation model	Two health campuses in Massachusetts	Discrete event simulation models applied with queuing to replicate real bed flow events. Three hundred different data simulation sets were explored per scenario. Results demonstrated a 35% reduction in ED wait times with introduction of fast-track during peak flow times	Simulation model. Does not consider real day complexities including capacities to resource staffing models or patient acuity dependent turnover rate
Beck et al[13]	To ascertain whether Lean principles progress ED throughputs and	Quantitative pre and post retrospective descriptive study	Pediatric patients presenting to general pediatrics and subspecialty	Lean intervention group, general pediatric ward, demonstrated median order entry and discharge time reductions through introduction of altered staffing model, rounding	Single tertiary hospital study. Alternative multimodal quality improvement initiatives.

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
	limit ED boarding		services over 2-y period	standards, and multidisciplinary predischarge planning processes. Patients' percentages discharged before noon increased from 14% to 26%. This had a positive effect on reducing ED boarding times by 49 min.	
Shetty et al[14]	To explore effects of ED SSU on bed occupancy rates, NEAT and DNW rates	Quantitative descriptive	Emergency department patient presentations between 2012 and 2014	SSU accounted for 10.4% (20,081 patients) of the 43.8% admitted patients from emergency department. There was a mild positive correlation of short stay with NEAT and weak correlation with DNW. Bed occupancy rate of > 100% demonstrated briefer short stay admissions, NEAT, and DNW. SSUs should be used appropriately for ED flow, not inpatient flow, and can add to congestions when used incorrectly.	Single tertiary level adult hospital study. However, large sample size suggests statistical significance and reproducibility.
Tenbensel et al[32]	Review the introduction of 4-h rule and its effects on ED wait times	Mixed methods	Four hospitals in New Zealand, 2009-2012	Improving patient flow, as seen with 4-h rule, demonstrates benefits to ED LOS. SSU are being utilized more to supports sites in possible breach of 4-h rule due to increasing demands on the emergency department. Concerns have been raised as to how hospitals will cope if ED presentations continue to grow and efficiencies are maximized, SSU full. SSU tend to mask true ED LOS.	Owing to a multimodal intervention with increased staffing and infrastructures, the research cannot assume that the changes in ED LOS are purely attributable to 4-h rule
Elamir[12]	To explore solutions to address the main causes of ED crowding	Quantitative analytical applied research	ED patient presentations between November 26 and December 2, 2014, Kuwait	A total of 39-bed emergency department with 82 nurses and 40 doctors; 6,383 patients were reviewed, and 210 of these patients experienced ED access wait times more than 6 h. Reasons for delay to ED access were 52% waiting	Inconsistencies in triaging systems, lack of integrated electronic monitoring systems, no specific allocated party to complete

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
				inpatient beds; the remaining 48% of delays was due to lack of Lean throughputs at peak flow times including timely radiology processes. Suggested solutions include themes of inputs, throughputs, and outputs. These themes consider some Lean concepts including use of fast-track systems; electronic health information management systems; inpatient discharge services; bed crisis management protocols; increased rounding, point-of-care testing, nurse shift changes to accommodate surges. ED doctors to have admitting rights.	audits, so lacks consistency in data collation. Extreme outliers can also distort data.
Blom et al[15]	To explore whether ED primary triage at times of high inpatient bed capacity affects patients' access to ED	Quantitative descriptive-retrospective cohort study	ED patient presentations to Helsingborg General Hospital, 2011-2012, Sweden.	There is an increase in ED admissions during times of high inpatient capacity, suggesting that primary nurse-led triage can increase ED congestions at times of high stressors. Suggested solutions include fast-track, adding physician to triage in times of high inpatient capacity, nurse-led test orders, diverting away from emergency department as per primary triage categorizing as ED, primary care, or discharge home, utilizing chronic disease follow-up in community models.	Single-site study. Limitations in the study power of 72-h readmissions make it difficult to provide statistically relevant assumptions as to the after-effects of discharges by primary nurses
Yarmohammadian[37]	To present scholarly solutions to reduce ED wait times and overcrowding	NR sourced from historical literature until 2016	Sourced from historical literature until 2016	From 1,006 articles, 136 were selected, and 30 informed final review as met inclusion criteria. Articles that did not assess real patient flow in hospital emergency departments or provide solutions to address ED crowding were excluded. Ideal strategies to address crowding discussed including	English and Persian articles only. Possible selection bias

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
				fast-track systems for streaming of minor injuries, team triage, point-of-care testing, nurse-requested X-ray and emergency patient journey models through triage and registration	
Blom et al[16]	To assess whether hospital bed capacity effects the management strategy of acute abdominal pain presentations to emergency department	Quantitative descriptive	ED patient presentations at Helsingborg General Hospital, 2011-2013, Sweden	Patients with acute abdominal pain are less likely to be admitted when hospitals are experiencing access block. Of 52,790 visits made to the emergency department, 23,884 complained of acute abdominal pain. Patients aged <18 y, patients deceased in emergency department, who DNW or were transferred to another hospital were excluded from evaluation. A total of 19,620 patient presentations were examined; 37.5% were admitted; however, when access block with hospital experiencing 100% capacity, this no. reduced to 35% admissions. ED LOS increased by 20 min; 72-h readmission rates were not affected. This makes one question triage systems and role of nurse- versus physician-led triage.	Single-site study. Lack of analysis of mortality data makes it difficult to analyze ill effects. Lack of procedural data in emergency department makes it difficult to ascertain whether it was triaging processes or procedures in emergency department that made an impact on inpatient admission data.
Zeitz and Watson [5]	To explore suite of principles in support of reducing ED boarding and improving throughputs for mental health patients	Quantitative descriptive	ED consumers presenting with mental health concerns in 2 hospitals in Adelaide and Australia, 2014-2016	The implementation of a 3-phase project addressing leadership; realignment of hospital bed footprints; escalation processes; care planning, journey boards; development of analytic models; revamping of admission processes and implementation of a short stay model of care, reduced boarding in emergency department for MH patients. The ALOS in July 2014 was 20.4 h. After 1.5 y of project	Multimodal changes implemented over 3 phases, so difficult to ascertain which changes added value and whether there were other changes at a whole of health system level that impacted on results.

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
				implementation, MH ALOS had reduced to 8.5 h.	
Nolan et al[18]	To determine incidence, contributing factors of ED boarding and increased LOS for MH patients in the United States	Quantitative retrospective	MH patients presenting to emergency department in United States, 2008	Patients with MH disorders are 4.78 times more likely to board in emergency department than nonpsychiatric counterparts. Psychiatric patients experience longer boarding times, with 21.5% psychiatric patients as opposed to 11% nonpsychiatric patients experiencing ED boarding in United States	Electronic data systems may not capture all relevant MH diagnostic codes for this study
McKenna et al[36]	To define ED crowding, identify effects, and provide solutions	NR	Literature explored between 2002 and 2018. Key words: crowding; emergency service; hospital; patient safety	ED boarding is a whole of hospital systems issue. ED crowding is generally a function of hospital capacity. Consequences: increased 28-d mortality rates, increased DNW, increased medical errors, has a negative impact on hospital funding due to DNW. Ineffective interventions: expanding emergency department, diverging patients, additional staffs reduce strain but not boarding if admission beds to inpatient wards are blocked. Cures: staggering elective admissions through the wk, DBN, 7-days-a-week discharge, full capacity plans	No systematic nature to literature review therefore potential for author bias
Innes[38]	To focus on ED access block and identify proposed solutions	NR	Literature review, 2004-2018	Clarifies GP-related patients account for an insignificant amount of ED presentations, so are not contributors to access block. Notes that emergency departments are not the problem, rather access block is a whole of systems issue. Identifies positive solutions to throughputs including FCP, Lean principles, 4-h rule, reverse triage. Provides opinions	Single author. No systematic approach to review. Potential for bias

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
				advocating for FCP as a demand-driven protocol, not a preference, and that hospitals should use as such.	
Richardson and Mountain[3]	To explore the causes of ED crowding and solutions	NR	Literature review, 2001-2009	Identifies causes of ED access block: the reduced no. of hospital beds since 1995 due to improved surgical and medical efficiencies yet the increased demand on emergency departments. Discusses consequences including increased mortality rate, delayed time-critical interventions, medical errors, increased hospital LOS, ambulance diversions. Dispels myths: GP patients have little effect on ED load, less than 3%. ED size does not really make a difference on access block unless in disaster mode. Explains that crowding is a whole of system issue.	Dual authors. No systematic approach to review. Potential for bias
Hullick et al[19]	Review the introduction of a nurse-led phone support service on RACF patient transfers to emergency department	Quantitative, controlled pre-post intervention	4 intervention RACF and 8 matched controls	Despite introduction of nurse-led telephone service, there was no change on ED presentations. However, the study did demonstrate improved care coordination, identification of goals of care early in the mix, reduced ED LOS by 45 min, and overall reduced hospital admission rates by 40%.	
Theme – Care					
Artenstein et al[7]	To explore whether interdisciplinary care optimization reduces inpatient LOS	Mixed-methods performance improvement initiative	Patients admitted to Baystate Medical Center, a 720-bed and 94-ED	Daily IP discharge (d/c) rounds led to a 50% sustained d/c DBN and decrease LOS by 0.3. Despite increased ED presentations those 2 y, boarding reduced by 2.1 h. ED walk-out rates	2-y project; therefore, difficult to attribute a cause-and-effect relationship, as there may be other

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
			tertiary hospital in Massachusetts, 2013-2015	decreased by 32%. Some further solutions discussed including assigning boarding patients to inpatient beds, smoothing elective surgeries, pulling admissions from emergency department, empowering bed managers to support throughputs.	multimodal contributors. Single-site study.
Aziz et al[33]	To explore the effects of a 'Consultant of the Week' model on hospital LOS	Mixed methods	Patients admitted to general medical wards at Sandwell and West Birmingham hospitals, 2017-2018	A 5-d-a-wk service with daily 11:30 AM Acute Medical Unit MDT meetings expedited discharge planning and reduced LOS from 9.17 d to 6.61 d. Patients felt better continuity of care, junior doctors felt that education was improved, consultants felt that acute medical unit meeting improved traction with other teams and timely interventions.	Quantitative results seem favorable; however, qualitative components are not exhaustive, with mixed results from consumers, junior doctors, and consultants.
Gilfillan et al[20]	To assess how a patient journey redesign can improve patient flow in a general medical service	Quantitative rapid improvement initiative	Patients in acute general ward at 2 hospitals Victoria and Australia, 2013 and 2014 financial years	Through redesign including 7-days-a-week service, ED pull systems, and ward-based teams, hospitals were able to improve weekend discharge rates by 54.6%, demonstrate reduced bed occupancy of 19 d, and overall LOS by 0.88 d. Consultant hours only increased by 5.5 h across the whole health service, and there was little to no allied health or affordable nurse full-time equivalent variances. Mortality rates declined by 18%. Journey boards facilitated the pull process and identified early referrals and discharge dates.	12-mo project, so difficult to tell whether these interventions solely catered for overall efficiencies or whether there were other rapid improvement initiatives involved
Tariq et al[47]	Identify barriers to journey board use/adoption	Qualitative	Staffs in large teaching hospital in	Journey boards not used consistently. Design, configuration, and information regarding shared purpose were identified as contributors to	Small sample size n = 33. Qualitative interviews were brief and not exhaustive

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
			Sydney, Australia	poor implementation. Author suggests co-design in the future to ensure buy-in with new information technology systems	
Cadel et al[39]	To examine literature and explore best practices in hospital discharge processes; to identify initiatives and gaps.	Scoping review (peer reviewed and gray literature)	Mixed literature, 2004-2019	Articles between 2004 and 2019 sourced. Five themes identified, including practice change; infrastructure; information sharing; tools and guidelines, and other initiatives. Identified a call to action for governments to increase inpatient bed no., integrated care, and financing incentives. Other initiatives included the NHS improvement (United Kingdom) guide, which suggests a patient flow bundle, Red2Green d, long stay patient reviews, and multiagency discharge meetings	Search limited from 2004 to 2016, English articles only. Research was not critically appraised; therefore, all quality improvement projects must be interpreted with caution.
Cudney et al[21]	To develop an event simulation model in support of planning and staff rostering to address access block	Quantitative simulation model	Retrospective study and simulation based on patient data at single site	Simulation models can support service redesign. Three areas for improvement were identified at Sacramento Veterans Administration Medical Center to improve access and address access block. • Reduce bed turnover by 1 h and patient wait time will be reduced in emergency department • Reducing inpatient ALOS by 10 h reduces no. of patients waiting in emergency department from 11 patients to 4 patients • Increase beds in specific units	Data are historical and limited to 1 patient transfer; therefore, not necessarily a true reflection of the whole
Osborne et al[23]	To ascertain whether a	Quantitative-prospective,	Hospital patients in a tertiary	Mean LOS for complex long stay patients reduced by 33 d, equating to	Small sample size. Historical controls

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
	specialist Social Work model supports discharge for long-stay patients	matched cohort study with historical controls	hospital in Southeast Queensland, Australia, 2016	9,999 bed days annually and $A229,000 savings. Control group (n = 60), sample group (n = 52)	selected on different criteria; therefore, a degree of researcher bias evident. No analysis of patient outcomes or qualitative data explored
Haines et al[24]	To see whether there are any negative effects from removing a weekend allied health service on patient flow and discharges	Quantitative, 2 stepped-wedge cluster randomized control trial	Six acute medical and surgical wards in 2 metropolitan teaching hospitals, Melbourne, February 2014 to April 30, 2015	Two large trials conducted. Service was removed in trial 1 and redesigned, then reintroduced in second trial. Data demonstrated that removing the allied health service had no ill effects; in fact, LOS dropped by 2%, and adverse events reduced by 3%. The newly developed service had no change in effect when reintroduced.	
Sarkies et al[40]	To assess whether weekend allied health services are effective in reducing LOS in acute sector and rehabilitation	Systematic review and meta-analysis	Literature review January 2000 to May 2017	Providing additional rehabilitation for inpatients reduces LOS by 2.35 d. However, the impact of weekend physiotherapy services was unclear across acute medical and surgical sectors	Potential risk of bias in outcome measures such as hospital LOS where clinicians could expedite/slow down discharges to influence data. Not blind study.
Haas et al[25]	Assess the effects of acute weekend/ no weekend physiotherapy service on orthopedic protocol pathway patients LOS and outcomes	Quantitative Pre-post quasi-experimental 2 stepped-wedge cluster	Patients undergoing THR and TKR in public hospital, Melbourne, February 2014 to February 2015	2 sequential studies. Study 1 (n = 131) with weekend physio service in acute sector 6/12. Study 2 (n = 146) when weekend physio service removed 6/12. Outcome measures were primarily quantitative-hospital LOS. Result: no change in LOS; however, improved functional gains.	Single-site study. Casual cohort of staff used on weekends, so skill set may differ from normal acute therapists.
Malik et al[26]	Does day of surgery effect LOS for		Patients underwent	Sample size (n = 611). Outcomes:	Retrospective study. Single site

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
	total joint replacement	Quantitative retrospective cohort study	total joint replacement between January 2007 and December 2015 in University Hospital, Pakistan	• For unilateral TKR, there was a reduced LOS dependent on day of week surgical intervention had. Tuesdays, Saturdays, and Sundays demonstrated efficiencies • No variance for bilateral joint replacements, though	
DiSotto-Monastero et al[22]	Evaluate a 7-days-a-week inpatient service on hospital efficiencies	Quantitative, cross-sectional, retrospective review	Data collected from National Rehabilitation Reporting Systems February 2008 to January 2010	A 7-days-a-week allied health model reduces patient LOS, improving access to care. This model was more beneficial than the previous 5-day-a-week model	Retrospective study. Data integrity dependent on coders
Bekker et al[29]	To assess when flexible bed allocations prove beneficial in facilitating bed flow and capacity	Quantitative	Hospital bed allocations (not patient but rather organizational bed no.)	In large hospitals, full flexibility is not desirable as geographic wards and clustering of specialties improves overall efficiencies; however, a little flexibility is generally enough to provide benefits on bed flow and access	
Russell et al[28]	The aim was to assess the effects of inter-hospital transfers on efficiencies including LOS and quality outcome measures	Quantitative, retrospective	Patients in 2 tertiary hospitals from the same health care network, 2010-2012	Patients transferred demonstrated no ill effects, had reduced LOS and readmission rates. However, transfers after 4 PM demonstrated increased hospital LOS by 1 d. Weekend transfers had no impact on LOS. Mean LOS was 1.2 d for Hospital A and half a day less for transferred patients in Hospital B	
Rolls et al[27]	To investigate whether the introduction of electronic	Quantitative, retrospective study	Inpatient rehabilitation center in Victoria and	Reduced LOS 4.1 d with introduction of journey boards. Savings of approximately $A3,738 per episode. In total, an 18% reduction in LOS for	This study does not factor in other potential quality improvement

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
	journey boards reduces inpatient LOS		Australia 2013-2018	rehabilitation patients. Annual savings of approximately $A2.6 million	initiatives at the time. There is an assumption that retrospective data are accurate.
Smith[34]	To see whether introducing a Discharge Hospitality Center reduces ED boarding by streamlining flow	Mixed methods	Tertiary medical and level I trauma center, 2014-2017	Findings are not consistent as dependent on patient acuity and eligibility to attend Hospitality Center; however, current research identified a reduction in ED boarding times from 425 h to 368 h a month	Still in infancy stages at time of research, 6-month trial.
Theme - Community					
Feng et al[42]	To provide a profile of long-term care systems and the effects of policy on health care in China	Literature review	Literature review based on published works and gray literature	China has a rapidly aging population. Incidence of disability is high. Informal carer no. are low owing to recent rescind of 1 Child Policy in 2015. Government systems are exploring 90:7:3 policy; 90% care in the home, 7% community-based services, and 3% institutional, to address community need and increasing demands on health services	NR, so prone to bias. Mitigated by referencing scholarly works and OECD data.
Ergas and Paolucci[43]	Reviews the financing of Aged Care in Australia	Literature review	NR based on key word finding-published and gray literature	Provides forecasted epidemiology growth rates for aging population within Australia. Notes rates of dementia/disability and cost on health care and Gross Domestic Price. Discusses cost of institutional care versus formal and informal care. Proposes strategies to address exit block: • addressing voluntary tax-assisted savings dedicated to aged care, • universal mandatory insurance to address fiscal pressures on	Two authors, narrative in style, prone to bias

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
				Commonwealth and improve aged care access	
Gaughan et al[31]	To explore whether increased nursing home/care beds reduce no. of delayed discharges	Quantitative descriptive		An increase in care home beds by 10% reduces delay in discharges related to aged care by 6%-9%. Care home prices also affect delay in discharges. Lack of beds affects patient migration to different regions to access care. Increasing the supply of care beds will not necessarily affect total costs of care; however, the impacts of hospital long stay and institutionalization have not been addressed with this research. The research has only explored effect on delayed discharges and is therefore relevant to access block.	Authors have no conflict. Limitations include lack of qualitative review of impacts on patients in hospital long stay or potential hospital-acquired complications and negative incentivizing with activity-based funding.
Salonga-Reyes and Scott[35]	Identify causes of delayed discharges in maintenance care type patients, quantify problem, and offer solutions	Mixed methods retrospective	Nonacute maintenance type patients presenting to Princess Alexandra Hospital, Queensland, January 2012-May 31, 2015	A total of 131 maintenance patients had long stays accounting for 5,420 of 6,033 nonacute hospital type bed days. Causes: 44% lack of RACF beds, 13% guardianship and public trustee issues, funding issues for social services 4%-5%, carer refusal 7%, and 1%-3% aged care assessment team processes.	No conflict of interest declared. Sample limited to 1 tertiary hospital. Patient sample size small but still statistically significant. Staff survey response rate low 24% (13 of 55 people)
Bryan[41]	To review literature related to Community Care (delayed discharge) Act 2003 and policy to ascertain effects of Act on reducing no. of discharge delays	Literature review (published and gray)	Literature review	Roll out of the Act in 2003 with 99 Social Service Departments partaking in the initiative. After 1 y, there was a reduction of 1.9% in delayed transfers to care; this rise continued in 2004-2005 with a further 1.6% reduction. Grants were more of an incentive for RACF than penalties/tariffs. The Act (2003) did demonstrate improvements in reduction of ALOS from 8.1 to 7.1 d	Single author. Narrative style literature review. Previous similar studies by same author on topic may lead to perception of author bias

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
				despite increased admissions from 7.5 to 8.2 million patients in the same period. There was a growth rate of 33.3% in RACF admissions during this period. Concerns raised regarding institutionalizing patients when they could be cared for at home. Some suggestions include addressing prioritization, hospital factors, intermediate care factors, and social services.	
Kneale and Smith[30]	To examine whether extra-care housing can be a home for life	Quantitative study	Clients journey through 9 extra-care homes cross-matched with nearest-neighbor method to compare with those living at home	Extra-care housing can be a home for life for majority of patients, with only 8% of residents transferring to RACF. The exit to institution versus exit due to death is 1:3 at 5-year mark. Patients aged 75 to ≥80 y were more likely to move into institutions from home (35%-50%) than if they lived in extra-care housing.	To reduce error, demographics were matched as best practicable; however, there is a possibility of endogeneity as unobserved factors may impact on one's choice to move into extra-care housing versus RACF. Lack of qualitative data, which would make this study richer
Tao and McRoy[44]	To explore and provide suggestions on alternative heterogenous care models, rather than institutional type care	Literature review (published and gray)	Narrative literature review with keywords: aging, caregiver, technology	The review provides statistics on no. of formal and informal carers in the United States; the stressors that carers face, including poverty and job dissatisfaction. Discussions regarding the role of technology to support patient monitoring in the home were suggested, including home monitoring with biometric devices that can track set patient parameters.	NR prone to author bias, small search engines. Only 2 authors. No conflicts declared

continued

TABLE 2
Continued

Authors	Aim	Method	Participants	Major findings	Limitations
Magode and Lebar[45]	To provide an overview of the challenges facing long-term care across Europe	Literature review (published and gray)	NR	Aging population's need for long-term care and cost of health care on GDP are growing exponentially. Possible solutions suggested to improve access to care include cash benefits for carers, carers' rights, respite supports, counseling, social security (pension and health insurance), legislation, and policy changes	Not systematic review, no search engine identified, 2 authors
Aronson and Neysmith[46]	To explore the implications of long-term care on patients, family, and formal carers	Discussion paper, historical	Review of primarily qualitative literature to inform audience of patients,' families,' and caregivers' perspective on issues surrounding long-term care	This article provides commentary around 3 areas: • the patients' perception regarding care, • the families' perception • and the carers' perception Patients prefer to be at home but do not want to be a burden on their children. Patients are dissatisfied with carer work at times but do not wish to offend if standards not up to scratch as they need the service; choice is limited. Carers/family often have no choice in the caregiver role and are not paid appropriately. There is limited to no choice in social service providers or care homes too. Formal carers find that jobs are demanding and pay is poor; they often work outside their scope of practice with poor job satisfaction. This historic article calls for policy reform	Two authors, prone to bias, discussion paper

ALOS, average length of stay; DBN, discharge before noon; DNW, did-not-wait; FCP, full capacity protocols; GP, general practitioner; LOS, length of stay; MDT, multidisciplinary; MH, mental health; NEAT, National Emergency Access Target; NHS, National Health Service; NR, narrative review; RACF, Residential Aged Care Facilities; SSD, Social Service Department; SSU, short stay unit; THR, total hip replacement; TKR, total knee replacement; IP, inpatient; d/c, discharge; OECD, Organization for Economic Co-operation and Development; GDP, gross domestic product.

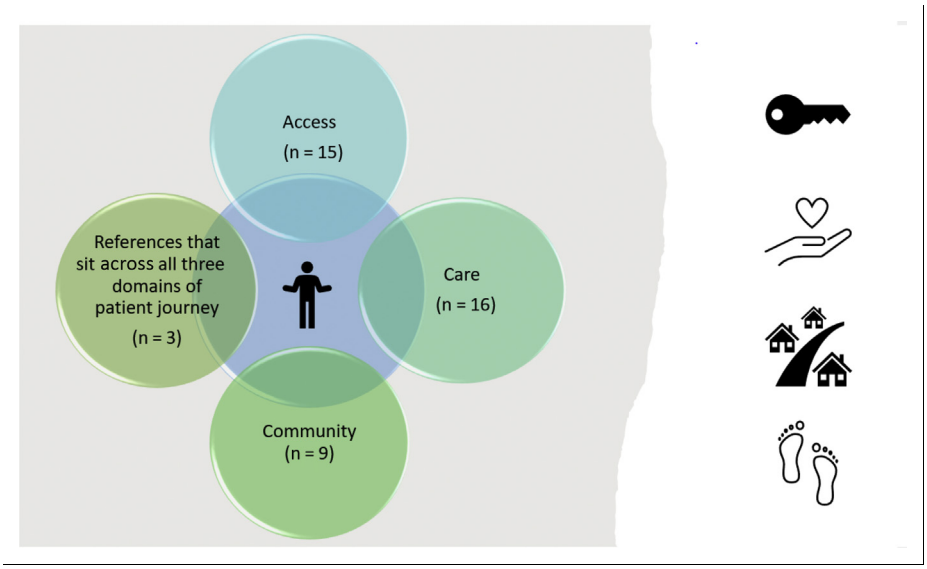

FIGURE 2
Categories of initiatives adopted to mitigate access block

defects, mitigating overproduction, time and resource management, transport productivities, inventory monitoring, supporting efficient motion, reducing excess processing, and optimizing talent utilization.[13]

Lean initiatives such as fast track systems support patient access to emergency departments,[10,17,36,37] however, not necessarily hospital throughputs, with LOS times remaining unchanged.[10,12,15] Similarly, short stay units, normally used to improve access to acute care, can increase access block when used inappropriately on patients with higher acuity requiring further management.[14,37] Point-of-care testing reduces time wastage in support of Lean constructs.[12,15,37] Full capacity protocols, otherwise known as overcapacity protocols (OCP), support the flow of patients awaiting inpatient beds from the emergency department to the acute wards, corridors, lounges, or overflow rooms.[12,38] This frees up ED beds, reducing ED boarding by up to 50%, guaranteeing "no patient left behind" in support of hospital access and Lean principles.[38]

Similarly, applying Lean staffing models and triage systems reduces access block. Nurse-led triage in the emergency department to support primary and secondary filtering for fast-track, emergency department, primary health care, or discharge to community demonstrates efficiencies.[37] However, in times of high bed capacity, efficiencies are often somewhat reduced, with nurses admitting some patients, erring on the side of caution.[15] A top-heavy, physician-led model demonstrates better throughput efficacies and discharge rates from the emergency department.[12] Furthermore, physicians are 35% less likely to admit patients with acute abdominal pain in times of peak bed capacity.[4,16-18] Nevertheless, to ensure harmony, cater for fluctuations in ED presentations, and maximize cost efficiencies, a physician-nurse-led triage system appears to be most effective in times of access block.[37] Research confirms success of these multimodal Lean principles in emergency departments, with recent global realization of the 4-hour rule on National Emergency Access Target.[12,14,32]

INPATIENT CARE

This category relates to inpatient care processes; communication and coordination are key to considerate care. Applying Lean principles demonstrated in the emergency department that inpatient throughputs including OCP, strategies around fast-tracking radiology, electrocardiograms, and pathology testing improves admitted inpatient flow. When you increase hospital infrastructures, bed numbers, and financial inputs but let these Lean fundamentals slide, as in the case of San Fernando General Hospital in Trinidad, crowding rears its ugly head again, with average LOS increasing by 25%.[11] To address inpatient care coordination and lessen access block, interdisciplinary team care, a 7-days-a-week service model, accountability, discharge before noon (DBN) processes, flexible bed allocations, lateral transfers, and health information management systems prove effective.[7,13,22-29]

TABLE 3
Recommended initiatives to address exit block

Author	Recommendations
Salonga-Reyes and Scott[35]	• Reduced or no RACF entry fees • Penalties against RACFs if refusal to accept eligible clients • Legal sanctions to levy financial imposts • Reinstatement of state public funding for community services • Agreements with providers to offer flexible care arrangements • Addressing family factors of refusal to accept offer of RACF bed
Bryan[41]	• Charge social service departments a daily tariff for delayed discharges
Innes[38] Cadel[39] Bryan[41] Salonga-Reyes and Scott[35] Kneale and Smith[30] Ergas[43] Aronson and Neysmith[46]	Increase choice of community options • with optimization in the home • increase in transitional community packages • increase in residential aged care packages • increase in step down and respite beds

RACF, Residential Aged Care Facilities.

ELECTIVE ADMISSIONS

While ED flow is variable, there are patterns and trends in epidemiology, time, and season that can be mapped to support staff rostering. Staggered elective admissions and staff rostering supports hospital throughputs during the week.[7,36] The Boston Medical Center applied these smoothing of elective surgical principles in 2003 and was able to reduce LOS by 45 minutes, waiting room times by 20 minutes, and cancelled procedures by 99.55%, all while seeing more patients through the emergency department than the year before.[36]

DISCHARGE BEFORE NOON

Simulation models allow one to map out areas for further improvements to inpatient bed access. Through 1-hour improvements in inpatient bed turnover rate, hospitals can reduce ED wait times by 10 hours and number of patients waiting from 11 to 4.[21] The reverse triage process with a push for 50% improvements in discharge documentation orders before noon can lead to an overall mean reduction in ED boarding time of 2.1 hours and ED walk out rates by 32%.[7] By introducing DBN, one can create a 5-year sustainable improvement of 42% discharge rates with no overall increase in readmission rates.[36] DBN supports bed flow and access to inpatient beds.[7,13,21,36]

DISCHARGE LOUNGES

Scholars advocate for the provision of patient lounges to support admission-discharge patient flow and lessen access block.[1,2,4,12,32] Recent research suggests formalizing lounges into hospitality centers whereby a nurse completes paperwork for discharge or, alternatively, admission.[20,34] Hospitality centers have demonstrated positive effects on reduced ED boarding times from a total of 458 hours a month to 368 hours a month, improving front end access and throughputs.[34,39]

ELECTRONIC JOURNEY BOARDS

The introduction of pull systems such as the electronic journey board (JB) allows for more timely referral processes and a degree of transparency in communication. JBs visible to all wards allow unit coordinators to pull patients from the emergency department early, provide timely flags to allied health disciplines for complex presentation management, and offer clarity around expected discharge dates and a central point of tendency.[20] Correct utilization of JBs can reduce LOS by 4.1 days and save the health care sectors $2.6 million annually.[27] However, JBs, like many initiatives, can lose value when placed in inappropriate locations with lack of suitable customizations, interoperability, and a shared vision in their usage.[47]

LATERAL TRANSFERS AND FLEXIBLE BED ALLOCATION

Inter-hospital transfers can support access to health care services. When hospitals are at capacity, supports from like-minded sites can improve ED access and throughputs with no ill effects to overall hospital LOS or patient outcomes.[28,29] However, transferring patients to concurring sites after 4 PM has been identified with a 1-day increased LOS, so it is important to identify suitable transfers, as per discharge processes, before noon.[28] Similarly, for large scale systems experiencing access block, some flexible bed allocations can support efficiencies, although full flexibility is not recommended, as geographic clustering is optimum for timely patient management.[29,36]

COMMUNITY CARE

The final category explores exit block as it positively relates to front end access block. Historically, the National Audit Office estimated a wastage of approximately 2.2 million hospital bed days in the NHS due to discharge delays, at a cost of estimated £170 million a year.[41] In total, delayed discharges accounted for 6% of hospital beds, a universal phenomenon.[41] Most delays were not due to hospital processes but rather attributed to funding approvals for social services, securing a Residential Aged Care Facility (RACF) bed, family dispute matters, and sourcing of appropriate community service providers.[23,35,38,39,41] This phenomenon was supported by more recent research from Salonga-Reyes and Scott,[35] where 44% of bed block was attributed to RACF beds, 13% to guardianship applications, 4% to 5% to administrative processes, 7% to family refusal of care, and 1% to 3% to delays in Aged Care Assessment Team reporting.

THE GROWING PROBLEM

At this point, it is important to note that the population is not only growing but aging too. In 2015, China had 144 million people aged ≥65 years, 10.5% of the total population, with an expectation that this number would double by 2050 to 115 million people aged over 80 years.[42] Similarly, the population aged ≥85 years in the United Kingdom increased from 4.2% to 21% over a 7-year period.[30] Likewise, the Australian population aged >85 years is expected to grow from 500,000 in 2020 to 1.8 million individuals by 2050.[43] To meet the forecasted 2025 growth in Australian aged care, an estimated further 83,100 low care and 87,400 high care RACF beds would be required.[43]

RACF AND INFRASTRUCTURE

Common sense would therefore implore a similar logic as with the ED sector: increase the RACF and disability sector infrastructure to support bed numbers, and the problem will be solved. Increasing availability of long-term care beds by 10% has demonstrated improvements in overall hospital access, reducing acute sector patient LOS by 6% to 9%.[31] However, despite a tripling of RACF bed numbers in China to accommodate for the aged care crisis and support hospitals with bed flow, exit block is not necessarily mitigated, with evidence noting a drop in RACF bed occupancies from 80% to 55% due to private sector prices, patients' lack of insurance, preference, facility location, and quality of care.[42]

CARE NEEDS IN THE COMMUNITY: FAMILIES AND THE CARE GIVER ROLE

Some may query the role of families in supporting exit block, taking loved ones home into their care. In the United States, there are 43.5 million family caregivers aged >50 years, 14.9 million who care for someone with dementia, and only 2.1 million paid formal carers.[44] Similarly, Romania, Czech, Austria, Bulgaria, and Ireland have approximately 10% of the population in informal carer roles, with up to 35% of the population in Greece caring for a loved one.[45] It would appear that government systems have already monopolized on the role of informal and formal carers, "demonstrating how capitalism reorganizes the labour process to make use of free service labour."[46] Tackling backend exit block in support of hospital access therefore appears complex, requiring a multimodal system approach and legislative reforms.

Discussion

This study explores and identifies contemporary approaches hospitals utilize to mitigate access block while ensuring timely patient-centered care. The findings highlight deficits in hospital access and bed flow due to backend exit block and call for government reforms to better optimize one's rights to appropriate care in the community. Most quantitative studies included in this review ranged between 6 months and 2 years, with 1 retrospective study over 5 years.[10-31] A simulation model did support predictive analysis for efficiencies in this scoping review, but unfortunately failed to contextualize real world experiences in a complex adaptive system; and the researcher therefore questioned its value.[17] Many of the studies were unable to demonstrate

independent successes owing to multimodal quality improvement initiatives running in tandem, making it difficult for the researcher to ascertain strengths in ingenuities.[5,7,10,13,16,20,27,32] Furthermore, most quantitative studies were at single sites and may not have been directly transferrable.[10-16,25-27,29] Future researchers should take these weaknesses into consideration when setting criteria for forthcoming scholarly works.

Despite several weaknesses in identified studies, the scoping review still managed to successfully address the research question and identified positive strategies that hospitals adopt to address access and exit block while optimizing patient care. Most quantitative studies pointed to Lean principles in improving overall hospital efficiencies and access block.[5,10-17] This review demonstrated that there have been significant proactive initiatives to address hospital sector ED efficiencies with the introduction of short stay units, the 4-hour rule, physician-led triage, point-of-care testing, fast-track systems, and OCPs.[1,3-5,10-19] The inpatient sector has demonstrated improved efficiencies on LOS through information sharing and communication with MDT meetings and journey boards, 7-days-a-week service, DBN processes, smoothing of elective admissions, reverse triage due to OCP, lateral transfers, and transit lounges.[12,20-29,36] All of these initiatives demonstrated evidence in support of access block mitigation.

The literature addressing backend exit block, however, was mostly narrative in nature, prone to bias, yet still managed to raise cause for concern.[41-48] The lack of scholarly quantitative references providing evidence-based solutions to address this bottleneck was evident. The author recognized this deficit and therefore attempted to offer possible solutions based on evidence through recommended initiatives (Table 3).[30,35,38,39,41,43] Despite this weakness, the scoping review still managed to clearly highlight aged care's role in 44% of backend bed block and the need for government supports, research, and reforms.[35]

STRENGTH OF STUDY

The strength of this study is in the identification and confirmations of proactive evidence-based initiatives that hospitals can and do adopt to reduce LOS and improve access block. The review, however, pointed to the need for further research and development in the backend. The study follows the PRISMA-ScR checklist, supporting strengths in literary findings.[9]

Limitations

As per Joanna Briggs Scoping Guidelines,[8] there are limitations to this study. The study did not extend to all relevant databases or non-English text owing to the expanse of literature and time constraints of the university trimester. Unlike the systematic reviews, the quality of the included studies was not apprised in this scoping review. The researchers attempted to mitigate any biases by referring to peer reviewed scholarly works throughout to define the problem of access block and remain solution focused.

Implications for Emergency Nurses

This review demonstrates the need to explore research in backend exit block. Through extrapolation of epidemiological data, researchers can define and map out maintenance care type inpatients, local hospital and nursing home/disability care bed capacities, community social service packages, and resources available. Once charted, global comparisons in support of identifying evidence-based efficient practices for future legislation and policy formulation can be synthesized.

Conclusion

There are many strategies that health services can and do adopt to improve patient access to critical services and progress patient bed flow and care while lessening exit block. Through the multimodal application of Lean processes across systems, health care services are demonstrating improved efficiencies in combating access block in the emergency department and inpatient setting. However, there are some bottlenecks that sit beyond health services remit; access to care in the community seems to be health care's Achilles' heel. At this stage, there needs to be some acknowledgment from governments that exit block cannot be separated from access block. Health sectors require government support to address this backend block. Through accountability and evidence-based research, governments can successfully map out existing resources and identify models of care that support fiscal pressures while ensuring optimal patient care and flow at the backend. Backend exit block research and policy reform need to be at the forefront of health and the governments' agenda.

Author Disclosures

Conflicts of interest: none to report.

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Hypertriglyceridemia-Induced Pancreatitis and a Lipemic Blood Sample: A Case Report and Brief Clinical Review

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NCPD Earn Up to 9.5 Hours. See page 492.

Abstract

Hypertriglyceridemia is the third most common cause of acute pancreatitis after gallstones and long-term alcohol use. There are specific therapeutic options unique to hyperglyceridemia-induced pancreatitis, such as continuous insulin therapy and plasmapheresis, emphasizing the importance of identifying hypertriglyceridemia as the cause. Triglyceride levels > 1000 mg/dL may result in a visibly lipemic blood sample. Lipemic samples may interfere with laboratory equipment, resulting in erroneous levels or the inability to measure several serum blood tests. Consider hypertriglyceridemia as a cause for acute pancreatitis in the setting of a lipemic blood sample or when gallstones have been excluded.

Key words: Hypertriglyceridemia; Pancreatitis; Lipemia; Insulin; Plasmapheresis; Laboratory

Introduction

Hypertriglyceridemia (HTG) is the third most common cause of pancreatitis after gallstones and chronic alcohol use.[1] Identifying HTG as the cause is essential because there are specific therapeutic options unique to hyperglyceridemia-induced pancreatitis (HTGP), such as continuous insulin therapy and plasmapheresis.[2,3] These specific therapies typically warrant admission to a critical care setting. The case that follows was a patient with HTGP with a cloudy blood sample noted by the emergency nurse, an early clue to the underlying etiology. The laboratory reported the sample to be severely lipemic and encountered difficulty running most of the blood chemistry. The patient had a triglyceride (TG) level > 5000 mg/dL (normal < 150 mg/dL). He was admitted to the intensive care unit for severe epigastric pain, where he received an insulin infusion to decrease his TG level. Obtain a TG level early in the clinical course when considering HTG as a cause for acute pancreatitis. Long-term alcohol use is associated with HTG; therefore, suspect HTG as a cause of acute pancreatitis in the setting of a lipemic blood sample or when gallstones are ruled out.

Case Presentation

A 23-year-old previously healthy male presented to the emergency department with an abrupt onset of severe, intolerable epigastric abdominal pain with multiple episodes of nonbloody emesis that started shortly after eating a high-fat meal. He denied alcohol and illicit drug use. The initial vital signs were an oral temperature of 36.7 °C (98.2 °F), a heart rate of 118 beats per minute, a respiratory rate of 22 breaths per minute, a blood pressure of 147/92 mm Hg, and a pulse oximetry of 98% on room air. His body mass index was 24. The examination was remarkable for diffuse upper abdominal pain with guarding. There was no McBurney point tenderness, and there was a negative Murphy sign. As the abdominal pain workup was begun, the emergency

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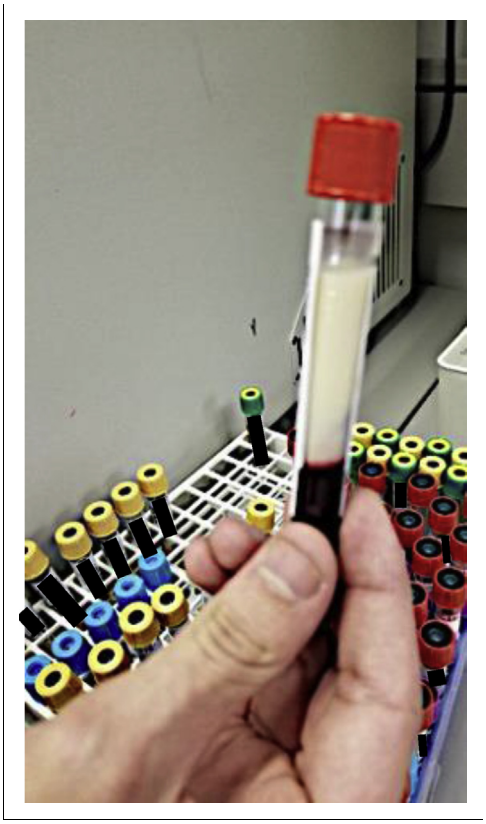

FIGURE 1

Lipemic blood sample drawn from the patient before centrifugation and analysis. Note the serum component of the sample is visibly opaque and milky, not the normal clear straw color.

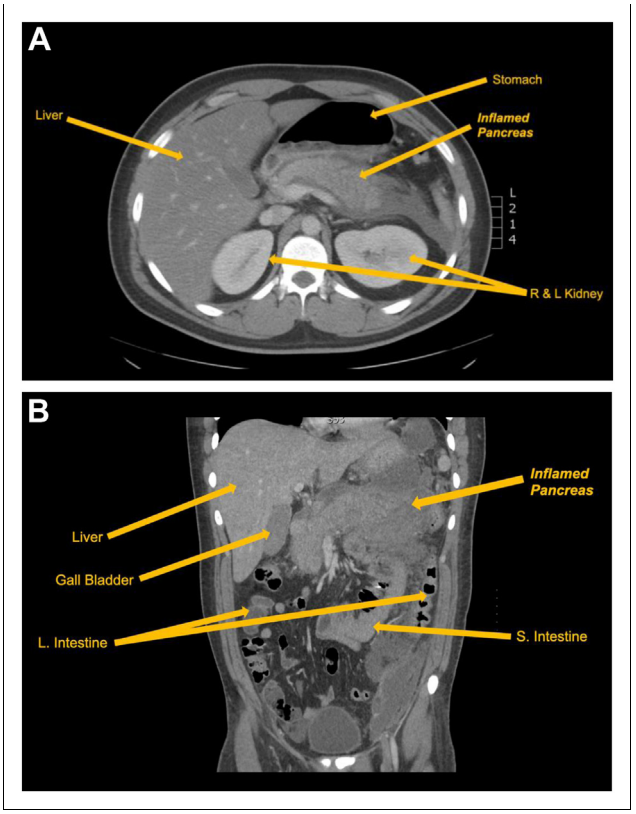

FIGURE 2

(A) Axial and (B) coronal CT scan with IV contrast of the patient showing an edematous pancreas with indistinct borders. The normal pancreas has well-defined borders on a CT scan with IV contrast. L. Intestine, large intestine; R and L Kidney, right and left kidneys; S. Intestine, small intestine; CT, computed tomography; IV, intravenous.

nurse noted a cloudy-appearing blood sample. Shortly thereafter, the laboratory called the emergency department reporting they could not analyze a significant proportion of the blood chemistry as a consequence of severe lipemia and sent a picture of the patient's blood sample shortly after receiving it from the emergency department (Figure 1).

Diagnosis and Treatment

The laboratory initially reported a complete blood count, sodium, potassium, calcium, albumin, and bilirubin. The chemistry analyzer could not report results for the remainder of the hepatic function panel or renal function panel, including a glucose, lipase, and creatinine level. A TG level was ordered because of the lipemic sample. The initial laboratory results were notable for a mildly low sodium and potassium, a normal bilirubin, a white blood cell (WBC) count of 9.0 $\times$ 10^9/L (reference range [RR] 3.8-10.6), a hemoglobin of 20.0 g/dL (RR 13.5-17.5), and a hematocrit of 45.7% (RR 41-53).

A right upper quadrant ultrasound was ordered to evaluate for biliary disease. It showed signs of severe hepatic steatosis without any signs of biliary disease such as cholecystitis or cholelithiasis. The pancreas was not visualized because of overlying bowel gas. As the patient's pain continued, he was administered intravenous (IV) fluids and IV acetaminophen, ketorolac, and ondansetron for pain and nausea.

With a right upper quadrant ultrasound without observed acute pathology to explain the patient's pain, the decision was made to obtain a computed tomography (CT) scan with IV contrast. The CT scan showed severe pancreatitis without biliary disease, such as gallstones, cholecystitis, choledocholithiasis, cholangitis, or complications such as pancreatic necrosis or pseudocyst (Figure 2). No other pathology was seen, such as small bowel obstruction, perforated peptic ulcer, appendicitis, ureterolithiasis, or pyelonephritis.

TABLE
Diagnostic criteria for AP and features of hyperglyceridemia-induced pancreatitis

Diagnostic criteria for AP (2 of 3 criteria required)[1]	1. Upper abdominal pain 2. Serum amylase or lipase > 3 times the ULN 3. Radiologic imaging consistent with AP
Features of HTGP[2]	1. Criteria for AP 2. May have normal or high serum amylase or lipase* 3. Elevated TG levels† ≥ 500 mg/dL‡ or ≥ 1000 mg/dL§ 4. May have lipemic serum, xanthomas, or metabolic syndrome

AP, acute pancreatitis; TG, triglyceride; HTGP, hypertriglyceridemia-induced pancreatitis; ULN, upper limit of normal.

* Lipase is more sensitive than amylase in pancreatitis associated with hypertriglyceridemia. Pancreatic enzyme levels may be falsely low caused by elevated TG, if not corrected by the laboratory.

† Serum TG samples must be drawn within 24 hours of clinical presentation, or at time or arrival to health care facility for accurate evaluation.

‡ High suspicion of HTGP in the absence of other identified pathology.

§ Strongly supports the diagnosis of HTGP.

After CT imaging, the laboratory was able to provide some additional results. They reported a corrected WBC count and hemoglobin levels of 15.3 × 10^9/L (RR 4.5-11.0 × 10^9/L) and 16.8 g/dL (RR 13.5-17.5), respectively, and an elevated serum lipase of 1558 U/L (RR 22-51). The analyzer was unable to report an initial TG level.

A diagnosis of acute pancreatitis was made with the patient's symptoms, elevated lipase, and supportive imaging (Table).[1] Supportive treatment continued with IV fluids, analgesic agents, and antiemetic agents given in the emergency department. The patient had poor control of pain, despite IV acetaminophen, ketorolac, morphine, and HYDROmorphone, leading to admission to the intensive care unit for a continuous ketamine infusion. Just before admission, the laboratory reported a severely elevated TG level of 5794 mg/dL (normal < 150 mg/dL), confirming HTG as the etiology of acute pancreatitis, consistent with a more specific diagnosis of HTGP. After admission (and initial fluid resuscitation), the patient's glucose level was found to be 275 mg/dL (RR 74-118) without an elevated anion gap. In addition to supportive treatment and the ketamine infusion, the patient was treated with an infusion of regular insulin at 0.1 U/kg/h to lower TG and glucose levels while avoiding hypoglycemia with a 5% dextrose IV solution. The patient's TG level was checked every 8 to 12 hours and decreased to 453 mg/dL by the fourth day of inpatient stay. The patient's initial hemoglobin A1C was 11.5% (RR 4.0-6.4), and he was subsequently diagnosed as having type 2 diabetes mellitus. He was later discharged from the hospital with a long-acting insulin, a statin for hyperlipidemia, and fenofibrate for HTG.

Discussion

Acute pancreatitis is commonly diagnosed in the emergency department and is the most common gastrointestinal illness resulting in hospital admission in the United States.[4,5] Although gallstones and alcohol abuse are the most common etiologies of acute pancreatitis, HTG is an underrecognized etiology with an increasing incidence that may be present in up to one-third of cases of acute pancreatitis.[1,6] HTG should be considered when biliary disease is excluded because long-term alcohol use is a risk factor for HTG.[2] Additional risk factors for HTG include the following: uncontrolled diabetes, pregnancy, poor diet, and certain medications.[2,7]

A TG level of 1000 mg/dL or greater is generally required to support a diagnosis of HTGP.[8] A TG level should be checked as soon as possible after HTGP is suspected (ideally within 24 hours of presentation), because a fasting state and IV fluids (standard interventions in moderate to severe pancreatitis) can decrease TG levels to below a threshold in which HTG may be suspected as the etiology.[2] This may lead to an inappropriate diagnosis of idiopathic pancreatitis.[2]

Although laboratory results play a significant role in diagnosing and managing HTGP, lipemic blood samples can complicate the diagnostic process via interference in laboratory equipment. Moderate to severe lipemia (TG levels > 500-1000 mg/dL) may cause erroneous levels of hemoglobin, WBC count, creatinine, lipase, and multiple electrolytes.[9-12] HTG commonly causes laboratory analyzers to increase hemoglobin, decrease WBC count, and decrease electrolyte levels, as was seen in the case presented here.[9-12] Of note, the point-of-care blood analyzer i-STAT (Abbott Point of Care Inc, Princeton, NJ) analyzes whole blood using an electrochemical method and reports elevated TG levels (> 900 mg/dL) do not interfere with any values on its Chem8+ cartridge except for blood urea nitrogen (falsely increases).[13] This is a potential solution to obtaining laboratory results more expeditiously in the setting of HTG but was not available in this case.

The most common causes of lipemic samples are inadequate fasting, recent ingestion of a high-fat meal, HTG, and recent IV lipid emulsion therapy.[14] Individual

laboratories should have protocols for reporting lipemic samples and may be able to run some tests on lipemic samples after ultracentrifugation or the addition of lipid-clearing reagents.[14] Visualizing lipemia in whole blood samples can be tough, even when TG levels are > 1000 mg/dL[15]; therefore, visual inspection alone cannot rule in or out HTG. However, when a sample appears visibly lipemic, the treatment team should be notified and consider obtaining a TG level, because it may affect management.

Current efficacious treatment options specific to HTGP include plasmapheresis and insulin therapy.[2,3,16,17] These rapidly reduce TG levels and are generally continued until TG levels decrease to < 500 mg/dL.[2,16,17] Existing literature suggests plasmapheresis can lower TG levels faster than insulin therapy; however, there are no current data suggesting improved outcomes of one therapy over the other.[18,19] Some recommendations favor plasmapheresis over insulin therapy; however, randomized controlled trials comparing these treatments are lacking.[18,20] Filtration plasmapheresis requires central venous access, is more resource intensive than insulin therapy, and generally requires a nephrologist or intensivist to manage.[2,16,21] Insulin therapy is most often administered through continuous infusion at 0.1 to 0.3 Units/kg/hour while preventing hypoglycemia with a dextrose infusion, very similar to established protocols for diabetic ketoacidosis.[17] In patients with uncontrolled diabetes and HTGP, insulin therapy has the additional benefit of safely treating both the hyperglycemia and the HTG.[22] IV heparin is a treatment previously used in HTGP in conjunction with insulin but has fallen out of favor owing to a lack of supportive evidence and data suggesting that its TG-lowering properties are transient and overall may lead to elevations in TG levels.[23,24]

Awareness of the specific treatment options along with HTGP's recurrent nature underscores the importance of recognizing this etiology in patients with acute pancreatitis. Consider HTG as a cause for acute pancreatitis in the setting of visibly or laboratory-confirmed lipemic blood sample or in a patient without gallstones on imaging studies. To prevent missing or delaying this diagnosis, obtain a TG level early, ideally within 24 hours.

Author Disclosures

Conflicts of interest: none to report.

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 Army, Department of Defense, or the US Government. The authors adhered to all aspects of Elsevier's Patient Consent Policy.

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ENA Position Statement: Hemorrhage Control

NCPD Earn Up to 9.5 Hours. See page 492.

EMERGENCY NURSES ASSOCIATION

Description

Uncontrolled external hemorrhage is a common cause of preventable death and is increasingly recognized as a serious public health concern.[1-5] Bleeding can be a life-threatening emergency, causing death within minutes. Immediate bystander intervention is critical to controlling bleeding, minimizing blood loss, and saving lives.[3,6] In recent years, active shooter and terrorist attacks using knives and explosive devices have highlighted the need for strategies to deal with uncontrolled external hemorrhage at the incident scene.[2,7,8] Delays in clinical intervention are due to the emergency service response time and personnel restrictions related to safety concerns at the scene.[3,9] As a result, multiple strategies have been devised to enable bystanders to control the bleeding until emergency medical services (EMS) arrive and transfer the patient to a definitive care facility.[4,10] Nurses may take on numerous roles within these scenarios, including applying hemorrhage control techniques within their scope of practice, being involved in community injury prevention programs, and researching and evaluating hemorrhage control interventions.[5] Ultimately, the involvement of all nurses, not just emergency nurses, in hemorrhage control is an opportunity to save lives.

Emergency nurses have a critical public health and educator role within any hemorrhage control strategy.[11,12] Key areas of responsibility include professional education and community collaboration based on evidence and research into the effectiveness of hemorrhage control interventions. The literature provides examples of nurses working within a public health and injury prevention role by educating and empowering their local community in Stop the Bleed techniques and promoting the accessibility of hemorrhage control kits. These actions may improve clinical outcomes.

ENA Position

It is the position of the Emergency Nurses Association that:

1. Hemorrhage control techniques such as direct pressure, the application of topical hemostatic agents, and tourniquet application are part of all nurses' scope of practice.
2. Emergency nurses promote and participate in public awareness campaigns and advocate for hemorrhage control education and training for health care workers and laypeople.
3. Emergency nurses collaborate with other disciplines and specialties, including EMS and other first responders to develop, implement, and evaluate hemorrhage control strategies.
4. Injury prevention community education, particularly in schools and other places where large volumes of people congregate (ie, athletic facilities, concert venues, universities), includes emergency nurses.
5. Emergency nurses advocate for the deployment of bleeding control kits in readily accessible public areas such as airports, schools, and stadiums.
6. Emergency nurses are involved in the development of evidence-based hemorrhage control guidelines, policies, and procedures and contribute to hemorrhage control research.

Background

Severe penetrating injuries can result in life-threatening blood loss within 5 minutes.[9,13] Uncontrolled bleeding remains the primary cause of death in 35% of trauma patients,[2,3,13] and evidence suggests that 57% of traumatic hemorrhagic deaths could be prevented through bystander intervention using basic bleeding control methods.[4,10]

In 2013, as a result of an increase in mass casualty incidents, particularly the Sandy Hook Elementary School shooting, the American College of Surgeons convened a multidisciplinary meeting to develop a strategy to reduce death and injury from penetrating trauma in an out-of-hospital environment.[14] The expert group published a document titled The Hartford Consensus directing all responders, both health care and civilian, to undertake additional education and increase their access to the necessary equipment to control severe bleeding at the incident scene.[14] The consensus documents aimed to increase survival from these penetrating trauma injuries by making military bleeding control materials available within a civilian setting. The Hartford Consensus recommendations include the application of tourniquets and wound packing, materials

and skills previously considered unsuitable for a civilian setting. The transfer of these skills empowers community bystanders to take an active role as first responders.[8,14,15]

In 2015, the United States government launched its aforementioned Stop the Bleed campaign[16] based on the findings of the Hartford Consensus.[14] The Stop the Bleed initiative is an essential component of a multidimensional approach to controlling hemorrhage and reducing death at the scene. A key aspect of this initiative is the empowerment of the community to undertake an injury prevention role, particularly in schools and other places where large volumes of people congregate.[3,8,14] Civilian bystanders act as first responders, implementing bleeding control interventions while awaiting the EMS. Key components of this strategy include education on the practical aspects of hemorrhage control, civilian access to appropriate equipment such as tourniquets and hemostatic dressings, bleeding kits, and the ability to coordinate transportation of the patients to a receiving trauma center in a timely manner.[4,17-19] To achieve this goal, training programs for control of hemorrhage need to be available to the public and offered by employers to schools and universities, religious groups, and other community facilities with a large footfall of people. The aim is to ensure that hemorrhage control education is widely available and as universally recognized as cardiopulmonary resuscitation (CPR) and automated external defibrillators (AED) training and forms an integral component within the chain of survival in penetrating traumatic injury. The skills to control hemorrhage are simple, evidence-based, and relatively easy to teach to a large number of people, and most importantly, to potentially save lives.

The increasing incidence of international mass casualty events (New Zealand–2019, Manchester–2017, Paris–2015, Sri Lanka–2019) and active shooter incidents (Las Vegas–2017, Orlando–2016, Pittsburgh–2019, Stoneman Douglas High–2018) demonstrate the need for community focused initiatives to address the risk of hemorrhage.[20-23] There have been at least 558 gunshot incidents within school grounds nationally, with an average of 19 mass shootings a year since 2013.[24] In 2019, there were 39,707 fire-arm related deaths in the United States.[25] Emergency planning, incorporation of prevention, and development of risk assessment and response plans should occur in all areas where large volumes of general public congregate such as schools, places of employment, sporting events, concerts, and shopping malls.[26-28] Retrospective incident reviews highlight the critical period of community response time between the incident and the EMS intervention.[3,29,30] This time period is when traditional responder roles are adopted and the community responder role is activated. In October 2017 in Las Vegas, during an active shooter incident in which 58 people died, over 30 minutes elapsed before health care providers were able to assess and treat patients.[6] The independent review of the Manchester terrorist attack in the United Kingdom notes that training the general public in first aid, including hemorrhage control, provides the emergency services with a large pool of potential volunteers who can offer direct assistance to the injured.[30] In 2019, at least 12 states introduced or passed legislation to inform, educate, and empower their citizens to become immediate responders who can save a life in the event of a bleeding emergency.[31]

The role of laypeople in responding to community health emergencies is increasingly acknowledged and is recognized as a key component in the chain of survival. Many studies establish the effectiveness of training the general public in CPR and AED use to saves lives.[3,32,33] There are numerous similarities between public access defibrillators and the Stop the Bleed initiative.[2] These similarities include placing hemorrhage control kits in easily accessible areas where large numbers of people congregate, ensuring that bystander equipment is easy to understand in an emergency situation and for ongoing maintenance and audit requirements.[3,4,18,34] In response to this initiative, at least 8 states (California, Illinois, Indiana, Missouri, North Carolina, New York, Tennessee, and Texas) introduced legislative bills that mandate that hemorrhage control kits be readily available in public schools and other government facilities.[35] Collectively, evidence in the literature supports the use of Stop the Bleed kits. However, a real-world limitation is the lack of enforcement of the equipment's quantity, placement, and contents.[7] Jacobs[14] suggests that Stop the Bleed kits should minimally include an effective tourniquet, compressive dressing, rolled gauze, trauma shears, and nitrile gloves.[7,36] Emergency planning teams should equip public sites with bleeding control supplies for a minimum of 20 people, with larger venues planning for larger number of patients.[7] When preparing for distribution, important considerations are ongoing mandatory training and monitoring and maintenance of supplies and equipment.

Tourniquet application is a crucial component of hemorrhage control.[3,7,9] Historically, tourniquets were not applied outside of the military owing to the risk of prolonged ischemia due to incorrect or inappropriate placement.[2,37,38] Current evidence demonstrates that amputation is rarely necessary, and the benefits of reducing bleeding and saving lives from tourniquet application outweigh the potential risk.[10] Goolsby et al[7] acknowledged a greater than 4-fold increase in mortality from hemorrhagic shock for patients who had tourniquets placed after arrival at hospital compared with application at the incident scene. This finding has important clinical and practical implications for educating the general public and reviewing

traditional role responses for health care workers. The American College of Surgeons Committee on Trauma and the Hartford Consensus directs that all professional responders have the education and necessary equipment to apply tourniquets and topical hemostatic agents in civilian settings.[14,16] Similar initiatives exist globally, including Citizen Aid in the United Kingdom.[39,40] Good Samaritan protection is extended to include bleeding control interventions by bystanders, to encourage a willingness to respond.[8,14] Evidence suggests that individuals require access to ongoing training to increase recall of this relatively rarely used skill to enable an increase in confidence and competence and willingness to respond and to reduce barriers to intervention.[2,9,17]

Hemorrhage control techniques, including the use of tourniquets and hemostatic agents, should be incorporated into undergraduate nurse education and ongoing nursing education as a component of their injury prevention role.[34,41,42] Controlling hemorrhage in the community setting is a public health priority and is essential as a part of the patient's chain of survival. Evidence supports the application and use of tourniquets and hemostatic agents to be included in every licensed nurse's educational preparation and scope of practice[43] and should be considered a component of essential clinical skills such as CPR and AED use. Education and familiarization with bleeding control techniques and equipment can improve the individual's willingness to respond, increase user's confidence, and ultimately improve clinical outcomes.[44,45] Emergency nurses have an opportunity to lead the way in controlling emergency hemorrhage through empowering and educating community members and collaborating with community partners, businesses, and local EMS colleagues.

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New Light on the Person With the Lamp: Tales from Shanghai, China

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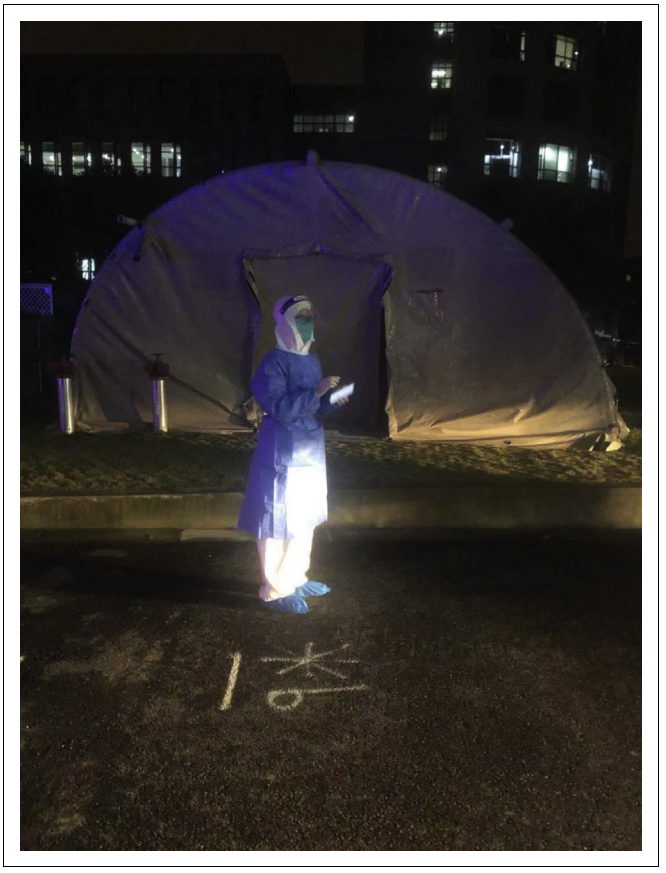

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It was a cold winter night when a hospital in Shanghai had to be urgently shut down because of the epidemic. Our hospital was called upon to receive patients referred from the closing hospital and to perform nucleic acid testing on the personnel involved. All of our emergency nurses canceled their vacations and arrived at the hospital overnight to work overtime. Our hospital has again adopted the mobile hospital we used in Shanghai and Wuhan during the early stages of the outbreak.[1]

The picture shows a nurse standing outside the mobile hospital holding the mobile equipment waiting for the patients who will be transferred from the closed hospital. The faint light is so bright in the cold winter night that it makes

people feel hopeful and warm. Such a picture cannot help but remind me of the legendary person with the lamp, the pioneer of nursing—Florence Nightingale. Déjà vu. Generation after generation of nurses are just like this. They take the lamp from their predecessors and pass it on from generation to generation.

For countless days and nights since the outbreak of the epidemic, emergency nurses have always stood on the front line. In this battlefield without fire, they are the person with the lamp of today. While continuing the practice tradition from the time of Nightingale's Pledge, they also write their own pledge now: "Learn for dispelling disease, Moralize for promoting benevolence, Unite for overcoming difficulties, Love in the world. We are not only the person with the lamp, we ourselves are the brightest source of light - burning ourselves and illuminating others."

We dedicate this to the nurses who have been fighting on the front line and thank them for their effort and dedication. We believe that the epidemic will eventually pass and we will triumph together.

Author Disclosures

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A Cross-sectional Study of Self-Perceived Educational Needs of Emergency Nurses in Two Tertiary Hospitals in Nairobi, Kenya

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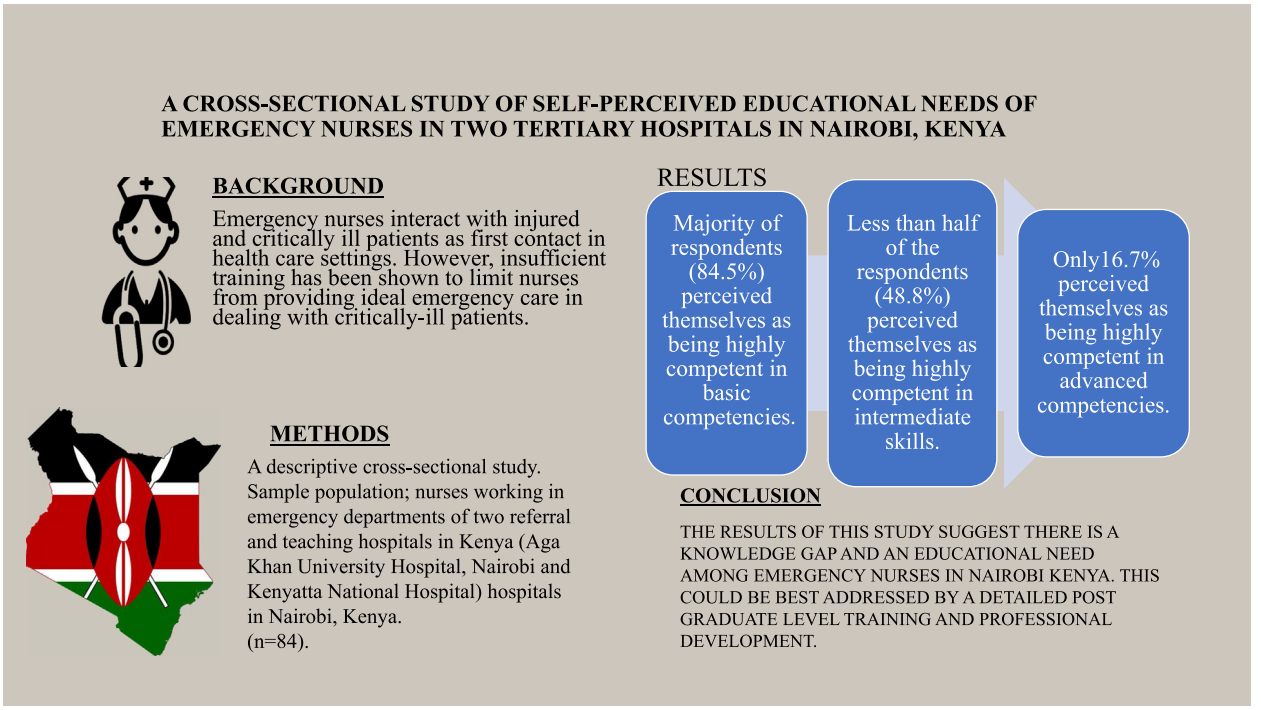

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A Cross-sectional Study of Self-Perceived Educational Needs of Emergency Nurses in Two Tertiary Hospitals in Nairobi, Kenya

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Abstract

Background: Many low- and middle-income countries lack resources for well-functioning emergency care systems. Emergency nurses interact with injured and critically ill patients as the first contact in many health care settings. However, insufficient training limits nurses from providing ideal emergency care. The purpose of this research was to highlight educational needs specific to nurses working in 2 emergency departments in Nairobi, Kenya.

Methods: A descriptive cross-sectional study involving emergency units of 2 of the largest referral and teaching hospitals (Aga Khan University Hospital, Nairobi, and Kenyatta National Hospital) in Nairobi, Kenya, was conducted. Data were collected by using an adapted structured, self-administered questionnaire. The data were analyzed using descriptive statistics. The skills and competencies of the participants were assessed. In addition, the educational gaps and needs of the participants around emergency care such as trauma, cardiovascular diseases, and respiratory and neurological illnesses were described. Results were presented in frequencies and percentages.

Results: The questionnaire response rate was 63.6% (n = 84). Most of the respondents held associate degrees in nursing (72.6%), whereas 19% had a bachelor's degree in nursing. Most respondents (84.5%) perceived themselves as being highly competent in basic skills such as performing cardiopulmonary resuscitation and assessment of body systems. Less than half of the respondents (48.8%) perceived themselves as being highly competent in intermediate skills such as assisting with endotracheal intubation. In advanced competencies, such as analyzing electrocardiograms and administering thrombolytic medications, only 16.7% perceived themselves as highly competent.

Conclusion: The results of this study suggest there is a knowledge gap and educational needs among emergency nurses in Nairobi, Kenya. It identified injuries/trauma; cardiovascular, respiratory, and neurological disease; and other emergencies as topics of focus areas with a high need. To address these knowledge and skills needs, a future specialty training in emergency nursing is recommended and this could be achieved through continuing professional development and short courses or postgraduate-level training.

Key words: Emergency nursing; Emergency department; Emergency nursing services; Nursing education; Kenya

Background

Emergency care remains one of the least developed aspects of health care in low- and middle-income countries (LMICs) because many of these countries lack coordinated systems and have limited resources.[1] If efficiency and organization of emergency care were improved in LMICs, more lives could undoubtedly be saved, despite emergency care's limitations in LMICs compared with high-income countries.[2] Even though communicable and maternal causes of death have decreased sharply globally as a proportion of total deaths in global disease burden, they still remain common causes in LMICs[3] with approximately 90% of the injury burden occurring in LMICs.[4]

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The need for emergency care improvements is particularly relevant in LMIC sub-Saharan Africa. In Kenya, the leading causes of mortality related to disease processes are communicable with HIV/AIDS, lower respiratory tract infections, and diarrheal diseases.[3] Kenya, like other developing countries, has seen a rise in fatalities from injury throughout the past 40 years, which can be partially credited to the lack of a comprehensive emergency trauma care system.[5] More specifically, Nairobi (the capital city) has seen a dramatic increase in building collapses in the recent past, adding to the overall burden of injuries.

Nurses make up the largest group of health care workers and form the backbone of health care delivery in Africa and are often the first health care professionals to manage a severely injured or critically ill patient.[1] Emergency nurses need an advanced skill set and in-depth clinical knowledge for effective management of their patients.[6] The capability of emergency nurses to promptly identify signs and symptoms in patients who are acutely sick is critical to provide safe patient care. Globally there are no uniform guidelines that direct the level of education that is required to work in nursing roles in emergency departments.

Australia, Canada, New Zealand, the United Kingdom, and the United States have well-established emergency nursing competency standards and advanced practice roles, including emergency nurse practitioners who require graduate education for qualification, certification, or registration.[7] Emergency nursing in Africa is progressing, but is confined by limited resources.[8] Previous studies demonstrate inadequate basic emergency skills, course knowledge, and exposure to emergency departments in nursing undergraduate training programs in Africa.[9] Formalized specialist emergency care is developing in many African countries such as Kenya, but many of these countries have not yet established emergency nursing as a nursing specialty.

Addressing these educational deficits through an African emergency nursing curriculum has been a challenge owing to a lack of resources, communications challenges and disruptions, low educational uptake, and a lack of monitoring and evaluation initiatives.[8] Patients with various clinical presentations to the emergency department are evaluated by health care providers of different medical specialties but all of these patients will still interact with emergency nurses during their care. Therefore, emergency nurses need a higher-level skill set and in-depth knowledge to manage these patients' care effectively.

According to a study conducted in Dar es Salaam, Tanzania, nurses lacked knowledge and skills pertaining to patient's triage assessments in emergency departments.[2] This knowledge and skill gap is concerning because triage in emergency departments is key for patient prioritization and may influence patient outcomes. A different study in South Africa found that only 2 of their sampled nurses (n = 128) working in the emergency department had formal training in emergency nursing. Almost half of these respondents (48%) had low self-perceived competency levels.[6]

Emergency nurses need advanced expertise and vast clinical knowledge to enable them to manage and provide effective patient care, which demonstrates a need for continuing educational advancement and ongoing professional development among Kenyan emergency nurses. This study aimed to describe self-perceived educational needs of nurses working in emergency departments in Nairobi, Kenya. Specific objectives entail (1) describing levels of perceived competencies among emergency nurses, (2) identifying the educational needs of nurses working in emergency units in Nairobi, Kenya, and (3) determining potential means of addressing these gaps.

Methods

DESIGN

This was a descriptive, cross-sectional study describing the self-perceived educational needs and competency levels among nurses working in emergency departments in Nairobi, Kenya. Data were collected in December of 2019.

SETTING

The setting of the study included the emergency units of 2 of the largest referral and teaching hospitals in Kenya. Of the 2 hospitals in Nairobi chosen to be part of this study, Aga Khan University Hospital, was privately funded, and Kenyatta National Hospital was state owned and funded. These 2 hospitals were selected because they have busy 24-hour emergency units with 200 to 250 daily patient visits and serve as major trauma and referral centers for Nairobi and Kenya as a country.

STUDY POPULATION

The target population were nurses working in the emergency departments of the 2 hospitals working in both adult and pediatric emergency departments. At the time of data collection, Aga Khan University Hospital employed 60 registered nurses and Kenyatta National Hospital employed 95 registered nurses in their emergency departments. All nurses are licensed by the Nursing Council of Kenya

(NCK) by means of a state board examination after nursing education training.

The inclusion criterion for the study was registered and enrolled nurses (enrolled nurses are nurses providing nursing care under the direction and supervision of a registered nurse and are licensed by the NCK; their roles are similar to licensed practical nurses in the US or nursing associates in the United Kingdom) in the emergency department of the 2 study sites who were directly involved in patient care. Those excluded were nurse managers, nurses not involved in direct patient care, and student nurses in the emergency departments.

SAMPLING

Convenience sampling was used to include all nurses who were available, directly involved in patients care and willing to participate.

DATA COLLECTION

The data collection tool was an adapted structured, self-administered questionnaire developed by Dulandas and Brysiewics[6] who also approved its use and adaptation. The validity of the tool has been assessed by specialists in emergency care in Ghana and the US.[6]

VARIABLES

Knowledge and skill competencies of emergency nurses can be defined in 3 stages: basic, intermediate, and advanced.[10] Basic skills are the fundamental knowledge an emergency nurse should have, such as performing cardiopulmonary resuscitation (CPR) and assessment of body systems. Intermediate skills are gained with experience and higher levels of knowledge, such as assisting with endotracheal intubation. Advanced skills such as analyzing electrocardiograms and administering thrombolytic medications involve knowledge application and critical reasoning gained through experience and specialty level training.[6] Competency levels were self-rated as least competent (1 score), competent (2 scores), and highly competent (3 scores). A higher score indicated higher self-perceived competence. The skills were categorized as basic, intermediate, and advanced skills.

Educational needs were rated in relation to 5 areas, namely trauma, cardiovascular, neurological, respiratory, and other emergency topics. The respondents were asked whether they agreed they had an educational need. Agreed scored 3 points, neither agree nor disagree scored 2 points, and disagree scored 1 point. Hence, the higher the score, the higher the educational needs.

TABLE 1
Number of participants per study site and their years of experience

Variable	Frequency (n = 84)	%
Site		
Study site 1	37	44
Study site 2	47	56
Years of experience		
0-11 mo	20	23.8
1-2 y	15	17.9
2-5 y	21	25.0
> 5 y	28	33.3

PROCEDURES

Appointments were made with the nursing managers of the respective units to contact their nurses and observe all due institutional protocols. Data were collected by research assistants by directly distributing paper questionaries to the nurses. All filled questionnaires were returned to the research assistant who then handed them over to the principal investigator and stored in a lockable cabinet. The questionnaires were stored in the lockable cabinet held by the principal investigator until they were entered into a password-protected and encrypted database.

ETHICAL CONSIDERATION

Permission and ethical approval to conduct the study were sought and granted by the Aga Khan University Ethics Committee, the research Committee of Kenyatta National Hospital/University of Nairobi, and National Commission for Science, Technology and Innovation. A written informed consent was obtained from each respondent prior to data collection.

DATA HANDLING AND ANALYSIS

Data were analyzed using the SPSS, version 20 (IBM SPSS Statistics). Descriptive statistical techniques were used to analyze the data, and the results were presented using frequencies and percentages. There were questions with incomplete responses that were missing at random. Missing

TABLE 2
Perceived competency levels (N = 84)

Basic skill	Highly competent		Competent		Least competent	
	n	%	n	%	n	%
Able to administer oxygen: cannula, mask, bag valve mask	77	91.7	7	8.3	0	0
Able to assess circulation: pulses, skin color, capillary refill, blood pressure, signs of bleeding	73	86.9	10	11.9	1	1.2
Able to assess breathing: rate, effort, cyanosis	68	81	16	19	0	0
Able to assess mental status: monitor Glasgow coma scale	66	78.6	17	20.2	1	1.2
Able to perform cardiopulmonary resuscitation	62	73.8	21	25	1	1.2
Intermediate skill	**Highly competent**		**Competent**		**Least competent**	
	n	%	n	%	n	%
Able to control hemorrhage: apply tourniquet, fracture splint, pelvic wrap	50	59.5	30	35.7	4	4.8
Able to manage shock: obtain intravenous/ intraosseous access and administer fluids	47	56.0	33	39.3	4	4.8
Able to prepare and assist with endotracheal intubation	47	56.0	30	35.7	7	8.3
Able to prepare and administer drugs in cardiac arrest	45	53.6	34	40.5	5	6
Able to prepare and administer thrombolytics	30	35.7	37	44	17	20
Able to administer local anesthetic and apply sutures	029	34.5	39	46.4	14	16.7

continued

TABLE 2
Continued

Intermediate skill	Highly competent		Competent		Least competent	
	n	%	n	%	n	%
Able to obtain and interpret electrocardiograms: detect arrhythmias eg, atrial fibrillation	29	34.5	36	42.9	19	22.6
Able to perform cardioversion/ defibrillation	20	23.8	41	48.8	23	27.4

data were caused by nonresponse from the study participants and were excluded list-wise.

Results

DEMOGRAPHIC CHARACTERISTICS

At the time of data collection, study site 1 had 47 emergency nurses of whom 37 agreed to complete the questionnaires and study site 2 had 85 nurses of whom 47 participated in the study. The response rate was 63.6% (n = 84) as illustrated in Table 1.

Most respondents held associate degrees in nursing 72.6% (n = 61), whereas 19% (n = 16) had a bachelor's degree in nursing and 4.8% (n = 4) had a higher degree or specialized training in emergency nursing (a postregistration-level training). Only 2 of the respondents had a certificate in nursing, and 1 respondent had a master's degree in nursing.

COMPETENCY LEVELS

As noted in the methods, competency levels were self-rated as least competent, competent, and highly competent, and the skills were categorized as basic, intermediate, and advanced skills. These data are illustrated in Table 2.

In basic competencies, most respondents (84.5% [n = 71]) perceived themselves as being highly competent (see Table 3 below). In intermediate skills, less than half of the respondents (48.8% [n = 41]) perceived themselves as being highly competent whereas 47.6% (n = 40) perceived themselves as competent. In terms of advanced competencies, only 16.7% (n = 14) perceived themselves as being highly competent (see Table 3).

EDUCATIONAL NEEDS

Regarding trauma topics, the highest educational need included intra-abdominal injuries at 83.3% (n = 70) and spinal cord and head injuries with both listed at 81% (n = 68). The cardiovascular topic thought by respondents to be of highest educational need was cardiogenic shock at 85.5% (n = 71) followed by acute myocardial infarctions and defibrillation/cardioversion with 81% (n = 68) and 79.8% (n = 67), respectively.

A high need for additional education on neurological topics was for stroke, intracranial bleeding, and convulsive disorders with 78.6% (n = 66), 78.6% (n = 66), and 71.4% (n = 60), respectively. High educational needs in the area of respiratory emergencies included blood gas analysis at 78.6% (n = 66) and mechanical ventilation at 77.4% (n = 65) and chronic obstructive pulmonary disease at 75% (n = 63).

Other areas of emergency nursing with a high need for education were triage at 89.3% (n = 75), disaster preparedness at 88.1% (n = 74), and advanced cardiac life support at 88.1% (n = 74). It is worth noting that in all of the above areas no topic scored less than 55% indicating a very high educational need (Table 4).

We also asked respondents about barriers to their emergency educational development. We asked the respondents whether they agreed or disagreed that funding, support from hospital management, access to educational institutions, staffing issues, and time were a barrier to their educational development. The majority (70% [n = 59]) highlighted that funding was the major barrier to their development. Staffing issues (61.9% [n = 52]), time (56.0% [n = 47]), support from management (41.7% [n = 35]), and access to educational institutions (36.9% [n = 31]) were other barriers to nurses' educational development.

TABLE 3
Competency levels for basic, intermediary, and advanced competencies (N = 84)

Competencies	Frequency (n = 84)	%
Basic competencies		
Least competent	1	1.2
Competent	12	14.3
Highly competent	71	84.5
Intermediate competencies		
Least competent	3	3.6
Competent	40	47.6
Highly competent	41	48.8
Advanced competencies		
Least competent	16	19
Competent	54	64.3
Highly competent	14	16.7

Discussion

We studied nurses working in 2 emergency departments, sought to identify current gaps in emergency nursing as a specialty in Kenya, and examined the educational needs specific to nurses working in emergency departments in Nairobi, Kenya.

DEMOGRAPHICS

Most nurses working in the emergency departments had an associate degree and did not have any formal training in emergency/trauma nursing. These findings are similar to other studies conducted in Africa that have drawn attention to the educational needs of nurses in our emergency departments.[2,6] Although all nurses in the study were registered by the NCK and are thus qualified to be practicing as nurses, basic nursing education does not provide sufficient emergency nursing competence for high-quality and safe care in the emergency setting.

BASIC SKILLS

Limited basic emergency knowledge and skills are included in undergraduate nurse training programs, and not all nursing programs include rotations through emergency departments. Consequently, there is a need for supplementary structured emergency nursing education.[9]

Nurses are key members of any health care system, and their clinical competency is crucially important, particularly in the emergency department. There is an association between nurses' clinical competency and quality of care.[11] Most nurses (84.5%) perceived themselves as being highly competent in basic skills, implying that the nurses are knowledgeable and skilled in providing quality and safe care in terms of basic skills. The lowest scored basic skill was CPR with only 73.8% perceiving themselves as highly competent in this area. This finding echoes Dulandas and Brysiewicz[6] in South Africa who studied nurses in tertiary hospitals and also found that CPR was the basic skill in which most nurses felt less competent. CPR is a critical element of basic life support and is the first-line response to cardiac/respiratory arrest before defibrillation and advanced life support are available. It is expected that nurses, especially those working in emergency departments, should be highly competent in CPR. Although it is commendable that 73.8% of nurses studied perceived themselves to be highly competent, there were also 26.2% who felt less competent in CPR. Bearing in mind that these study centers were referral and trauma centers in which direct care is provided to high acuity patients, this could have direct implications for patient care.

INTERMEDIATE SKILLS

In terms of intermediate skills, less than half of the emergency nurses (48.8%) in our study perceived themselves as being highly competent. In specific skills, ability to prepare and administer drugs in cardiac arrest and ability to manage shock were the areas where respondents were least competent with 53.6% and 56%, respectively. This is an area of concern because emergency nurses often encounter unexpected cardiac arrest with little information about the patients.[12] There is an expectation for nurses to have pharmacological knowledge of indications and adverse effects of the drugs used in cardiac arrest and correct doses, routes, and frequency. The fact that almost half the nurses do not perceive themselves as highly competent could be a plausible reason for poor outcomes in cardiac arrest in Kenya.

Only 56% of nurses studied felt they were highly competent in managing patients in shock. Could this affect the fact that hypovolemic shock associated with diarrheal diseases is the third leading cause of mortality in Kenya?[3] The emergency nurse's ability to assess and manage shock is vital.

ADVANCED SKILLS

In advanced skills, only 16.7% perceived themselves as highly competent. This is in keeping with other African studies.[6,13] One plausible reason is the lack of emergency specialty specific education and training. In

TABLE 4
Educational needs of the participants

Trauma	Agree (%)	Neither agree nor disagree (%)	Disagree (%)
Abdominal and trunk trauma	83.3	8.3	6.0
Spinal cord injuries	81.0	13.0	6.0
Head injuries	81.0	9.5	8.3
Burns injuries	78.6	15.5	6.0
Pediatric trauma	77.4	14.3	8.3
Orthopedic trauma	75.0	16.7	7.1
Obstetrics/gynecology/ pregnancy trauma	67.9	23.6	7.1
Ophthalmic (eye) injuries	67.9	26.2	6.0
Geriatric trauma	65.5	21.4	11.9
Cardiovascular topics	**Agree (%)**	**Neither agree nor disagree (%)**	**Disagree (%)**
Cardiogenic shock	84.5	10.7	4.8
Acute myocardial infarctions	81.0	8.3	10.7
Defibrillation/ cardioversion	79.8	13.1	7.1
Arrhythmias	78.6	14.3	7.1
Cardiac medications	78.6	15.5	6.0
Pediatric cardiac conditions	78.6	14.3	7.1
Acute coronary syndrome	76.2	14.3	9.5
Respiratory topics	**Agree (%)**	**Neither agree nor disagree (%)**	**Disagree (%)**
Arterial blood gas analysis	78.6	11.9	8.3
Ventilators	77.4	11.9	9.5
Chronic obstructive pulmonary disease	75.0	17.9	6.0
Pulmonary embolism	73.8	16.7	7.1
Breath sounds/chest auscultation	71.4	20.2	7.1

continued

TABLE 4
Continued

Respiratory topics	Agree (%)	Neither agree nor disagree (%)	Disagree (%)
Asthma	64.3	23.8	16.7
Pneumonia	58.3	25.0	13.1
Neurological topics	**Agree (%)**	**Neither agree nor disagree (%)**	**disagree (%)**
Stroke	78.6	8.3	10.7
Intracranial hemorrhage	78.6	9.5	10.7
Convulsions/epilepsy	71.4	17.9	9.5
Meningitis	65.5	22.6	11.9
Other emergency topics	**Agree (%)**	**Neither agree nor disagree (%)**	**Disagree (%)**
Triage	89.3	6.0	2.4
Advanced cardiac life support	88.1	4.8	4.8
Disaster/emergency preparedness	88.1	7.1	3.6
Pediatric advanced life support	86.9	8.3	3.6
Pain management	84.5	10.7	2.4
Poisoning	84.5	9.5	3.6
Prehospital trauma life support	82.1	10.7	6.0
Diabetes emergencies and updates	81.0	10.7	6.0
Pharmacology	78.6	19.0	1.2
Sexual assault/violence	76.2	21.4	1.2
Street drugs	73.8	19.0	4.8
Mental health	73.8	22.6	1.2
Wound care	67.9	25.0	4.8

The higher the score on the agree column, the higher the educational need for that particular topic/domain.

high-income countries such as the United States and the United Kingdom where advanced nursing practice is well defined and advanced practice nurses have more complex roles, pathways to obtaining skills and competencies are also well defined and include graduate-level degrees. Even though advanced practice

nurses' roles are different from those of staff nurses and cannot be directly compared, staff nurses in these countries do pursue additional education in the form of classes such as advanced cardiac life support, trauma nursing core course, and emergency nursing pediatric course placing them in a better position to manage their patients. Educational programs contain the same core components of coursework. The coursework equips the nurses with theoretical knowledge whereas the clinical mentorship training helps develop assessment, diagnostic skills, procedures, and competencies to practice at an advanced level.[14]

Formal pathways to the advanced practice nursing role may provide another important avenue to elevate clinical competency. In Australia, the introduction of advanced emergency nurse services has been instrumental in reducing waiting times for low-acuity patients and positively affecting ED service delivery. Evidence supports the value emergency advanced nursing practice roles.[15] If the same were to be implemented in Kenya, it may prove to be beneficial given the high disease burden in the country.

Our study demonstrated a high educational need for emergency nurses similar to other studies from Africa.[6] The role of the emergency nurse is still developing in Africa, and in efforts to formalize this role, the development of professional bodies such as the Emergency Nurses Society of South Africa, which is open to nurses from all African countries, has been instituted. Formalization of the emergency nursing role would be further supported and strengthened if a professional body such as the Emergency Nurses Society of South Africa were to be formed in Kenya. It would then be specific to emergency nurses in Kenya. In Kenya, the Emergency Medicine Kenya Foundation is one such organization, although it targets all emergency service personnel including physicians and prehospital emergency medical services personnel, all of whom have different scopes of practice. Currently, the Emergency Medicine Kenya Foundation does provide education for emergency nurses through provision of short courses and training.

Short courses such as basic life support, advanced cardiac life support, pediatric advanced life support, and triage have been pivotal in helping emergency nurses remain current with evidence-based practice that is best achieved through continuing professional development and follow-up. However, short courses alone may not be sufficient to meet all educational needs. In Kenya, a number of nursing colleges offer a postbasic specialized associate degree in emergency nursing. Postgraduate-/master's level training is yet to be established.

Implications for Emergency Nurses

Comprehensive patient care needs in the emergency care setting require a more complex understanding of emergency nursing care principles. The results of our study identified focus areas for future specialty training and education in emergency nursing.

Furthermore, the concepts of autonomy and advanced practice are fairly new in nursing education in Kenya; therefore, these skills and concepts will have to be developed through educational advancement and input from all the concerned stakeholders including NCK, Kenyan government, universities, and hospital bodies.

Limitations

The study was limited to 2 tertiary teaching and referral hospitals in Nairobi, Kenya. This restricts generalization in regard to the skills, competencies, and educational needs of emergency nurses in other areas. This was a report of a self-perceived assessment, and no actual measurement of competencies or knowledge was performed. Thus, this study offers useful insights/findings that employers, educators, or regulators may use to improve emergency nursing in Kenya. In addition, the difficulty in recruiting emergency nurses affected the sample size. At the time of recruitment, both centers reported to be suboptimally staffed and may have contributed to the small sample size of the study.

Conclusion

An understanding of the perceived skills and competencies levels, educational needs, and barriers to education among emergency nurses at the Aga Khan University Hospital, Nairobi, and Kenyatta National Hospital was obtained from this study. With low perceived competency levels, skills, and knowledge among most emergency nurses, there is a clear need for educational development to improve basic, intermediate, and advanced skills of emergency nurses.

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Coronavirus Disease 2019 in the Emergency Department: Establishing an Interprofessional Incident Command System

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Abstract

Coronavirus disease 2019 was declared a national emergency in the United States on March 13, 2020, at which time the Children's National Hospital Emergency Department in Washington, DC, mobilized to develop and implement a unit-based Incident Command System. Anticipating that the unique and challenging nature of this pandemic might require a large interprofessional team, emergency nurses, emergency physicians, and emergency physician assistants were placed in traditional Incident Command System roles to provide an organizational framework for the ED response. This framework served multiple purposes but most importantly it helped to efficiently streamline and coordinate communications within the emergency department, with hospital leadership and with other hospital departments. The focus on intentionally taking an interprofessional approach to assigning Incident Command System roles was key to optimize staff safety, patient care, and clinical efficiency. This paper highlights a unique concept of applying the Incident Command System model to a single hospital department in a disaster scenario, using existing ED staff to function in various roles not typically held during regular operations. Given that policies and procedures can be ever-changing during a pandemic, emergency departments can implement an interprofessional incident command structure to provide a framework for communications and operational planning that allows for agility based on evolving priorities. The Children's National Hospital ED Incident Command System model established during the coronavirus disease 2019 pandemic can serve as a guide for other emergency departments during a disaster response.

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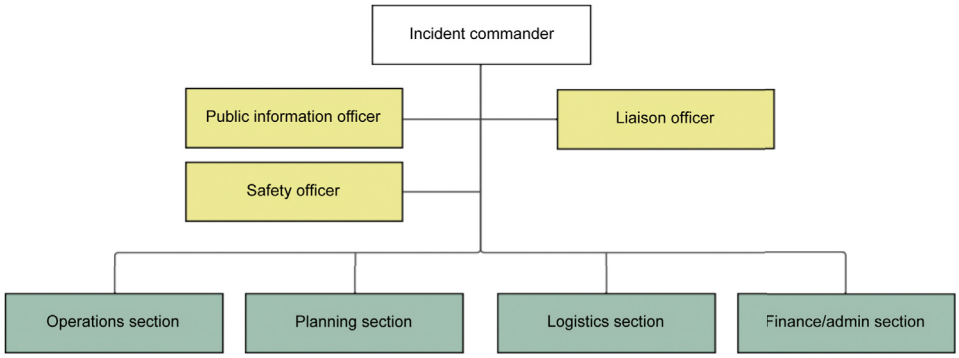
Introduction

Coronavirus disease 2019 (COVID-19), the disease caused by the novel coronavirus, was declared a public health emergency by the World Health Organization on January 30, 2020.[1] Subsequently, the District of Columbia reported its first case on March 7, 2020,[2] and COVID-19 was deemed a US national emergency on March 13, 2020.[3] In response to the declared national emergency, the pediatric emergency department at Children's National Hospital (CNH) in Washington, DC, implemented an interprofessional unit-based ED Incident Command System (ED ICS) that went into effect on March 14, 2020.

Background

CNH is a 319-bed, freestanding, tertiary hospital serving pediatric patients in District of Columbia, Maryland and Virginia, with an annual ED visit volume of approximately 124,000 with 15,000 admissions. Although initial reports indicated the elderly were primarily affected by COVID-19,[4]



Incident commander: The individual responsible for on-scene incident activities, including developing incident objectives and ordering and releasing resources. The Incident Commander has overall authority and responsibility for conducting an incident.

Public information officer: A member of the ICS Command Staff responsible for interfacing with the public and media and/or with other agencies with incident-related information needs.

Liaison officer: A member of the ICS Command Staff responsible for coordinating with representatives from cooperating and assisting agencies or organizations.

Safety officer: A member of the ICS Command Staff responsible for monitoring incident operations and advising the Incident Commander or Unified Command on all matters relating to operational safety, including the health and safety of incident personnel. The Safety Officer modifies or stops the work of personnel to prevent unsafe acts

Operations section: The ICS Section responsible for implementing tactical incident operations described in the Incident Action Plan. In ICS, the Operations Section may include subordinate branches, divisions, and/or groups.

Planning section: The ICS Section that collects, evaluates, and disseminates operational information related to the incident and for the preparation and documentation of the Incident Action Plan. This section also maintains information on the current and forecasted situation and on the status of resources assigned to the incident.

Logistics section: The ICS Section responsible for providing facilities, services, and material support for the incident.

Finance/administration section: The ICS Section responsible for an incident's administrative and financial considerations.

References[7, 16]

FIGURE 1

Standard incident command structure. ICS, Incident Command System. (Reproduced with permission from NIMS: frequently asked questions. U.S. Department of Homeland Security. Accessed October 11, 2021. https://www.fema.gov/pdf/emergency/nims/nimsfaqs.pdf; and Glossary of related terms ICs review. Intermediate Incident Command System for Expanding Incidents. Published March 2018. Accessed October 11, 2021. https://training.fema.gov/emiweb/is/icsresource/assets/glossary%20of%20related%20terms.pdf)[16]

preparations were also made for a potential surge of pediatric ED patients. Within the first 2 months, CNH treated more than 400 patients diagnosed as having COVID-19 in the emergency department, with 25% requiring hospitalization and, of those, 25% requiring critical care.[5] Given the highly transmissible nature of severe acute respiratory syndrome coronavirus 2, staff safety, the acquisition of personal protective equipment (PPE), and education of safety protocols were prioritized. Staying up to date on infection control measures and clearly communicating to staff became paramount and a major impetus for the rapid stand-up of a comprehensive incident command structure.

The National Incident Management System was created by the Department of Homeland Security to provide a standardized framework for responding to large-scale incidents.[6] The ICS (Figure 1) represents a standardized organizational structure often used in emergency management that can be adapted to a variety of situations to reduce redundancy in tasks and allow for a streamlined reporting structure.[6–8,16] This structure enables effective and

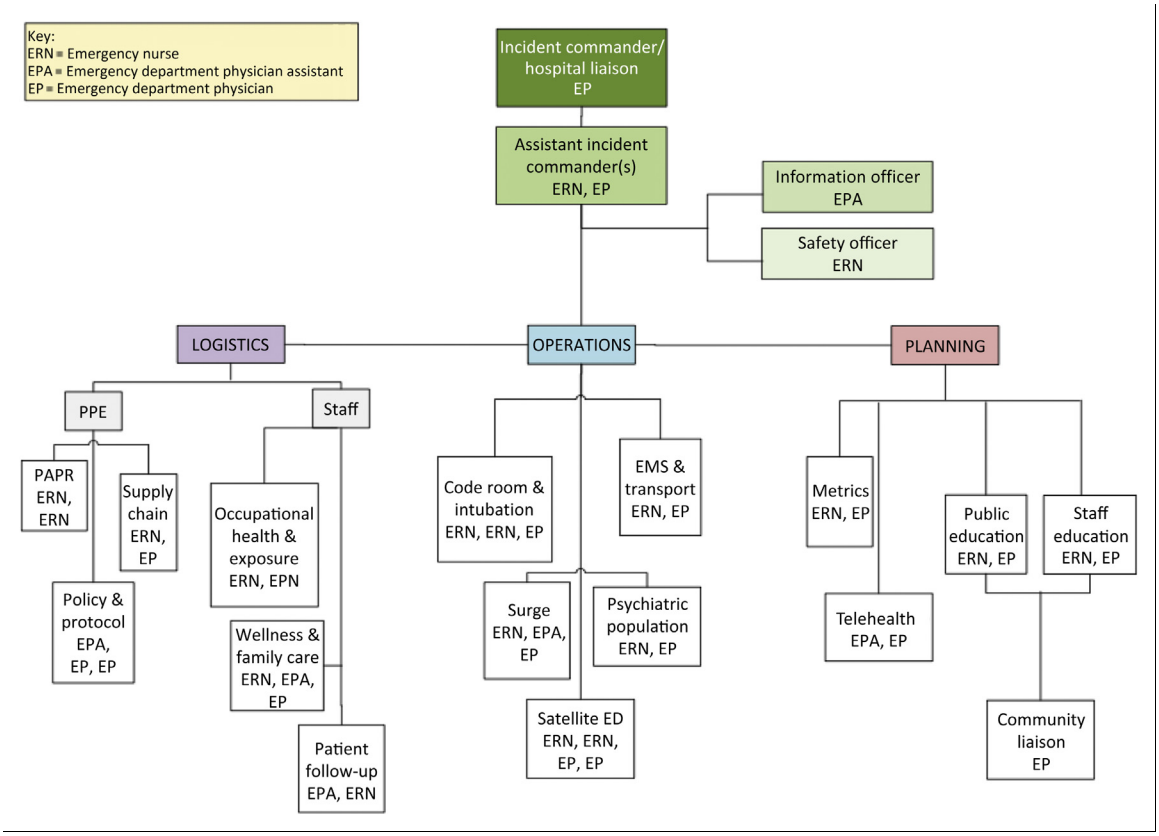


FIGURE 2

Children's National Hospital unit–based interprofessional incident command system. ERN, emergency nurse; EPA, emergency physician assistant; EP, emergency physician.

efficient incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational framework.[7] The ICS has 5 major management functions: command, operations, logistics, planning, and finance.[8,9]

Methods

INCIDENT COMMAND IN THE EMERGENCY DEPARTMENT

The COVID-19 Incident Command in this pediatric emergency department (Figure 2) included an interprofessional team of emergency nurses, emergency physicians, and emergency physician assistants. Multiple groups from the ED ICS worked closely with hospital leadership, infection control, language services, registration, and other hospital departments and stakeholders to develop and lead implementation of policies and plans in the emergency department.

COMMAND SECTION

The ED incident commander (IC) reported directly to the hospital COVID-19 ICS. The ED leadership decided to establish an ICS independently, given the frontline status of the emergency department and the need to make rapid decisions as the situation evolved. The finance function of the ED ICS was led by the ED IC. Relevant finance duties/management included tracking staff hours toward COVID-19-specific duties and any supply expenditures. This information was shared with the finance section of the hospital COVID-19 ICS. The ED IC also attended the hospital COVID-19 ICS meetings and was the ED spokesperson to represent at essential city and state forums that were involved in the community-wide response. Two assistant incident commander (AIC) roles were created to focus on the emergency department–specific issues, one

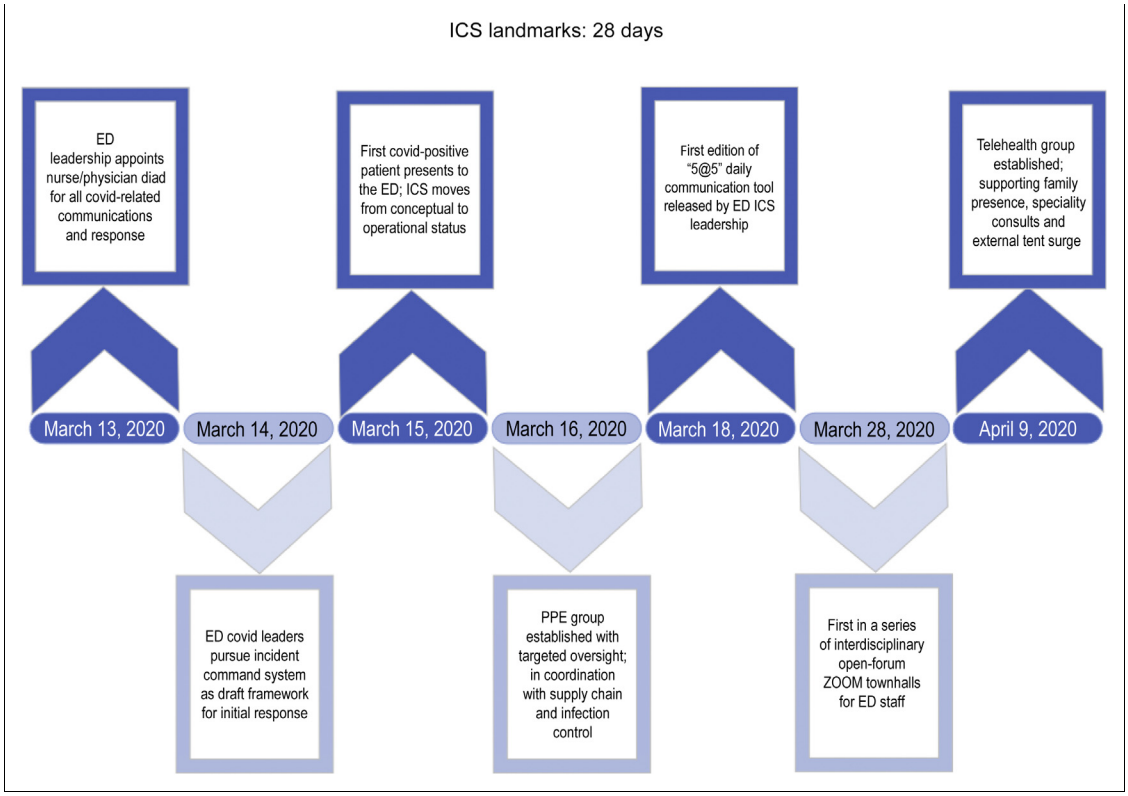


FIGURE 3

CNH ED COVID-19 ICS timeline. CNH, Children's National Hospital; COVID-19, coronavirus disease 2019; ICS, Incident Command System; PPE, personal protective equipment.

an emergency physician leader and one an emergency nurse leader, who worked in tandem throughout the response.

An emergency physician assistant was assigned the *information officer* role. In this role, they managed a designated COVID-19 email account and helped streamline communications to the department. The IC team also worked closely with a designated *safety officer*, who was an emergency nurse with extensive ICS training. The *safety officer's* primary role was to oversee PPE-related concerns. The fundamental ICS concept that every individual has only one designated supervisor, known as "unity of command," was strictly adhered to, improving the flow of information, helping with the coordination of operational efforts, and enhancing operational safety.[10]

OPERATIONS SECTION

The *operations section* was responsible for all day-to-day activities related to COVID-19 in the emergency department. The *surge unit* focused on creating a surge plan to increase the capacity for ED patient assessments and management should a large influx of patients overwhelm current capacity.

The *psych unit* worked with psychiatric services to manage mental health patients by helping to develop testing protocols and guidance for psychiatry admission protocols.

The *code room/intubation unit* worked in conjunction with the *PPE branch*, infection control, and the critical care department to develop policies and procedures to keep staff protected during high-risk procedures such as intubations, critical care resuscitations, and aerosolizing procedures.

The *patient follow-up unit* developed and maintained a system to address the large number of COVID-19 test results that required follow-up in a timely manner. Although test follow-up is an already established process in the emergency department (eg, culture results), the sheer number of COVID tests requiring follow-up necessitated a team to develop a new process to manage the increased workload.[11] The *education unit* prepared COVID-19-specific discharge instructions for families using guidelines from the Centers

for Disease Control and Prevention, led staff educational updates, and maintained revisions on informational signage throughout the unit.

The *emergency medical services/transport unit* worked with prehospital partners and the interfacility transport team to ensure consistency of practice and standardization of protocols for transferring patients from the field or an outside facility. This required extensive coordination among the regional EMS systems, various regional EMS providers, and the interhospital transport team.

PLANNING SECTION

The *planning section* addressed internal and external planning, rapidly creating new teams as the need arose. For example, a *telehealth unit* was established to improve ED telehealth capabilities focused on virtual patient follow-ups and enhanced caregiver communication via virtual platforms. The *community/primary care unit* worked with the local referring provider community to inform them of ED policies, facilitate referrals, and communicate follow-up processes.

LOGISTICS SECTION

The *logistics section* had 2 primary roles: PPE and staffing. In this pandemic, the rapid standup of the *PPE branch* was imperative and was overseen by the *safety officer*. The *PPE branch* ensured adequate supply of PPE and worked closely with infection control to develop PPE protocols for emergency department–specific, high-risk clinical situations such as caring for patients undergoing an aerosol generating procedure.

The *staff branch* worked closely with the hospital occupational health department to manage reports of exposures and persons requiring quarantine, oversee changes to the clinical schedules, and address the unique stressors posed by the pandemic. This included connecting staff with mental health resources and facilitating staff connections for childcare. The *staff branch* also organized regular wellness activities, including virtual happy hours, and managed the distribution of donated food to staff on shift.

COMMUNICATION MODEL

Effective communication in any disaster is paramount.[12] The COVID-19 pandemic provided a unique challenge, given the vast number of unknowns about the disease, the evolving nature of the level of outbreak, and shifting priorities and recommendations from public health and government officials. Correcting misinformation and being transparent about what was unknown, especially early on, were key features of our communications strategy.

For decades, the American Heart Association and American Academy of Pediatrics have provided guidance on interprofessional communication during a crisis, via certification courses such as Pediatric Advanced Life Support (PALS). Although PALS scenarios are often exercised during smallscale resuscitation events, the same key team dynamic principles were used daily to navigate the COVID-19 pandemic in the emergency department. Closed-loop communication, clear messaging, clear roles, knowing one's limitations, knowledge sharing, constructive intervention, reevaluation and summarizing, and mutual respect were all familiar practices for ED staff to rely upon and apply during this COVID-19 response.[13] Role confusion is another phenomenon identified as uniquely prevalent during crises that is proven alleviated by checklist or job aid amidst an emergency event.[14] The clear hierarchy inherent to ICS application not only establishes a who's-who contact list but also minimizes redundancy by delineating responsibilities at the command, group, and individual levels. Concise definition of roles should be shared with all staff for accountability with top priorities for each role reassessed frequently among ICS team members.

Communication within the ED ICS was shared via a single email distribution list for all members of the ED ICS and a text group for urgent issues. Initially, the ED ICS met daily on video-conference calls run by the AICs. The frequency of these meetings decreased as groups became more self-sustaining, global needs reduced, and the influx of new information to guide policies and practice became more consistent.

It was important that communication to the ED staff was frequent, concise, easily digestible, and readily available. To accomplish this, an email titled "5@5" was used daily to reach the ED staff. At 5 PM each day, the AICs summarized 5 key points regarding the COVID-19 response. This email became a popular and widely used source of information well beyond the ED recipients and at its height included nearly 600 people from multiple departments and executives throughout the hospital. Topics ranged from urgent notifications to inspirational messaging, important process changes, lessons learned, latest science, ED trends in data, free resources available to health care workers, and lighthearted quotes.

To provide a forum for questions, a separate dedicated email account through which staff could send COVID-19-related queries was developed and managed by the information officer. Multiple department-wide virtual town halls

were also conducted, which allowed staff to ask the ED ICS team leaders questions directly, engage in real-time discussions, and unwind and socialize with their peers.

Implications for Emergency Nurses

Establishing an interprofessional ICS structure for a disaster such as the COVID-19 pandemic is an efficient and effective way to organize a department-level response, particularly in lieu of the restrictions placed on being able to meet in person and the switch to prioritizing virtual forms of communication during the pandemic. This article describes a unit-based ICS framework implemented during COVID-19 to efficiently streamline and coordinate interdisciplinary communications within the emergency department and with other hospital departments. The ICS was established quickly, with major elements functional within 28 days (Figure 3). The disruption of routine staff meeting schedules and urgency for nimble operational changes to keep up with the evolving hospital and public health guidelines for managing the pandemic culminated in a need for the emergency department to have a leadership framework similar to the hospital and public health department framework. Goals were to optimize staff safety, patient care, and clinical efficiency. Although not formally measured, success with this unit-based framework was determined by positive feedback from staff, low workplace infection rates, reduced redundancy of tasks at the leadership level, and a notable decrease in individual questions and queries from staff as regular communications increased. This unit-based framework for crisis communications and operational planning using established ICS roles can serve as a guide for other emergency departments during a disaster response.

Key take-home points are as follows:

- Create an interprofessional approach to ICS leadership (emergency nurses, emergency physicians, emergency physician assistants) that allows for buy-in and perspectives that represent the needs of various disciplines in the emergency department.
- Regularly engage key relevant hospital departments and hospital leadership (eg, infection control, intensive care units, laboratory, medicine).
- Identify liaisons to hospital committees and departments to facilitate bidirectional and streamlined communication.
- Implement relevant ICS units as key issues emerge and retire groups as their goals are met.
- Establish regular meetings with all ICS members and modify the frequency of meetings as the situation evolves.
- Encourage a formal team-dynamics framework, such as that given by the American Heart Association PALS programming, for a template of established, interprofessional communication tools.
- Streamline department-wide communications to convey important, timely, and accurate messaging to aid in information management and mitigate misinformation.
- Create a streamlined system for bidirectional communication between staff and ICS leadership.

Conclusion

COVID-19 has affected every facet of life, both professionally and personally. Establishing an emergency department–focused ICS leadership structure with emergency nurses, emergency physicians, and emergency physician assistants in the early stages of the pandemic was key to success. Although there are other examples of ICS structures during COVID-19,[15] this is the first we are aware of in the published literature to specifically highlight the use of an interprofessional unit-level team and not one composed entirely of physicians.[13] Although this experience is based on a pediatric emergency department, this framework has broad applicability to any ED setting.

As the COVID-19 pandemic continues to evolve across the US, success in this emergency department's response was attributed to implementing leadership strategies rooted in an emergency preparedness framework. This experience demonstrates that the ICS structure can serve as a model for leadership in an ED disaster response and the importance of including all disciplines of the clinical team.

Author Disclosures

Conflicts of interest: none to report.

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Evaluation of Peripheral Administration of 10% Calcium Chloride in a Retrospective, Single-Center Electronic Health Record Cohort

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NCPD Earn Up to 9.5 Hours. See page 492.

Contribution to Emergency Nursing Practice

- Peripheral administration of 10% calcium chloride is routinely accepted and occurs without significant observed complications. However, some reports have indicated that calcium extravasation can result in erythema, papule formation, necrosis, and possible skin sloughing.
- Our study found that 4 documented infusion-related adverse events occurred in 3 patients of the total 72 administrations analyzed, all with low-grade symptoms. None of the documented extravasations resulted in permanent tissue injuries. All were administered through a large bore peripheral line in a proximal vein. Our study demonstrates that administration of 10% calcium chloride via peripheral line administration was feasible, carried a low charted incidence of complications, and may offer an alternative to central line administration in emergent settings. However, more studies are needed to confirm these results.
- At a single institution, calcium chloride seemed to be safe when administered via peripheral intravenous catheters. Other institutions should review their own internal data to evaluate the safety of peripheral administration of calcium chloride.

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Abstract

Background: Calcium chloride is commonly used in emergency departments in the treatment of a variety of emergencies. Historically, administration via central venous catheters has been preferred owing to its high osmolarity and vesicant properties. Although preferred, central access may not always be available in time-sensitive, emergent situations leading to many instances of peripheral administration. The objective of this analysis was to evaluate the charted safety of peripheral venous administration of 10% calcium chloride.

Methods: A single-center retrospective chart review was performed in patients who received 10% calcium chloride in the adult emergency department evaluating for the incidence of infusion-related adverse events. Patients were excluded if they were less than 18 years of age or had a lack of catheter documentation during 10% calcium chloride administration or if the 10% calcium chloride was documented as given through a central venous catheter.

Results: A total of 72 administrations were evaluated. Patients were predominantly male (67%), with a median age of 55 years and body mass index of 29.2. The primary outcome demonstrated that 4 infusion-related adverse events occurred (6%) with grade 1 (n = 1) and grade 0 (n = 3) documented incidence of infusion-related adverse events. None of the documented incidence of infusion-related adverse events resulted in permanent tissue injury, and all patients had conservative management.

Discussion: This study demonstrated that administration of 10% calcium chloride via peripheral venous catheters may be feasible and seemed to carry a low incidence of documented complications. Further prospective studies are needed to confirm study observations.

Key words: Calcium; Calcium chloride; Extravasation; Peripheral line; Critical care; Emergency medicine; Central venous catheter; Medication safety; Adverse events

Introduction

Calcium chloride is commonly indicated for the treatment of severe hypocalcemia, used for deleterious effects of hyperkalemia, and suggested for the treatment of calcium channel or beta blocker overdose.[1,2] Historically, 10% calcium chloride administration has been preferentially administered via a central venous catheter (CVC) due to concerns with its high osmolarity and vesicant properties. However, owing to limited time availability of providers in the demanding environment of emergency departments and preferred line placement confirmation, CVCs are not always available. This is further compounded by weighing the potential CVC placement complications such as arterial puncture, pneumothorax, or subcutaneous hematoma.[3–5] Other formulations of intravenous calcium include calcium gluconate, which is readily available in most emergency departments. However, calcium chloride is manufactured in a ready-to-use Carpuject, minimizing preparation time required in the emergent setting. In addition, drug shortages and recalls with calcium gluconate may necessitate the utilization of calcium chloride.[6]

The main reason that peripheral administration of calcium chloride has been historically avoided is related to the risk of extravasation and local tissue injury. Calcium extravasation can result in erythema, papule formation, necrosis, and skin sloughing within a few hours to days after the infiltration.[7–13] Early symptoms of calcium extravasation include burning, tenderness, induration, and edema. In contrast, extended damage including iatrogenic calcinosis cutis occurs when deposition of calcium in the dermis leads to local tissue injury and inflammation. This results in intracellular calcium release and further adds to local insoluble calcium deposits in the form of calcium hydroxyapatite.[8,14] These calcinosis cutis lesions develop within 2 weeks and resolve with local wound care after 2 to 6 months.[8]

Another attribute routinely cited against the administration of 10% calcium chloride through peripheral venous catheters (PVCs) is its relatively high osmolarity of 2040 mOsm/L. However, emergency nurses commonly administer other hyperosmolar solutions such as 3% sodium chloride (1027 mOsm/L), 8.4% sodium bicarbonate (2000 mOsm/L), and 50% dextrose (2500 mOsm/L) via PVCs in emergent situations without issue.[15] Although hyperosmolar solutions theoretically elevate the risk of extravasation and local tissue injury, few studies have characterized the incidence and severity of 10% calcium chloride infusion-related adverse events (IRAEs) via peripheral line administration.[6]

In one of the largest studies to date, Lin et al reviewed 371 patients who underwent parathyroidectomy of whom 96 patients received 5% calcium chloride peripheral administration and found a 3% incidence of skin necrosis.[10] However, calcium was administered via small peripheral veins in the hands and legs, given as larger doses with variable concentrations, not given as an intravenous push, and not administered in clinical emergencies. Most of other publications involve case reports or small case series evaluating the safety of various concentrations of intravenous calcium chloride or calcium gluconate through various points of access but similarly do not evaluate the clinical scenario commonly encountered in the emergency department.[7–12,16]

Clinically, peripheral administration of 10% calcium chloride is often used and occurs frequently without any significant observed complications. However, considerable ambiguity remains regarding the safety of this practice. At our institution, administration of 10% calcium chloride through a PVC is permitted in emergent situations at the provider's discretion where delay of administration could result in clinical deterioration and during periods of calcium gluconate shortage.[6] Therefore, the purpose of this study was to quantify the charted incidence of 10% calcium chloride extravasation during peripheral administration in the emergency setting.

Materials and Methods

INTERVENTION

A retrospective, single-center, institutional review board–approved cohort study was conducted at an adult emergency department in a quaternary care academic teaching hospital seeing approximately 70 000 emergency room visits per year. All adult patients admitted to the emergency department who received 10% calcium chloride between January 1, 2018, and December 31, 2020, were screened for inclusion with data obtained from an information technology inquiry. The start date of January 1, 2018, was used because this was the date the institution introduced a new electronic health record system. Patients were included if they were ≥ 18 years of age or had documented receipt of at least one dose of 10% calcium chloride through a PVC or if they only had PVCs at time of 10% calcium chloride administration when site of administration was not documented. Patients were excluded if they were less than 18 years of age or had a lack of catheter assessment documentation after 10% calcium chloride administration or if the 10% calcium chloride was documented as given through a CVC.

MEASURES

Data collection included patient demographics, characteristics of the PVC (placement date and time, location, gauge [G], and insertion attempts), and presence of risk factors

for extravasation at the time of admission. Patient-specific risk factors for IRAEs include comorbidities consisting of age, obesity, disseminated skin diseases, diabetes mellitus, peripheral vascular disease, coronary artery disease, peripheral neuropathy, lymphedema, Raynaud's disease, or receiving chemotherapy, anticoagulation, or antiplatelet as a home medication or administered at the institution before administration of 10% calcium chloride.[7,15,16] Owing to the severity of previously reported IRAEs requiring skin grafts,[7,10] overreporting was favored in cases where the specific PVC used during administration was not documented. For example, if a patient had 3 PVCs present and no CVC when 10% calcium chloride was administered and the administering provider did not indicate which PVC the 10% calcium chloride was administered through, we evaluated all 3 PVCs for extravasation and considered any incidence to be related to 10% calcium chloride administration. In addition, if the patient did not have the specific PVC indicated in the administration of 10% calcium chloride and the patient obtained a CVC at the same time or before administration of 10% calcium chloride, data collection for the particular patient was terminated. Finally, if a patient had no documentation of PVC line assessment after administration of 10% calcium chloride, the data were reported as missing and data collection was terminated.

The primary outcome of this study was to report and characterize the incidence of charted IRAEs with the administration of 10% calcium chloride through a PVC. Incidence of charted IRAEs was evaluated for the entire duration of hospitalization. IRAEs were classified according to the Infusion Nurses Society Infiltration Scale incorporating the degree of pain, extent of swelling, presence of blanching, and extent of circulatory impairment on the skin (Table 1)[3] where grade 0 consisted of no symptoms and grade 4 consisted of the most severe symptoms. Infusion-related injury descriptions and grade of injury according to the Infusion Nurses Society Infiltration Scale were noted by nurse documentations in the electronic health record. In addition, internal quality improvement reports were evaluated to assess documented incidences of 10% calcium chloride IRAEs. Secondary outcomes include time to IRAE, hospital and ICU length of stay, and mortality during admission.

TABLE 1
Infusion Nurses Society Infiltration Scale

Grade	Clinical criteria
0	No symptoms
1	Skin blanched
	Edema < 1 inch in any direction
	Cool to touch
	With or without pain
2	Skin blanched
	Edema 1-6 inches in any direction
	Cool to touch
	With or without pain
3	Skin blanched, translucent
	Gross edema > 6 inches in any direction
	Cool to touch
	Mild to moderate pain
	Possible numbness
4	Skin blanched, translucent
	Skin tight, leaking
	Skin discolored, bruised, swollen gross edema > 6 inches in any direction
	Deep pitting tissue edema
	Circulatory impairment
	Moderate-severe pain
	Infiltration of any amount of blood product, irritant, or vesicant

ANALYSIS

Demographic and clinical data were abstracted from the electronic health record and entered into a Research Electronic Data Capture database. The Research Electronic Data Capture is a secure, web-based software platform designed to support data capture for research studies, providing (1) an intuitive interface for validated data capture, (2) audit trails for tracking data manipulation and export procedures, (3) automated export procedures for seamless data downloads to common statistical packages, and (4) procedures for data integration and interoperability with external sources.[17,18] Descriptive statistics for continuous variables were presented as mean values with standard deviation if the values were normally distributed and median with interquartile range (IQR) if not normally distributed. Categorical variables were presented using numbers and percentages. Interobserver reliability was calculated using Cohen's kappa coefficient in a randomly selected 25% sample in an effort to reduce individual observer bias during data collection.[19] All analyses were conducted using the Statistical Package for Social Science, version 1.0.0.1406.

Results

There was a total of 143 10% calcium chloride medication prescriptions for nursing administration in the adult emergency department from January 1, 2018, to December 31, 2020. Notably, 71 administrations were excluded because of missing line assessment documentation (n = 44, 30.77%), CVC in place during 10% calcium chloride administration (n = 20, 13.99%), and no administration recorded (n = 7, 4.90%). That left 43 patients with a total of 72 administrations of 10% calcium chloride via PVCs who were evaluated for the charted incidence of adverse events.

Baseline characteristics are listed in Table 2. Patients were predominantly male (67%), with a median age of 55 years. Most common risk factors for IRAEs during time of 10% calcium chloride administration include hypertension (44%), diabetes mellitus (30%), and coronary artery disease (23%). The vast majority of the PVCs used were placed in the cephalic vein (51%) as illustrated in Table 3. In addition, 40% of PVCs were 18 G or larger in bore size.

Our primary outcome demonstrates that 4 documented IRAEs occurred of 72 total administrations (6%) in 3 of 43 patients (7%), all with low-grade symptoms (grade 1 [n = 1] and grade 0 [n = 3]). Two patients had 1 IRAE each, and 1 patient had 2 IRAEs. The patient with 2 IRAEs had 2 separate calcium chloride injections administered through the same peripheral line. All documented IRAEs resulted in no permanent tissue injuries charted given that all patients had conservative management of the IRAEs (Table 4). In addition, Cohen's kappa was run to determine whether there was agreement between the 2 evaluators' judgment on presence of IRAE. The result was perfect agreement between the judgments (k = 1.00).[19,20] Our secondary outcomes demonstrate that the median time to IRAE was 71 hours (IQR 56-72). Median hospital length of stay was 4 days (IQR 1-9), median ED length of stay was 3 hours (IQR 2-4), and mortality during admission resulted in 25 of 43 patients (58%). A detailed review of patients with documented IRAEs is presented in Table 5. These patients ranged from 44 to 68 years of age with majority being male (67%). All patients had a cephalic PVC with either an 18 G or 22 G. No patients with documented IRAEs received medications to treat or prevent skin injury, such as hyaluronidase, nor were seen by a plastics consultation team for debridement.

Discussion

10% calcium chloride is often used for the treatment of emergent disease states and administration only via a CVC has been the historical precedent.[1,2] It is common for emergency nurses and providers to encounter patients

TABLE 2
Baseline characteristics of all patients (n = 43)

Baseline characteristics	Median or n	IQR or (%)
Female, sex (%)	14	(33)
Median age, years, IQR	55	39-66
Median BMI, IQR	29.2	23.9-33.8
Risk factors for IRAE		
Hypertension (%)	19	(44)
Diabetes mellitus (%)	13	(30)
Coronary artery disease (%)	10	(23)
Presence of altered mental status (%)	8	(19)
Stroke/cerebrovascular accident (%)	3	(7)
Peripheral vascular disease (%)	3	(7)
Anticoagulation therapy present		
Venous thromboembolism prophylaxis (%)	35	(81)
Therapeutic (%)	7	(16)
Antiplatelet therapy present (%)	19	(44)

All values are shown as number (percentage), unless otherwise specified.
BMI, body mass index; IQR, interquartile range; IRAE, infusion-related adverse event.

TABLE 3
Characteristics of PVCs used for all administrations (n = 72)

Characteristics of PVCs used	n	%
Location		
Cephalic	37	51
Intraosseous	7	10
Jugular	3	4
Basilic	2	3
Brachial	2	3
Unknown	21	29
Gauge		
14	1	1
16	2	3
18	26	36
20	24	33
22	1	1
Unknown	18	25

All values are shown as number (percentage).
PVC, peripheral venous catheter.

who need emergency calcium products but do not have a CVC. In these emergent situations where delay of administration could result in clinical deterioration and during periods of calcium gluconate shortage, data evaluating outcomes of 10% calcium chloride via PVC administration are limited. Lin et al[10] evaluated 371 patients who underwent a parathyroidectomy of whom 96 patients received peripheral administration of calcium chloride for postoperative hypocalcemia. A total of 3 patients (3%) had skin necrosis after administration of various concentrations and dosages of calcium chloride (n = 1, 20 mL of 5% calcium chloride; n = 2, 10% calcium chloride in 100 mL infusion). Notably, the varying concentrations were all administered in small peripheral veins (n = 1, dorsum of hand; n = 1, distal lower extremity; n = 1, greater saphenous vein without dilution). Anger et al[21] evaluated the safety of compounded calcium chloride admixtures (10% calcium chloride in 5% dextrose as 600 mg/250 mL and 300 mg/100 mL) in adult inpatients during a national shortage of calcium gluconate. Of the 333 doses administered via peripheral lines, 4 patients (1.8%) experienced a moderate to severe infusion site reaction. Of the 4 patients, 3 experienced phlebitis, and 1 experienced an infiltration. Notably, calcium chloride was diluted to a lesser elemental calcium concentration than 10% calcium gluconate, and this study evaluated nonemergent administration. In addition, Miguez et al[13] published a review of 37 articles evaluating 60 total cases of peripheral calcium extravasations in children and adults with most patients being neonates with an average age of 8 days. The most common area of injury was in the dorsum of the hand and wrist; 70% of extravasation were from calcium gluconate with 17% coming from calcium chloride. Overall, extravasation resulted in erythema (65%), swelling/edema (48%), skin necrosis (47%), indurated skin (33%), and yellow-white plaques or papules (33%).

The overall incidence of observed IRAEs related to peripheral administration of 10% calcium chloride ranges from 1% to 17% in reports in the published literature.[10,13] Theoretically, calcium gluconate contains less elemental

TABLE 4
Primary and secondary outcomes

Primary outcome	All administrations (n = 72) median or n	IQR or (%)
IRAEs (%)	4	(6)
Grade 1 (%)	1	(1)
Skin blanching		
Grade 0 (%)	3	(4)
Secondary outcomes	**All patients (n = 43) median or n**	**IQR or (%)**
Time to IRAE, h, IQR	71	56-72
Median hospital length of stay, d, IQR	4	1-9
Median ED length of stay, h, IQR	3	2-4
Mortality during admission (%)	25	(58)

All values are shown as number (percentage), unless otherwise specified.
d, days; h, hours; IQR, interquartile range; IRAE, infusion-related adverse event.

TABLE 5
Review of patients with documented IRAEs

Age/sex	Comorbidities	PVC and gauge	Description of IRAE	Time to IRAE (h)	PVC removed?
68/F	AMS, DM, HTN, CAD, CVA	Cephalic/18 G	Grade 1; infiltrated, skin blanched	69	Yes
44/M	HTN	Cephalic/22 G	Grade 0; no voiced complaints	17	Yes
45/M	AMS, DM, HTN, CAD, CVA	Cephalic/18 G	Grade 0; no voiced complaints	72	Yes
			Grade 0; no voiced complaints	72	Yes

AMS, altered mental status; CVA, cerebrovascular accident; DM, diabetes mellitus; F, female; G, gauge; HTN, hypertension; IRAE, infusion-related adverse event; M, male; PVC, peripheral venous catheter.

concentration of calcium per milliliter and may lead to less adverse effects compared with calcium chloride when similar volumes are administered. However, given that equipotent doses are typically prescribed, the relative safety of the 2 salts is unknown and further comparator studies are needed.[1,8] All calcium doses included in our study involved 10% calcium chloride push doses of 10 mL, except for 1 patient with 3 administrations of 10% calcium chloride diluted in 100 mL normal saline. Despite differences in concentrations and site of administration, we found an incidence of charted extravasation events that were comparable with other studies evaluating calcium chloride and calcium gluconate.[13,22]

In our study including 72 total administrations of 10% calcium chloride through PVCs, a total of 4 IRAEs were observed (6%). Most patients who had 10% calcium chloride administered peripherally had a large bore catheter, which we defined as 18 G or larger, placed in the cephalic vein.[23] All 3 patients who experienced extravasations had 10% calcium chloride injections infused via a cephalic vein in an 18 G or 22 G PVC. The low incidence and severity of charted IRAEs documented in our study may be caused by the high percentage of large veins used and utility of large catheter bores, allowing for greater blood flow to distribute the calcium chloride and minimized contact with the vascular epithelium leading to a decreased risk of tissue damage.[21] Prominent risk factors for extravasation also related to the patients include comorbidities that impair blood flow, weaken blood vessels, or impair the ability to report an extravasation event.[15] All 3 patients had at least one comorbidity with potential to impair blood flow, with 2 patients having multiple risk factors for extravasation including altered mental status at time of administration, diabetes mellitus, hypertension, coronary artery disease, and previous stroke/cerebrovascular accident. In addition, institution-related factors included skilled nurses and physicians inserting PVCs that could contribute to minimizing the risk of extravasation.[24] This is highlighted in the statistics that all our patients had only one PVC insertion attempt documented.

Given that limited data are published regarding the safety of peripheral administration of 10% calcium chloride in the emergency setting, future studies should seek to better describe the severity of IRAE and identify patients that are at an increased risk of having severe extravasation.[8–12,25] These studies should additionally evaluate the perceived increased safety of calcium gluconate compared with calcium chloride. The most serious adverse event reported in our study included skin blanching. None of these cases required a surgical consult.

LIMITATIONS

Our study does have several methodological limitations. First, our study is a single-center, retrospective chart review with more than 30% of the outcome data missing in the health records. This subjects our study to reporting and documentation bias from the electronic health record. Second, our sample size is small with a low IRAE event rate documented partly owing to our restriction to the adult emergency department. However, we restricted our patients to the emergency department not only because this is the most likely department to require emergent administration of 10% calcium chloride but also because it is the least likely to have CVCs in place before calcium administration. Owing to our small sample size and underrepresentation of the population, overreporting of IRAEs may have also been favored. A larger sample size may be required to identify incidents of tissue necrosis from extravasation. However, we did evaluate internal quality improvement reports, which is one of the primary avenues of IRAE reporting at the institution. We found no other

extravasations other than the ones reported. Third, lacking a control group, we cannot conclude that 10% calcium chloride administration via PVC is safer than via a CVC or safer than administration of calcium gluconate. Future prospective multicenter studies should not only compare peripheral with central administration of calcium chloride but additionally explore the relative safety of calcium chloride versus calcium gluconate when administered peripherally. Fourth, we cannot comment on patient outcomes because our primary outcome only assessed the charted incidence of IRAEs. Fifth, the median age of our patients was 55 years, so we are unsure how calcium chloride administration would affect veins of elderly patients. Sixth, the incidence of acute calcium extravasation can take hours to days after the infiltration to develop, and given the high incidence of early mortality observed, it is possible that the patients could have died before discovery of an IRAE. Finally, given that we were only able to evaluate for IRAEs during the hospital stay, there is a potential that they may have presented themselves after hospital discharge. Nevertheless, our study is one of the largest to date evaluating the peripheral administration of calcium chloride and justifies further prospective studies that challenge the relative safety of 10% calcium chloride.

IMPLICATIONS FOR EMERGENCY CLINICAL PRACTICE

The information presented has multiple implications for emergency clinical practice. First, this study expands on the limited published data evaluating peripheral administration of 10% calcium chloride in the emergency setting. Second, although our study had a low incidence of documented IRAEs, this study provides useful guidance for clinicians seeking to conduct their own review at their institution to determine the relative safety of administering 10% calcium chloride via peripheral catheters in emergent situations at the provider's discretion where delay of administration could result in clinical deterioration and during periods of calcium gluconate shortage. Third, this study provides additional data challenging the dogma surrounding the perceived increased safety of calcium gluconate compared with calcium chloride. Finally, our study emphasizes the importance of emergency nurses in the interdisciplinary specialty. The low incidence of charted IRAEs found in our results highlights the knowledge and skill surrounding the discretion and decision making around peripheral administration by emergency nurses. Furthermore, our findings underscore the importance of accurate documentation of all line insertions, medication administrations, and line assessments to provide valuable information in attributing extravasations to certain medications for internal safety evaluation.

Conclusion

Peripheral administration of 10% calcium chloride seemed to be associated with a low incidence of documented IRAEs. Although prospective studies confirming external validity are warranted, providers wishing to administer 10% calcium chloride peripherally should preferentially choose the largest bore PVC in the most proximal vein. Our study demonstrated that administration of 10% calcium chloride via PVC may be feasible, seemed to carry a low incidence of charted complications, and may offer an alternative to CVC access in emergent at the provider's discretion where delay of administration could result in clinical deterioration and during periods of calcium gluconate shortage. However, broad adaption of this method of administration is cautioned until larger prospective studies are conducted to confirm our observations.

Author Disclosures

Conflicts of interest: none to report.

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