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Integrating Emergency Care with Population Health

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Official Journal of the California Chapter of the American College of Emergency Physicians, the America College of Osteopathic Emergency Physicians, and the California Chapter of the American Academy of Emergency Medicine

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JOURNAL FOCUS

Emergency medicine is a specialty which closely reflects societal challenges and consequences of public policy decisions. The emergency department specifically deals with social injustice, health and economic disparities, violence, substance abuse, and disaster preparedness and response. This journal focuses on how emergency care affects the health of the community and population, and conversely, how these societal challenges affect the composition of the patient population who seek care in the emergency department. The development of better systems to provide emergency care, including technology solutions, is critical to enhancing population health.

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Addressing System and Clinician Barriers to Emergency Department-initiated Buprenorphine: An Evaluation of Post-intervention Physician Outcomes

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Introduction: Emergency departments (ED) are in the unique position to initiate buprenorphine, an evidence-based treatment for opioid use disorder (OUD). However, barriers at the system and clinician level limit its use. We describe a series of interventions that address these barriers to ED-initiated buprenorphine in one urban ED. We compare post-intervention physician outcomes between the study site and two affiliated sites without the interventions.

Methods: This was a cross-sectional study conducted at three affiliated urban EDs where the intervention site implemented OUD-related electronic note templates, clinical protocols, a peer navigation program, education, and reminders. Post-intervention, we administered an anonymous, online survey to physicians at all three sites. Survey domains included demographics, buprenorphine experience and knowledge, comfort with addressing OUD, and attitudes toward OUD treatment. Physician outcomes were compared between the intervention site and the control sites with bivariate tests. We used logistic regression controlling for significant demographic differences to compare physicians' buprenorphine experience.

Results: Of 113 (51%) eligible physicians, 58 completed the survey: 27 from the intervention site, and 31 from the control sites. Physicians at the intervention site were more likely to spend <75% of their work week in clinical practice and to be in medical practice for <7 years. Buprenorphine knowledge (including status of buprenorphine prescribing waiver), comfort with addressing OUD, and attitudes toward OUD treatment did not differ significantly between the sites. Physicians were 4.5 times more likely to have administered buprenorphine at the intervention site (odds ratio [OR] 4.5, 95% confidence interval 1.4–14.4, $P = 0.01$), which remained significant after adjusting for clinical time and years in practice, (OR 3.5 and 4.6, respectively).

Conclusion: Physicians exposed to interventions addressing system- and clinician-level implementation barriers were at least three times as likely to have administered buprenorphine in the ED. Physicians' buprenorphine knowledge, comfort with addressing and attitudes toward OUD treatment did not differ significantly between sites. Our findings suggest that ED-initiated buprenorphine can be facilitated by addressing implementation barriers, while physician knowledge, comfort, and attitudes may be harder to improve. [West J Emerg Med. 2024;25(3)303–311.]

INTRODUCTION

Opioid-related overdose deaths in the US have increased since the 1990s, and in the 12 months ending June 2023 provisional overdose deaths exceeded 81,000.[1] The emergency department (ED) has been involved in addressing the opioid crisis by implementing opioid-sparing pain management protocols and treating opioid overdoses. Yet patients with non-fatal unintentional opioid overdose visits to the ED are still 100 times more likely to die of an overdose within a year of their index visit than those from a demographically matched population.[2] Emergency departments are in the unique position to initiate and link to evidence-based treatment for opioid use disorder (OUD) when a patient presents acutely with opioid withdrawal or non-fatal overdose.

Buprenorphine, a partial opioid agonist, is an effective medication to treat OUD that has historically not been offered in ED settings. In 2015, D'Onofrio et al published a seminal, randomized controlled study demonstrating the efficacy of ED-initiated buprenorphine and ongoing engagement in OUD treatment at 30-days post discharge.[3] Follow-up studies also demonstrated that ED-initiated buprenorphine is an effective intervention, with ongoing OUD treatment at 30 days in 50–86% of the patients.[4,5] On the heels of these findings, the Substance Abuse and Mental Health Services Administration published a resource guide in 2021 acknowledging the ED as an important site for provision of OUD treatment.[6] In the same year, the American College of Emergency Physicians published consensus recommendations for OUD treatment including use of buprenorphine in the ED.[7]

While buprenorphine use in the ED has increased in recent years,[8] multiple barriers at the system and clinician level limit the implementation of ED-initiated buprenorphine.[9–13] System-level barriers include lack of streamlined order sets for OUD treatment, difficulty referring to ongoing treatment services after discharge, limited availability of expert physicians and pharmacists for consultation, and lack of access to dedicated care coordinators, social workers, or peer counselors. Clinician-level barriers include lack of knowledge, comfort and experience with buprenorphine and OUD treatment, a historical need for a buprenorphine prescribing waiver,[14] as well as stigma toward patients with OUD.

Few studies have examined specific interventions that address clinician-level barriers and post-intervention clinician outcomes. Foster et al described a financial incentive program for emergency physicians to complete the then-required buprenorphine waiver training and reported a positive but variable increase in buprenorphine prescribing in the five months after the incentive.[14] Butler et al reported on a set of behavioral-science informed interventions that increased physician initiation of OUD-related treatments[15] at a single academic ED site with a robust addiction clinic program. Khatri et al randomized physicians to a clinician-level intervention of either a didactic-only group or a didactic plus weekly messaging and a financial incentive group.[16] While 33% of all participants prescribed buprenorphine for the first time in the 90 days post-intervention, buprenorphine administration frequency or knowledge did not differ significantly between the groups. In an ongoing, multicenter effectiveness study of buprenorphine initiation in the ED, D'Onofrio et al described multiple system-level implementation facilitators that include clinical protocols, learning collaboratives, and referral programs.[17,18] The implementation facilitation period was associated with a higher number of emergency clinicians who completed the buprenorphine prescribing waiver, as well as ED visits where clinicians prescribed buprenorphine and naloxone.[19]

We contribute to the growing body of literature by describing a set of interventions that addressed multiple system- and clinician-level implementation barriers to ED-initiated buprenorphine in a safety-net ED. We evaluated post-intervention physician outcomes and compared these between the ED site with targeted interventions and two related sites without targeted interventions. Our aim was to determine whether addressing multiple implementation

Population Health Research Capsule

What do we already know about this issue?
While ED-initiated buprenorphine for the treatment of opioid use disorder has increased, system- and clinician-level barriers continue to limit its use.

What was the research question?
We sought to compare whether interventions addressing barriers to ED-initiated buprenorphine would improve administration of buprenorphine.

What was the major finding of the study?
Physicians at the intervention site were 4.5 times more likely to have administered buprenorphine (95% CI 1.4–14.4, P = 0.01).

How does this improve population health?
ED-initiated buprenorphine can be facilitated by addressing both system- and clinician-level barriers, although physician knowledge, comfort, and attitudes may be harder to improve.

barriers to ED-initiated buprenorphine is associated with improved buprenorphine knowledge, comfort with addressing OUD, and attitudes toward OUD treatment among physicians at the intervention site. We hypothesize that physicians at the intervention site had improved experience with administering buprenorphine in the ED.

METHODS

Study Design

We conducted a cross-sectional study of attending physicians at three EDs affiliated with a large, urban emergency medicine (EM) residency program. Physician knowledge, comfort with, and attitudes toward OUD treatment, as well as experience with administering buprenorphine in the ED, were compared between one intervention site (where a multifaceted set of interventions aimed at addressing clinician- and system-level barriers to ED-initiated buprenorphine was implemented) vs two control sites (where interventions focused on ED-initiated buprenorphine were not implemented). The study was approved by the affiliated institutional review boards (IRB#2019-10920).

Setting

This study took place at three EDs affiliated with a large academic EM training program with 84 residents per year and 100 full-time attending physicians on faculty. One ED site is part of the New York City municipal hospital system, while the other two ED sites are part of a large, private, academic health system. All three EDs see a high visit volume around 70,000 per annum per site and provide safety-net care to a payor mix that is predominantly publicly insured. All three EDs are in the borough of The Bronx, New York, where the opioid-related overdose rate was 73.6 per 100,000 in 2022, representing the highest of all five boroughs in New York City.[20] Consistent with most EM practices across the country, the three ED training sites have not historically offered buprenorphine for opioid withdrawal and OUD treatment.

Intervention Site

Between November 2018–June 2020, the municipal hospital-based ED site (herein referred to as "intervention site") implemented a multifaceted set of interventions to address system-and clinician-level barriers to ED-initiated buprenorphine. System-level interventions customized for the ED included the following: 1) an electronic health record (EHR) note template for opioid withdrawal and OUD assessment; 2) a clinical protocol for administering buprenorphine in the ED; 3) a clinical workflow to provide naloxone training and take-home kits for overdose prevention; and 4) a peer navigation program to facilitate referral and linkage to outpatient buprenorphine treatment, including an in-house substance use disorder treatment program. System-level interventions were funded and developed by a centralized leadership team from the municipal public hospital system. Local ED implementation was facilitated by a clinician champion (JM) who worked closely with an interdisciplinary team of emergency medicine, behavioral health, pharmacy, and social work leadership. Initial salary support for this work was grant-funded.

Clinician-level interventions included the following: 1) a modest financial incentive for voluntary completion of buprenorphine waiver training and obtaining the prescribing waiver; 2) regular updates and reminders about system-level interventions at EM faculty meetings every two weeks; and 3) two, one-hour grand rounds lectures that reviewed the evidence for ED-initiated buprenorphine and the availability of clinical protocols to support buprenorphine treatment. Grand rounds lectures at the time of intervention were conducted in person and voluntarily attended by faculty and residents across the EM residency program. Many of the interventions were introduced in an overlapping manner and refined iteratively during the two-year implementation period.

Control Site

During the same period, a clinical protocol and an order set to support hospital-initiated buprenorphine were also being implemented at the two other ED sites based at the private, academic health system (referred to as "the control site"); however, these interventions did not focus on the ED. Peer navigators based in the ED were available but were not dedicated to support referral and linkage to outpatient buprenorphine treatment. Neither were financial incentives for completion of buprenorphine waiver training or physician meetings dedicated to ED-initiated buprenorphine offered.

Participants

We recruited study participants based on the following criteria: 1) licensed physician eligible to obtain a waiver to prescribe buprenorphine; and 2) attending physicians practicing at either the intervention or control site. We did not include resident physicians in our sample because they rotate at both the intervention and control sites and would have experienced variable exposure to the interventions aimed at ED-initiated buprenorphine. Neither did we include physician assistants who are an important part of the EM workforce because they did not receive the financial incentive and did not attend faculty meetings or grand rounds where most of the clinician-facing interventions occurred.

Data Collection

Between September–December 2020, we emailed 113 eligible emergency physicians at the three ED sites to introduce the opt-in study and continued to send monthly email reminders. We also announced the study in person at attending physician meetings at two of the three sites that

could allocate meeting time during the COVID-19 public health emergency. Individualized email reminders were sent to attending physicians at all sites in the last month of study recruitment. The survey was administered anonymously in English using the online platform Qualtrics (Qualtrics, Provo, UT). Upon completion of the questionnaire, participants were eligible to enter a raffle to win one of five $50 gift cards.

A 22-item survey was adapted from previously published research on clinician barriers to buprenorphine prescribing.[9,11] The survey instrument we developed consisted of five domains: demographics; buprenorphine experience; buprenorphine knowledge; comfort with addressing OUD; and attitudes toward OUD treatment.

Self-reported demographics included age, gender, race, ethnicity, years in practice, and amount of time spent working clinically (clinical time). The number of years in practice was measured by the number of years since American Board of Emergency Medicine certification date, and respondents were considered junior attending physicians if they had seven or fewer years in practice. Clinical time was a dichotomous measure of less than vs $\geq$ 75%, based on the rationale that attending physicians who spend <75% clinical time represent clinician-educators, researchers, or administrators.

For buprenorphine experience, participants were asked to answer yes/no to ever administering buprenorphine in the ED, completing the buprenorphine waiver training, and receiving their buprenorphine prescribing waiver. Buprenorphine knowledge was evaluated with seven questions specific to the clinical use of buprenorphine using a three-point Likert scale ("agree-neutral-disagree"), where agreeing or disagreeing correctly to the knowledge questions was a key outcome. Comfort with OUD treatment was also evaluated with a three-point Likert scale ("comfortable-somewhat comfortable-not comfortable") regarding management of opioid withdrawal, response to opioid overdose, counseling on and administering medications for OUD, and referral to outpatient treatment for substance use disorder. Attitudes toward OUD treatment were measured with level of agreement ("agree-neutral-disagree") to stigmatizing statements describing patients with OUD as difficult to treat, buprenorphine as substituting one drug for another, and prescribing buprenorphine for OUD as increasing medicolegal risk.

Data Analysis

We calculated descriptive statistics for demographic characteristics, buprenorphine experience, and buprenorphine knowledge for physicians at the intervention and control sites. Fisher exact tests were used to assess whether physicians' demographic characteristics and buprenorphine experience differed by site. We examined buprenorphine knowledge by calculating a composite knowledge score based on the number of correct answers to the seven knowledge questions and compared them by site using the Mann-Whitney U-test. Physicians' comfort with addressing OUD and attitudes toward OUD treatment are described with proportion of responses with "comfortable" and "agree," and compared by site with Fisher exact tests and Fisher-Freeman-Halden tests, for variables with more than two categories.

We conducted a post-hoc multivariable analysis because of a statistically significant difference between physicians' buprenorphine experience of "ever administered buprenorphine" by site. We examined possible confounding of this association by the demographic characteristics that are significantly associated with the site. We used logistic regression to assess the association between buprenorphine administration and site while controlling for these covariates. Following the recommendation that one variable should be used for every 10 participants with the outcome, we ascertained that only two variables could be included in a single analysis as there were 20 participants who had "ever administered buprenorphine." Thus, we ran analyses with site and each of the possible confounders separately. All tests were two-sided with a statistical significance criterion of 0.05. We used SPSS version 27 (IBM Corp, Armonk, NY) for all statistical analyses.

RESULTS

Among the 113 eligible attending physicians, 58 (51.3%) physicians fully completed the survey, with 27 responses from the intervention site and 31 responses from the control site. As shown in Table 1, no significant differences in the demographic characteristics of gender, race, and ethnicity were found among emergency physicians by site. Physicians were more likely to spend <75% of time in clinical practice at the intervention vs control sites, 44.4% vs 19.4%, respectively ($P = 0.05$). Nearly twice as many physicians at the intervention site were in clinical practice for seven years or less compared to those at the control site, 70.4% vs 38.7%, respectively ($P = 0.02$). In other words, physicians at the intervention site were more likely to be clinician-educators, researchers and administrators, and junior attending physicians.

For buprenorphine experience, more physicians at the intervention site reported "ever administered buprenorphine" in their clinical practice than physicians at the control site, 51.9% vs 19.4%, respectively ($P = 0.01$). Over half of the physician respondents completed the waiver training at both the intervention and control sites, 55.6% and 51.6%, respectively. Of those who completed the waiver training, most physicians obtained the prescribing waiver. There was no statistical difference in waiver training completion and status by site. For buprenorphine knowledge, the median score of correct answers (of the seven knowledge questions) was three for physicians at the

Table 1. Demographic, experience, and knowledge participant characteristics.

	Intervention site N = 27 n (%)	Control sites N = 31 n (%)	*P*-value
Demographic characteristics			
Gender			0.50
Female	14 (51.9)	13 (41.9%)	
Male	11 (40.7)	17 (54.8%)	
Decline to answer	2 (7.4%)	1 (3.2%)	
Race			0.69
White	17 (63.0%)	22 (75.9%)	
Black	3 (11.1%)	3 (10.3%)	
Asian	2 (3.7%)	3 (10.3%)	
Other	2 (7.4%)	1 (3.4%)	
Decline to answer	4 (14.8%)	1 (3.4%)	
Ethnicity			0.68
Hispanic or Latina/o	2 (7.4%)	4 (12.9%)	
Not Hispanic or Latina/o	25 (92.6%)	27 (87.1%)	
Clinical time			0.05
<75%	12 (44.4%)	6 (19.4%)	
75%+	15 (55.6%)	25 (80.6%)	
Years in practice			0.02*
>7 years	8 (29.6%)	19 (61.3%)	
≤7 years	19 (70.4%)	12 (38.7%)	
Buprenorphine experience			
Ever administered buprenorphine			0.01*
Yes	14 (51.9%)	6 (19.4%)	
No	13 (48.1%)	25 (80.6%)	
Completed waiver training			0.80
Yes	15 (55.6%)	16 (51.6%)	
No	12 (44.4%)	15 (48.4%)	
Obtained prescribing waiver among those who completed waiver training			0.74
Yes	12 (80.0)	12 (75.0)	
No	3 (20.0)	4 (25.0)	
Buprenorphine knowledge			
Mean (SD) number of correct responses (7 items)	3.4 (2.0)	3.3 (2.1)	0.82
Median (range)	3 (0–7)	4 (0 6)	0.88

*Statistical significance with p-value for comparison (p < .05).

intervention site, which was similar to the median score of four at the control site (Mann-Whitney U = 428, $P = 0.88$). As seen in Figures 1 and 2, physicians' comfort with addressing OUD and their attitudes toward OUD treatment did not differ significantly between the intervention and control sites.

The post-hoc analysis (see Table 2) of the association between buprenorphine administration and site indicates that physicians at the intervention site were 4.5 times more likely to have administered buprenorphine than those at the control site (OR 4.5, 95% CI 1.4 – 14.4, $P = 0.01$). After adjusting for the two demographic characteristics that differed by site (clinical time and years in practice), the likelihood of buprenorphine administration remained high and statistically significant among physicians at the intervention site compared to the control site (OR 3.5 with clinical time controlled, 4.6 with years in practice controlled, respectively).

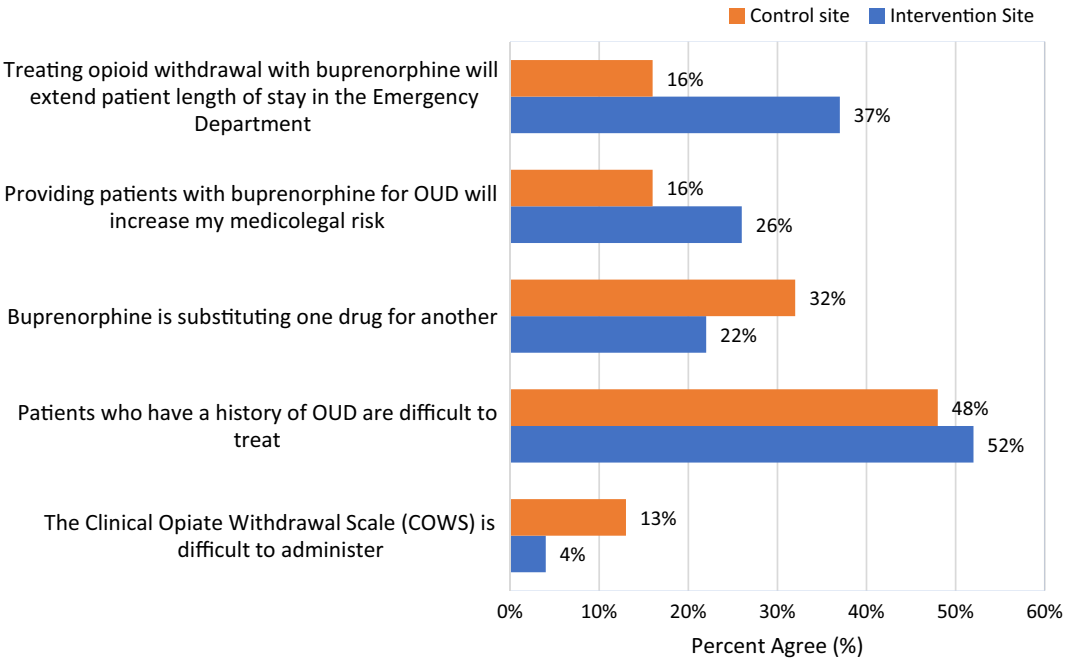

Figure 1. Physician attitudes towards patients living with opioid use disorder (OUD)[1] and use of buprenorphine by site (percent agree.) Physician agreement with the statements along the vertical axis by site. No statistical difference found.

DISCUSSION

In this study, we found that emergency physicians who were exposed to a multifaceted set of interventions that addressed system- and clinician-level barriers to ED-initiated buprenorphine at their clinical site were at least three times as likely to have administered buprenorphine after adjusting for clinical time and years in practice. Yet physicians' buprenorphine knowledge, comfort with addressing OUD,

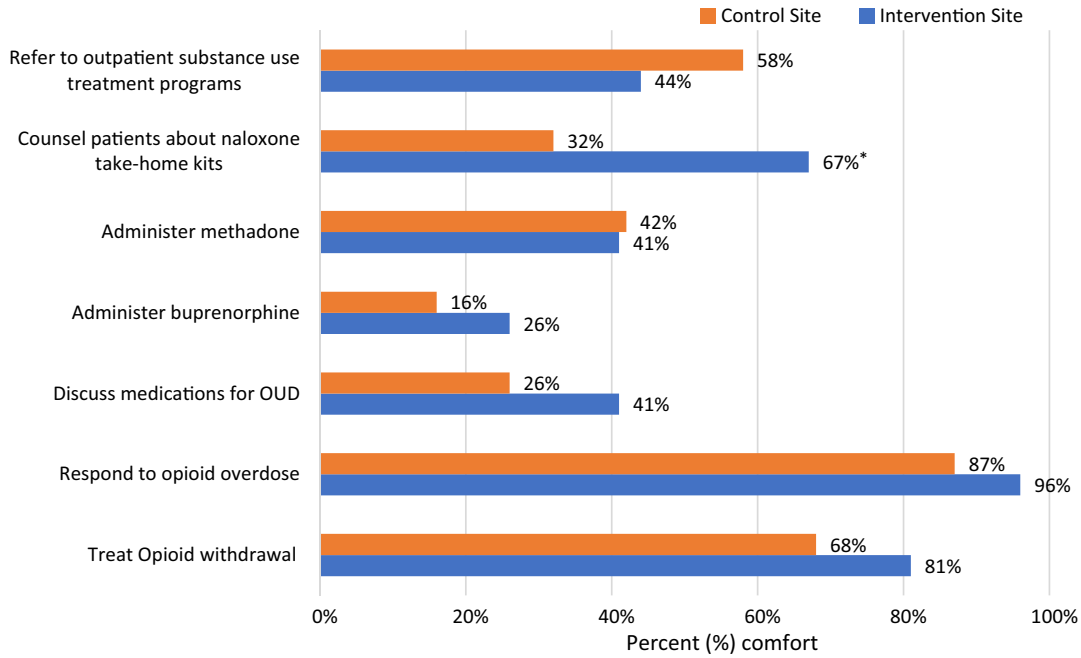

Figure 2. Physician percent comfort with addressing opioid use disorder by site.
Physician comfort with the activities listed along the vertical axis by site. *Statistical significance with *P*-value for comparison ($P < .05$).

Table 2. Predictors of buprenorphine administration by physician characteristics.

	Model 1 Univariate	Model 2 Site and clinical time	Model 3 Site and years in practice
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Site			
Intervention	4.5 (1.4–14.4)*	3.5 (1.0–12.0)*	4.6 (1.3–15.8)*
Control	Ref	Ref	Ref
Clinical time			
<75%	5.4 (1.6–18.0)*	4.3 (1.2–15.0)*	
75%+	Ref	Ref	
Years in practice			
≤7 years	1.5 (0.5–4.5)		0.9 (0.3–3.2)
>7 years	Ref		Ref

*Statistically significant *P*-value < 0.05.
Ref, reference group; *OR*, odds ratio.

and attitudes toward OUD treatment did not differ significantly between the intervention and control sites. Our findings suggest that ED-initiated buprenorphine can be facilitated by addressing system-level implementation barriers, while clinician knowledge, comfort, and attitudes may be harder to improve and may require long-term and/or different interventions.

The system-level interventions described were a series of tools and services introduced to the ED by interdisciplinary stakeholders to encourage the use of evidence-based, ED-initiated buprenorphine that had not previously been considered standard treatment for patients living with OUD. Integrated EHR templates and clinical protocols and workflows were tools to support clinical decision-making, while the peer navigation program provided harm reduction interventions and supported post-discharge planning and linkage to care. The implementation of these system-level interventions was intended to minimize the burden on clinicians and to reduce variation in care.[21] The impact of each intervention was not measured individually because many components were introduced and refined in an overlapping, iterative manner during the implementation period. (For example, announcements and education regarding the EHR order sets and clinical protocols occurred at a similar time and across subsequent meetings.) The cross-sectional study captured only clinician outcomes after receiving the whole set of system-level interventions, which is a limitation of measuring real-world implementation facilitation.

Implementation of these system-level tools and services required interventions at the clinician level to introduce, familiarize, and remind clinicians of available tools and support services. Frequent reminders, educational opportunities, financial incentives for the then-required buprenorphine prescribing waiver coursework were an attempt to encourage knowledge of and comfort with ED-initiated buprenorphine with the goal to support a change in clinical practice to *treat* OUD, not just respond to acute overdoses, in the ED. Our clinician-level interventions eased the implementation of system-level interventions in a similar manner, as the behavioral science-based "nudges" were used to increase the number of physicians who obtained a waiver at another urban, academic ED.[22] The same group also used clinician-level nudges in the form of best practice advisories in the EHR and monthly emails to increase the use of ambulatory referrals to a Bridge Clinic and buprenorphine administration.[15] An important part of the process appears to include a clinical champion who can work with stakeholders to overcome institutional barriers[18,19,23] to refine workflows and protocols, and who can also be a content expert resource to colleagues to introduce evidence-based practice updates and reminders.

In our study, physicians' clinical time and years in practice had an impact on the likelihood of practicing ED-initiated buprenorphine. Clinical time in practice is a variable used to differentiate between physicians with or without dedicated time for clinical education, research, and administration, which was hypothesized to have an independent effect on adoption of emerging clinical practices. Years in independent clinical practice is used as a measure to account for secular trends in EM training; attending physicians with fewer than seven years in clinical practice may have been exposed to frequent press on the opioid epidemic and changing guidelines for OUD treatment in the ED. Im et al report that junior emergency physicians are more likely to view OUD as a chronic disease and approve of buprenorphine initiation in the ED,[24] even if junior emergency physicians expressed a similar sense of frustration treating patients with OUD as senior physicians. Our study did not include resident physicians to minimize cross-contamination of exposure to interventions. Other studies have found that emergency physicians in their residency training are eager to implement ED-initiated buprenorphine.[15,22] Attitudes among emergency physicians are generally changing toward OUD, and it is increasingly being viewed as a chronic disease with

acute manifestations that should be treated in the ED setting.[24,25]

The removal of the buprenorphine-prescribing waiver requirement is an acknowledgment that this clinician-level barrier impeded access to treatment for OUD.[26,27] While this study was completed at a time when the buprenorphine-prescribing waiver requirement was still in effect (and justified financial incentives for emergency clinicians who voluntarily obtained a prescribing waiver), we expect that future interventions to address clinician-level barriers to buprenorphine initiation in the ED will still require a clinical champion who can regularly provide updates about implementation and lead education efforts.

LIMITATIONS

Limitations to our study include a relatively small sample size with a 58% response rate, which may have contributed to a sampling bias. Our clinical sites are in an urban area with a high prevalence of opioid overdose and OUD, which may influence physician interest in and knowledge of OUD and, thus, participation in the survey. Implementation of ED-initiated buprenorphine at the intervention site received financial support and departmental resources in a tertiary-care municipal hospital as well as initial grant funding for salary support of the clinical champion, which may limit generalizability to ED settings in smaller, rural and/or under-resourced hospitals. Without pre-/post-evaluations for each intervention, we were unable to assess whether a particular intervention influenced the difference in buprenorphine administration at the intervention site. Buprenorphine experience is self-reported; responses regarding buprenorphine administration in the ED are not linked to pharmacy data from the interventional or control sites. Lastly, cross-contamination of attending physicians' exposures to interventions may have occurred via residents who rotate among the intervention and control sites. It may have also occurred at the grand rounds lectures where all faculty from the residency sites are invited; however, total faculty attendance typically hovered below 10% for the then in-person lectures.

CONCLUSION

Our study compares the administration of ED-initiated buprenorphine at two similar and related ED settings where physicians at one site were exposed to a multifaceted set of interventions to ED-initiated buprenorphine. Physicians exposed to interventions designed to address system- and clinician-level barriers were more likely to initiate buprenorphine for OUD treatment in their clinical practice. Future implementation efforts should examine interventions that are tailored to implementation barriers even after the buprenorphine- prescribing waiver requirement has been eliminated, including residency education to improve the understanding and uptake of ED-initiated buprenorphine. Coupling pharmacy-level buprenorphine administration and prescribing data with physician-reported outcomes will also help parse out impact of future interventions.

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Factors Associated with Acute Telemental Health Consultations in Older Veterans

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Introduction: The United States Veterans Health Administration is a leader in the use of telemental health (TMH) to enhance access to mental healthcare amidst a nationwide shortage of mental health professionals. The Tennessee Valley Veterans Affairs (VA) Health System piloted TMH in its emergency department (ED) and urgent care clinic (UCC) in 2019, with full 24/7 availability beginning March 1, 2020. Following implementation, preliminary data demonstrated that veterans ≥65 years old were less likely to receive TMH than younger patients. We sought to examine factors associated with older veterans receiving TMH consultations in acute, unscheduled, outpatient settings to identify limitations in the current process.

Methods: This was a retrospective cohort study conducted within the Tennessee Valley VA Health System. We included veterans ≥55 years who received a mental health consultation in the ED or UCC from April 1, 2020–September 30, 2022. Telemental health was administered by a mental health clinician (attending physician, resident physician, nurse practitioner, or physician assistant) via iPad, whereas in-person evaluations were performed in the ED. We examined the influence of patient demographics, visit timing, chief complaint, and psychiatric history on TMH, using multivariable logistic regression.

Results: Of the 254 patients included in this analysis, 177 (69.7%) received TMH. Veterans with high-risk chief complaints (suicidal ideation, homicidal ideation, or agitation) were less likely to receive TMH consultation (adjusted odds ratio [AOR]: 0.47, 95% confidence interval [CI] 0.24–0.95). Compared to attending physicians, nurse practitioners and physician assistants were associated with increased TMH use (AOR 4.81, 95% CI 2.04–11.36), whereas consultation by resident physicians was associated with decreased TMH use (AOR 0.04, 95% CI 0.00–0.59). The UCC used TMH for all but one encounter. Patient characteristics including their visit timing, gender, additional medical complaints, comorbidity burden, and number of psychoactive medications did not influence use of TMH.

Conclusion: High-risk chief complaints, location, and type of mental health clinician may be key determinants of telemental health use in older adults. This may help expand mental healthcare access to areas with a shortage of mental health professionals and prevent potentially avoidable transfers in low-acuity situations. Further studies and interventions may optimize TMH for older patients to ensure safe, equitable mental health care. [West J Emerg Med. 2024;25(3)312–319.]

INTRODUCTION

In 2020, 52.9 million people in the United States (US) suffered from a mental health or substance use disorder.[1,2] Emergency department (ED) visits and admissions for psychiatric concerns continue to increase.[3–7] Despite the increased demand, there is a widespread mental health professionals shortage in the US, which negatively affects access to timely, efficient mental healthcare for society's most vulnerable populations. An estimated 7,632 clinicians are needed to bridge the gap in low-resourced areas.[8] Approximately 66% of rural or partially rural counties are designated by the federal government as mental health professional shortage areas.[8] Patients in these areas have been found to have worse health outcomes, including shorter life expectancy and higher rate of suicide.[9–11] Innovative solutions are needed to address these key gaps to expand access to equitable mental health services, particularly in the setting of acute crises.

Telehealth was first described in clinical practice in the late 1950s.[12] Over the past two decades, use has expanded in a variety of clinical settings.[13] The Veterans Health Administration has adopted telehealth across a variety of settings, including mental health complaints.[14] By 2016, nearly half of EDs in the US reported the use of telehealth, with 20% using it for mental health purposes (telemental health [TMH]).[15,16] The use of TMH in routine ED clinical practice grew dramatically during the COVID-19 pandemic.[5] For many EDs, it is the only avenue to emergency psychiatric care.[15]

On March 1, 2020, the Tennessee Valley Veterans Affairs Health System implemented full-time TMH for veterans who presented to the ED for mental health complaints. Both TMH and in-person consultations performed by a mental health clinician were available 7 days a week, 24 hours a day, including holidays, at the ED and during all operating hours at the UCC (daily 8 AM – 8 PM). Consultation modality was left to the choice of the mental health clinician. In-person clinician coverage was always available by an attending physician, resident physician, nurse practitioner, or physician assistant during facility operating hours. Capabilities did not change depending on the role of the clinician. A more detailed description of the program is provided elsewhere.[17] Despite the implementation of this TMH program, preliminary data showed 20% of mental health consultations still occurred in person.[17] Veterans who received in-person mental health evaluations were notably older compared to those receiving TMH, with 31% in-person consults occurring in veterans ages ≥65 vs 18% of TMH consults.[17]

Older patients with mental health complaints face unique challenges in the emergency setting. Attention to these patients during the implementation of new processes of care is vital to ensure they receive high-quality mental health evaluation. With the exponential growth projected for the older population in the US, understanding factors associated with variability of TMH use will inform future implementation and sustainability in acute care settings.[18] In this study we sought to examine factors associated with older veterans receiving TMH consultations in acute, unscheduled, outpatient settings to identify potential barriers to widespread use of TMH in the ED. Encounters involving patients older than 75, urban location, resident physicians, and higher acuity were hypothesized to be more likely to occur in person.

Population Health Research Capsule

What do we already know about this issue?
There is a widespread shortage of mental health professionals in the US, which decreases access to timely emergency mental healthcare.

What was the research question?
What factors are associated with older veterans receiving acute, unscheduled telemental health (TMH) vs in-person consults?

What was the major finding of the study?
High-risk chief complaints (suicidal or homicidal ideation, or agitation) were associated with decreased TMH use (OR 0.39, 95% CI 0.18–0.81). Type of clinician and location of care were also associated with TMH use.

How does this improve population health?
TMH represents an opportunity to expand access to mental healthcare, thereby reducing potentially unnecessary patient transfers and shortening boarding times.

METHODS

Study Design, Setting, and Patient Population

This was an exploratory, retrospective, cohort study conducted at the Tennessee Valley VA Health System ED and urgent care clinic (UCC).[20] Described in more detail elsewhere, this TMH program was initially piloted during limited hours in 2019 and then went live with 24/7 coverage in March 2020 with the onset of the COVID-19 pandemic.[17] Patients were initially evaluated by an ED or UCC clinician (attending physician, resident physician, nurse practitioner, or physician assistant) and determined to need mental health consultation. A consult order was then requested through the

electronic health record (EHR) with direct communication between the emergency physician and on-call mental health clinician (nurse practitioner, physician assistant, or attending psychiatrist). Consult modality was left to the decision of the on-call mental health clinician. The TMH visit was provided via Apple iPad (Apple Inc, Cupertino, CA) with audio and visual capabilities, whereas in-person evaluations were performed by the same mental health clinician in the ED or UCC. Both in-person and TMH consultations were available 24/7 in the ED and during operating hours of the UCC.

We included veterans who were ≥55 years and received a mental health consultation in the ED between April 1, 2020–September 30, 2022. Since there is no universally accepted age that defines "older age," we chose 55 years old as the cut-off to maximize our sample size while maintaining a median age of 65 years old, a traditional cut-point. Non-veterans without service benefits, direct admissions who did not present through the ED, and patients with a missing modality of consultation were excluded. For veterans with multiple ED mental health encounters, only the first consultation encounter was included. Of 1,478 initial visits within the study period, we selected 510 charts to review; 497 had complete mental health consultations in the chart. A substantial proportion of patients received TMH during the study period. Therefore, 2–3 TMH consultations were included for each in-person consultation. We balanced the number of charts selected for each month of the study to reduce temporal bias. We then excluded all patients <55 years from this analysis. This study was approved by the local institutional review board as exempt.

Data Collection

We designed the chart review methodology to follow accepted guidelines.[21] Data was manually extracted from the VA EHR and Clinical Data Warehouse. The following patient factors were included in this analysis: age; race; gender; marital status; rurality; ED triage chief complaint; mental health history; total active number of psychoactive medications; and presence of additional non-psychiatric medical complaint (eg, chest pain). Rurality was determined by the Rural-Urban Commuting Area Codes based on the patient's ZIP code.[22] We considered the following system-level factors: location (ED vs UCC); timing of presentation (9 AM – 5 PM or nights/weekends) and mental health clinician type (nurse practitioner, physician assistant, resident physician, or attending physician).

Patient demographics, visit date, homelessness, psychiatric history, and medications were manually abstracted by a physician (ECK) and nurse (SP). Senior authors trained abstractors prior to data collection. Each reviewer underwent mentored training on how to review each chart with a trial period of manual double-checking by the senior author to ensure competency. Each chart was reviewed by either the physician or nurse reviewer and then was carefully double-checked by the same reviewer for inaccuracies. Each chart was reviewed by one person. Data abstraction forms were used, and the data was compiled using REDCap electronic data capture tools hosted at US Department of Veterans Affairs.

We used the total number of psychiatric conditions documented in the EHR prior to the index ED visit to determine psychiatric comorbidity burden. Any mention of suicidal ideation, homicidal ideation, and agitation qualified as high-risk mental health chief complaints, regardless of whether this was the patient's primary reason for ED evaluation. Additional medical reasons for the ED visit were collected by reviewing triage and physician documentation.

Outcome Measures

The primary dependent variable of interest was receipt of TMH vs in-person mental health consultation by a mental health clinician who was an attending physician, resident physician, or nurse practitioner.

Data Analysis

We reported central tendency and dispersion as medians and interquartile ranges for continuous variables. Categorical variables were reported as frequencies and percentages. A multivariable logistic regression analysis was performed to determine factors associated with use of TMH. We created a moderately saturated model with 7–8 covariates to minimize overfitting.[23] Given the small sample size, independent variables were ranked a priori based on expert opinion from psychiatrists (EJW, CC) and emergency physicians (MJW, JHH) who routinely care for mental health patients. The top seven ranked factors for TMH vs in-person mental health evaluation included age, race, high-risk chief complaint, presence of dementia, urban location, timing of presentation, and history of substance abuse. To explore additional factors associated with TMH vs in-person mental health consultation, we performed a highly saturated model incorporating all factors into the multivariable logistic regression model. Because site (ED vs UCC) of patient presentation may have strongly influenced TMH vs in-person mental health, this factor was incorporated into the models. Adjusted odds ratios (aOR) with 95% confidence intervals (CI) are reported. We conducted all statistical analyses with R statistical software, v3.6.2 (The R Project for Statistical Computing, Vienna, Austria).

RESULTS

Of the 510 health records reviewed, 254 patients met age inclusion criteria (≥55 years of age) and were included in the study. Characteristics of this older cohort vs the entire cohort of charts reviewed is included as a supplemental table. Of those eligible, 177 (69.7%) veterans received TMH

Table 1. Baseline demographic data of patients presenting to the emergency department or urgent care center receiving psychiatric consultation.

Variable	In-person (n = 77)	Telemental health (n = 177)
Age, (years)	65 [61, 71]	65 [61, 70]
Gender, n (%)		
Female	3 (3.9)	14 (7.9)
Male	74 (96.1)	163 (92.1)
Race, n (%)		
Black	30 (39.0)	72 (40.7)
Non-Black	47 (61.0)	105 (59.3)
Marital status, n (%)		
Married	26 (33.8)	44 (24.9)
Unmarried/unknown	51 (66.2)	133 (75.1)
Chief complaint risk, n (%)		
Low	49 (63.6)	130 (73.4)
High	28 (36.4)	47 (26.6)
History of dementia, n (%)		
Yes	10 (13.0)	18 (10.2)
No	67 (87.0)	159 (89.8)
Location, n (%)		
ED	76 (98.7)	151 (85.3)
UCC	1 (1.3)	26 (14.7)
Rural, n (%)		
Rural	24 (31.2)	45 (25.4)
Urban	53 (68.8)	132 (74.6)
ESI score ≥ 2, n (%)	77 (100.0)	177 (100.0)
ESI score, n (%)		
<3	22 (28.6)	61 (34.5)
≥3	55 (71.4)	116 (65.5)
Timing of presentation, n (%)		
Off hours	28 (36.4)	64 (36.2)
Business hours	49 (63.6)	113 (63.8)
History of substance abuse, n (%)		
No	36 (46.8)	74 (41.8)
Yes	41 (53.2)	103 (58.2)
Mental health clinician type, n (%)		
Attending physician	62 (80.5)	123 (69.5)
Resident physician	7 (9.1)	1 (0.6)
Nurse practitioner or physician assistant	8 (10.4)	53 (29.9)
Total psychoactive medications, median [IQR]	2.00 [1.00, 4.00]	2.00 [1.00, 4.00]
Total psychiatric comorbidities, median [IQR]	1.00 [1.00, 2.00]	2.00 [1.00, 2.00]
Additional triage medical complaint, n (%)		
No	48 (62.3)	118 (66.7)
Yes	29 (37.7)	59 (33.3)
Homelessness, n (%)		
No	64 (83.1)	144 (81.4)
Yes	13 (16.9)	33 (18.6)
CCI score, median [IQR]	2.00 [1.00, 4.00]	2.00 [1.00, 5.00]

ESI, Emergency Severity Index; *IQR*, interquartile range; *CCI*, Charlson Comorbidity Index; *UCC*, urgent care clinic; *ED*, emergency department.

consultations, and 77 (30.3%) veterans received an in-person evaluation. There were no missing data points on chart review. In the unadjusted results, UCC location and consultation performed by nurse practitioners and physician assistants was associated with a statistically significant trend towards TMH use (Table 1). Consultations performed by resident mental health physicians were more likely to occur in person but represented few consults overall (Table 1). Age, race, presence of dementia or substance use disorder in medical history, total psychoactive medications, psychiatric comorbidity burden, homelessness, and marital status were not associated with significant differences in consult modality.

We then performed multivariable logistic regression analysis. Models were adjusted for location to account for site practice differences at the ED and UCC, as the UCC performed nearly all consults via TMH. Table 2 demonstrates a moderately saturated risk model. No factors were significantly associated with TMH use beyond urgent care location (AOR 15.15, 95% CI 1.98–116.04). In a highly saturated model, patients evaluated by resident physicians were less likely to receive TMH (AOR 0.04, 95% CI: 0.00–0.58), while those evaluated by nurse practitioners and physician assistants received it more frequently (A5.07, 95% CI: 2.13–12.03), compared to attending physicians (Table 3). Patients with high-risk chief complaints (suicidal ideation, homicidal ideation, or agitation) were less likely to receive TMH (AOR: 0.39, 95% CI: 0.18–0.81) in the highly saturated risk model (Table 3). Gender, age, race, comorbidity burden, timing of presentation, history of substance use disorder, history of dementia, and homelessness were not associated significant differences in consult modality.

Table 2. Multivariable regression analysis – moderately saturated model.

Variable	Adjusted odds ratio	95% confidence interval
Age	1.02	0.98–1.07
Race–Non-black	0.87	0.35–2.13
High-risk chief complaint	0.54	0.29–1.00
History of dementia	0.86	0.35–2.13
Location at UCC	15.15	1.98–116.04
Urban location	1.54	0.82–2.88
Timing of presentation during off hours	1.16	0.64–2.09
History of substance abuse	1.33	0.72–2.44

UCC, urgent care clinic.

Table 3. Multivariable regression analysis – highly saturated model.

Variable	Odds ratio	95% confidence interval
Age	1.04	0.99–1.09
Gender–male	0.35	0.07–1.70
Race–non-Black	0.79	0.40–1.57
Marital status–unmarried or unknown	1.11	0.54–2.30
High-risk chief complaint	0.39	0.18–0.81
History of dementia	0.51	0.18–1.42
UCC location	29.11	2.76–306.99
Urban location	1.48	0.74–2.98
Timing of presentation during off hours	1.36	0.70–2.63
History of substance abuse	1.14	0.57–2.26
Mental health clinician type		
Nurse practitioner or physician assistant	5.07	2.13–12.03
Resident physician	0.04	0.00–0.58
Total psychoactive medications	1.11	0.94–1.32
Total psychiatric comorbidities	1.18	0.90–1.54
Additional triage medical complaint	0.72	0.37–1.40
Homelessness	1.13	0.47–2.71
CCI score	1.09	0.97–1.23

UCC, urgent care clinic; *CCI*, Charlson Comorbidity Index.

DISCUSSION

In an older cohort of veterans presenting to the ED or UCC with acute psychiatric complaints, we found that high-risk psychiatric chief complaints, clinician type, and location of the mental health consult were key drivers of consultation modality. Specifically, we observed that patients with high-risk psychiatric chief complaints (suicidal ideation, homicidal ideation, and agitation) were more likely to receive in-person consultations. Resident physicians performing consults were less likely to use TMH, while nurse practitioners and physician assistants were more likely to choose TMH. The UCC used TMH near universally.

The moderately saturated risk model of most highly ranked a priori factors showed AORs greater than 1 in urban location, timing of presentation during off hours, and history of substance use disorder. However, the 95% CI were too wide to be significant. These findings were similar in the highly saturated model. While not statistically significant, these factors may hold clinical relevance. Further studies with a higher sample size are needed to clarify any significance.

One potential explanation for reduced use among higher severity complaints is that mental health clinicians may feel more compelled to conduct in-person consultation in higher acuity situations because this is what they are most familiar with. Practice changes such as the use of TMH may create a disruption as physicians struggle to "unlearn" what they are most familiar with prior to establishing a new practice pattern.[24] Alternatively, as recognized by the Society for Academic Emergency Medicine Consensus Conference on Emergency Telehealth, little research has been done on the quality and safety of telehealth.[25] Recent work has sought to address this. Evidence suggests patients presenting with acute psychosis may tolerate telehealth well.[26,27] Telemental health has been found to have no difference in long-term outcomes of rehospitalization and death in patients with suicidal ideation and suicide attempts compared to in-person consultation.[26,28] Additionally, recent work has suggested that TMH is not associated with increased 30-day return visits, readmissions, or death compared to in-person evaluations in acute care settings.[26] Therefore, ED and mental health clinicians should be educated on the safety of TMH in older ED patients with high-risk mental health chief complaints.

Prior research demonstrated that clinicians contribute substantial variability to the decision to use telehealth and may partially explain why there are such differences in the use of TMH by clinician type (ie, resident physicians vs nurse practitioners and physician assistants).[29] There were no differences in clinician scheduling that could account for the findings in our study. All mental health clinicians, including residents, were available to perform in-person or TMH evaluations. Therefore, location did not make residents more or less likely to evaluate patients in person. The pandemic demonstrated variability in telehealth use with clinician factors having a greater influence on the use of video telehealth when compared with patient factors.[29] Moreover, prior studies indicate there are variabilities in patients who are offered telehealth despite being video-capable.[30] Prior

qualitative studies suggest that increased exposure to telehealth improved clinician attitudes, while perceptions of complexity within the process led to reduced utilization.[31] Further research is needed to better understand whether inequities and any contributing factors exist.

Systems with unanimous leadership buy-in and policies use telehealth more frequently.[31] Despite the availability of an in-person mental health clinician, the UCC used TMH for nearly every encounter. It is plausible that similar systemic factors may be contributing to this phenomenon. Investigating the policies and decision-making processes through qualitative studies could shed light on the underlying reasons for the near-universal use of TMH at the UCC, as factors not captured in this study are likely involved.

Reluctance to adopt TMH may contribute to potentially avoidable transfers in EDs with limited mental health resources. Prior research found that mental health patients were the most likely to be transferred from VA EDs and represent the largest group of potentially avoidable transfers, defined as those transfers rapidly discharged from the ED or within 24 hours from hospital admission (without a procedure).[32] Our findings suggest that mental health clinicians felt comfortable evaluating patients via TMH in low-acuity situations. In places without access to in-person mental health consultation, patients with lower acuity complaints may be evaluated and safely discharged via TMH, reducing the risk of unnecessary transfer.[33]

We identified only one resident TMH encounter throughout the entire study period. As residents generally rotate between multiple VA and non-VA clinical services, this finding may be due to lack of familiarity with the process in this system. Due to the low overall number of consultations performed by residents, it is difficult to draw conclusions regarding this data. Educational initiatives targeting telehealth use among resident physicians may increase familiarity with TMH.[34,35] As telehealth expanded across multiple specialties during the pandemic, medical training curricula could be adapted to include telehealth initiatives.[34,35]

LIMITATIONS

Limitations of this study included a small sample size. Our sample size may have been too small to identify risk factors for TMH use. Additionally, because this study was conducted in a single center it may not be generalizable to other settings. Risk factors identified in our exploratory analysis and the significant associations observed may have been secondary to overfitting as statistical significance was only noted in the highly saturated model. As a result, these findings should be confirmed in a larger sample size. Additionally, the VA has a low proportion of women veterans (estimated 11.5%), potentially limiting the generalizability of our study outside the VA population.[36] Further studies outside the VA population are needed to assess for any gender-specific differences that may impact consult modality choice.

The ED/UCC clinician and mental health clinician generally had a verbal conversation on call prior to mental health consultation. These conversations may have influenced modality choice by the mental health clinician. Our quantitative data would not have been able to capture these conversations. Further qualitative work may bridge this gap to understand a clinician's modality choice.

There are potential confounders to this study that were not accounted for. Severity of illness likely affects both the likelihood of acute care presentation and the consult modality choice. While we adjusted for high-risk psychiatric complaints to account for severity of illness, residual confounding likely still exists. Encounters that occurred during the COVID-19 pandemic also likely influenced both the likelihood of acute care presentation and the consult modality choice. More mental health clinicians may have opted for TMH to reduce the risk of virus transmission, especially during periods of widespread COVID-19 transmission. Patients may have also been more fearful of presenting to the ED for care during these times. Ongoing post-pandemic data analysis both at this facility and externally should be performed to evaluate the effects of the COVID-19 pandemic on TMH use.

CONCLUSION

In this exploratory retrospective analysis, illness severity, location, and clinician characteristics appeared to influence use of telemental health in patients over age 55. Lower acuity, older patients represent a patient population with whom more clinicians would be comfortable using TMH. For resource-poor settings, TMH may represent an opportunity to expand access to mental healthcare in shortage areas and reduce potentially unnecessary patient transfers that could otherwise be prevented via remote consultation. Further research is needed to examine hesitancy to adopt TMH in more acutely ill populations and the generalizability of the findings presented in this work.

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Implementation and Evaluation of a Bystander Naloxone Training Course

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Introduction: Bystander provision of naloxone is a key modality to reduce opioid overdose-related death. Naloxone training courses are available, but no standardized program exists. As part of a bystander empowerment course, we created and evaluated a brief naloxone training module.

Methods: This was a retrospective evaluation of a naloxone training course, which was paired with Stop the Bleed training for hemorrhage control and was offered to administrative staff in an office building. Participants worked in an organization related to healthcare, but none were clinicians. The curriculum included the following topics: 1) background about the opioid epidemic; 2) how to recognize the signs of an opioid overdose; 3) actions not to take when encountering an overdose victim; 4) the correct steps to take when encountering an overdose victim; 5) an overview of naloxone products; and 6) Good Samaritan protection laws. The 20-minute didactic section was followed by a hands-on session with nasal naloxone kits and a simulation mannequin. The course was evaluated with the Opioid Overdose Knowledge (OOKS) and Opioid Overdose Attitudes (OOAS) scales for take-home naloxone training evaluation. We used the paired Wilcoxon signed-rank test to compare scores pre- and post-course.

Results: Twenty-eight participants completed the course. The OOKS, measuring objective knowledge about opioid overdose and naloxone, had improved scores from a median of 73.2% (interquartile range [IQR] 68.3%–79.9%) to 91.5% (IQR 85.4%–95.1%), $P < 0.001$. The three domains on the OOAS score also showed statistically significant results. Competency to manage an overdose improved on a five-point scale from a median of 2.5 (IQR 2.4–2.9) to a median of 3.7 (IQR 3.5–4.1), $P < 0.001$. Concerns about managing an overdose decreased (improved) from a median of 2.3 (IQR 1.9–2.6) to median 1.8 (IQR 1.5–2.1), $P < 0.001$. Readiness to intervene in an opioid overdose improved from a median of 4 (IQR 3.8–4.2) to a median of 4.2 (IQR 4–4.2), $P < 0.001$.

Conclusion: A brief course designed to teach bystanders about opioid overdose and naloxone was feasible and effective. We encourage hospitals and other organizations to use and promulgate this model. Furthermore, we suggest the convening of a national consortium to achieve consensus on program content and delivery. [West J Emerg Med. 2024;25(3)320–324.]

INTRODUCTION

Time is a critical contributing factor in patient outcomes in many emergencies. In the United States, the average response time by emergency medical services to a 9-1-1 call is seven minutes.[1] To bridge this gap, many efforts have been launched to empower laypersons, who are typically first on the scene, to intervene and employ skills ranging from cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) use to bleeding control interventions.[2] Basic Life Support (BLS) course content is based upon rigorous and frequently updated consensus (ie, American Heart Association [AHA] Guidelines Update for CPR and Emergency Cardiovascular Care).[3,4] These courses are taught in a standardized fashion by the AHA and the American Red Cross. Likewise, the Stop the Bleed (STB) program, a national initiative launched in 2015 focused on empowering the public and public safety professionals to recognize and control life-threatening bleeding, has several types of courses, the most prominent being the American College of Surgeons' (ACS) Basic Hemorrhage Control Course (BCon).[5,6]

While CPR, AED and STB training focus on preventable deaths, another significant source of preventable deaths is the opioid overdose epidemic, which remains one of the most pressing public health issues of our time, having claimed about 1,000,000 lives in the US since 1999.[7] The number of overdose deaths has increased greatly in recent years, with yet another record number in 2021, predominantly due to fentanyl.[8] Bystander naloxone administration, which can be used to reverse an opioid overdose, has been introduced as one potential mitigating factor. In 2018, the US Surgeon General issued an advisory on naloxone and opioid overdose that encourages community members who come into contact with people at risk for opioid overdose to know how to use naloxone and keep it within reach.[9] Likewise, the US Department of Health and Human Services' overdose prevention strategy includes harm reduction, with a goal to widen access to opioid overdose reversal treatments.[10]

Unlike CPR, there is no one standardized course for bystander naloxone training. Online courses are offered by agencies such as the Centers for Disease Control and Prevention (CDC),[11] the American Red Cross,[12] individual states (eg, Massachusetts[13] and New York[14]), and other non-profits (eg, GetNaloxoneNow[15]). The courses lack a standardized core content, measures of effectiveness, or agreed-upon delivery methods (in person, hybrid, remote, simulation, didactic, etc). Although anecdotes exist of layperson use, we have a limited understanding of an effective, layperson naloxone-empowerment curriculum, and gaps remain in knowledge about training parameters and strategies.[16]

In this study, we evaluated an overdose-response naloxone training program administered to laypersons. We emphasized the structure and curriculum of the course and evaluated efficacy with a validated screening tool.

METHODS

The naloxone course was designed to be a brief intervention with 20 minutes of didactics and 20 minutes of practical experience with a mannequin. The course was bundled with the ACS BCon course as part of a bystander empowerment program. Course instructors were three board-certified emergency physicians. The session took place at a professional office building. Although the participants worked in an organization related to healthcare, all worked as office staff and none were clinicians. Two identical sessions were offered, and both took place in June 2018 during normal business hours. Participants were not compensated specifically for participating but attended in lieu of their normal duties. We administered anonymous pre- and post-course evaluations. The project was determined to not meet the criteria for human subject research by the Mass General Brigham Human Research Office.

Curriculum

Created by the course instructors, the curriculum included the following topics: 1) background about the opioid epidemic; 2) how to recognize the signs of an opioid overdose; 3) actions not to take when encountering an overdose victim; 4) the correct steps to take when encountering an overdose victim; 5) an overview of naloxone products; and 6) Good Samaritan protection laws. Content was created by first searching for existing training resources online, including training manuals from the states of New York (https://www.dhses.ny.gov/naloxone-information-first-responders) and Texas (https://txoti.org), and Canadian province Manitoba (https://www.gov.mb.ca/health/publichealth/docs/training_manual_overdose.pdf). This information was integrated with additional content from course instructor expertise into a didactic module containing 30 slides (Appendix 1), and participants were provided with a hard copy of the slides. The practical module entailed small groups around a simulation mannequin with a course instructor. Participants were able to practice with two types of naloxone kits (pre-packaged nasal naloxone spray and an autoinjector) on the mannequin. Discussion was encouraged until all participants' questions and concerns were addressed.

Course Evaluation

To evaluate the efficacy of the course, we used the Opioid Overdose Knowledge (OOKS) and Opioid Overdose Attitudes (OOAS) scales for take-home naloxone training evaluation.[17] The first half of this validated tool (OOKS) asks objective questions about opioid overdose to evaluate trainee knowledge, including indicators of opioid overdose, how to manage an overdose, the mechanism of action of naloxone, and its duration of action. The second part (OOAS) asks questions pertaining to perceptions of competencies to manage an opioid overdose, concerns about managing an overdose, and readiness to intervene in an opioid overdose.

Statistical Analysis

All participants completed pre- and post-evaluations on paper forms. Subjects were asked to write the same random four-digit number on each of the two evaluations for paired analysis purposes. Responses were transferred to a spreadsheet, and a second investigator confirmed the accuracy of the transcription. The OOKS scale is a series of true/false statements, and the correct answers were summed, with a total possible 41 points. We modified the original 45-point version slightly, as multiple points were possible for several individual questions (eg, "What is naloxone used for?" and "How can naloxone be administered?") and we counted them only as one point each. There was also a choice of "don't know" for several questions, and that was considered an incorrect answer as indicated in the scoring instructions. The OOAS scale is 28 questions divided into three domains and measured on a five-point Likert scale (5 = completely agree and 1 = completely disagree). Although the post-test OOKS results and one of the domains on the OOAS were normally distributed as determined by the Shapiro-Wilk test, the remainder of results were non-normal. Thus, all results, including the scales on each domain of the OOAS and the overall score on the OOKS, are described with medians and interquartile range (IQR) and compared with the paired Wilcoxon signed-rank test. We analyzed data with JMP v16 (JMP Statistical Discovery LLC, Cary. NC).

RESULTS

Twenty-eight participants took the course. All completed the pre-test and the post-test, although three participants did not answer all questions on the pre-test OOAS scale. Therefore, the corresponding answers in the domains for these three individuals on the post-test were not included in the analysis. The OOKS, measuring objective knowledge about opioid overdose and naloxone, had improved scores from a median of 73.2% (IQR 68.3%–79.9%) to 91.5% (IQR 85.4%–95.1%), $P < 0.001$. The three domains on the OOAS score also showed statistically significant results. Competency to manage an overdose improved from a median of 2.5 (IQR 2.4–2.9) to a median of 3.7 (IQR 3.5–4.1), $P < 0.001$. Concerns about managing an overdose decreased (improved) from a median of 2.3 (IQR 1.9–2.6) to median 1.8 (IQR 1.5–2.1), $P < 0.001$. Readiness to intervene in an opioid overdose improved from a median of 4 (IQR 3.8–4.2) to a median of 4.2 (IQR 4–4.2), $P < 0.001$.

DISCUSSION

In creating and evaluating a naloxone training program for bystanders, we found improvement in both subjective attitudes and objective knowledge about opioid overdose and naloxone. The training is relatively brief (lasting under an hour) and effective. We have subsequently taught this curriculum several times to local community organizations, including those who work with people who use drugs. Although we did not measure objective outcomes subsequently, the concept of bystander empowerment, teaching both naloxone and STB skills, has been well received and represents important outreach from our hospital to the local community.

One key question that remains is whether this training is necessary for bystanders. In our previous research, we found that 49 of 50 bystanders were able to correctly administer naloxone in a simulated experience on a public sidewalk with guidance by a simulated 911 dispatcher.[18] However, not everyone will have the guidance of a dispatcher when using naloxone, and there may be confusion about how to use the kit and the timing of a second dose (if needed) without that assistance. Bystander training may also be valuable as a way to foster self-efficacy, increasing the likelihood that a layperson will recognize and respond to an overdose. In our course, we also cover when bystanders should administer naloxone and dispel myths about any harm that can be caused by giving it, as well as how to access naloxone.

Naloxone for bystanders is currently available via standing order in several states, meaning that individuals can obtain it from pharmacies without a prescription.[19–22] Standing orders are associated with reductions in fatal overdoses in the community.[23] The current packaging of prescription nasal naloxone has a flap that opens giving just-in-time (JIT) instructions to the bystander, but that may not be sufficient. The US Food and Drug Administration (FDA) recently approved making nasal naloxone an over-the-counter medication, even though its briefing document described several cases of incorrectly administered naloxone, including an individual who did not place the tip of the dispenser fully in the nostril, someone who squeezed the device but did not push the plunger, another who placed the device upside down so that the plunger was in the nostril, and several individuals who did not wait 2-3 minutes before administering a second dose.[24] While the FDA advisors voted unanimously to make naloxone available without a prescription,[25] these errors in administration indicate the need for a bystander course that could further improve outcomes.

Another reason to teach such a course is to address stigma, which is pervasive when considering opioid use disorder (OUD).[26] A recent study of individuals who did not use illicit opioids themselves but knew others who did reported stigma about OUD and misinformation about opioid-related risks.[27] Naloxone-based interventions can introduce the concept of harm reduction, empower bystanders, and encourage individuals to carry naloxone in case they encounter an overdose victim.[28]

Although not a part of our study, despite the positive results on our objective and subjective testing, we do encourage the creation of standardized training. The STB BCon portion of our course was created and endorsed by the ACS, using standardized content and certified trainers.

A similar process could be used for naloxone, either as part of a BLS training, such as from the AHA or American Red Cross, from a specialty society, such as the American Academy of Emergency Medicine, the American College of Emergency Physicians, or the American Society of Addiction Medicine, or from a national advocacy group such as Shatterproof. Such branding and promotion may empower more bystanders to become trained and further reduce stigma and misconceptions about OUD among the general population.

While CPR training for laypersons is the gold standard, many gaps in implementing bystander training remain, and an investment in the study of the effectiveness of the relatively simple steps of naloxone administration may help us learn and improve techniques of CPR and STB training as well. For example, despite educational initiatives that began in the 20th century, only one-third of out-of-hospital cardiac arrest patients receive bystander CPR. Time, location, and duration have all been perceived by the public as barriers to CPR classes.[29] Blacks and Hispanics are less likely than Whites to receive CPR at home or in public.[30] In the last decade, there have been many initiatives with variable efficacy, in most cases not measured, to use JIT tools like flashcards, video or talking kits to provide users with real-time instructions for the use of automated external defibrillators or STB equipment. While the agreement of course content and identifying efficacy is a first step, future work should also focus on developing, trialing, and scaling effective JIT naloxone-administration tools.

LIMITATIONS

There are limitations to our study. We taught this course to a small sample of administrative professionals in a suburb of Massachusetts, a state with a high burden of opioid-related overdose. It is possible that bystanders from different backgrounds and geographic locations would have answered the questions differently. We also did not collect any demographic data about our study participants to protect confidentiality. However, this information might have determined the characteristics of individuals who may benefit most from the training. The content of the practical session of the course was not standardized. Finally, we did not measure knowledge retention or use of naloxone following the course.

CONCLUSION

A brief course designed to teach bystanders about opioid overdose and naloxone was feasible and effective. We encourage hospitals and other organizations to use and promulgate this model. Furthermore, we suggest convening of a national consortium to achieve consensus on program content, delivery, and opportunities for development of just-in-time tools to administer naloxone.

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Emergency Department SpO_2/FiO_2 Ratios Correlate with Mechanical Ventilation and Intensive Care Unit Requirements in COVID-19 Patients

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Background: Patients with coronavirus 2019 (COVID-19) are at high risk for respiratory dysfunction. The pulse oximetry/fraction of inspired oxygen (SpO_2/FiO_2) ratio is a non-invasive assessment of respiratory dysfunction substituted for the PaO_2:FiO_2 ratio in Sequential Organ Failure Assessment scoring. We hypothesized that emergency department (ED) SpO_2/FiO_2 ratios correlate with requirement for mechanical ventilation in COVID-19 patients. Our objective was to identify COVID-19 patients at greatest risk of requiring mechanical ventilation, using SpO_2/FiO_2 ratios.

Methods: We performed a retrospective review of patients admitted with COVID-19 at two hospitals. Highest and lowest SpO_2/FiO_2 ratios (percent saturation/fraction of inspired O_2) were calculated on admission. We performed chi-square, univariate, and multiple regression analysis to evaluate the relationship of admission SpO_2/FiO_2 ratios with requirement for mechanical ventilation and intensive care unit (ICU) care.

Results: A total of 539 patients (46% female; 84% White), with a mean age 67.6 ± 18.6 years, met inclusion criteria. Patients who required mechanical ventilation during their hospital stay were statistically younger in age ($P = 0.001$), had a higher body mass index ($P < .001$), and there was a higher percentage of patients who were obese ($P = 0.03$) and morbidly obese ($P < .001$). Shortness of breath, cough, and fever were the most common presenting symptoms with a median temperature of 99°F. Average white blood count was higher in patients who required ventilation ($P = <0.001$). A highest obtained ED SpO_2/FiO_2 ratio of $\leq$300 was associated with a requirement for mechanical ventilation. A lowest obtained ED SpO_2/FiO_2 ratio of $\leq$300 was associated with a requirement for intensive care unit care. There was no statistically significant correlation between ED SpO_2/FiO_2 ratios >300 and mechanical ventilation or intensive care unit (ICU) requirement.

Conclusion: The ED SpO_2/FiO_2 ratios correlated with mechanical ventilation and ICU requirements during hospitalization for COVID-19. These results support ED SpO_2/FiO_2 as a possible triage tool and predictor of hospital resource requirements for patients admitted with COVID-19. Further investigation is warranted. [West J Emerg Med. 2024;25(3)325–331.]

INTRODUCTION

The coronavirus 2019 (COVID-19) pandemic profoundly impacted hospital systems worldwide. Identifying patients presenting with COVID-19 in the emergency department (ED) at greatest risk for requiring mechanical ventilation or intensive care unit (ICU) care is of paramount importance since this would facilitate more efficient allocation of limited medical resources. Severe COVID-19 infection can be life-threatening and is associated with significant hypoxemia and the development of acute respiratory distress syndrome (ARDS).[1,2] Identifying early predictors of respiratory failure and ICU need is vital both for patient care and logistics in the setting of a global pandemic with limited ICU resources.

The pulse oximetry/fraction of inspired oxygen (SpO_2/FiO_2 ratio) has previously been used as a predictor of high-flow nasal cannula failure, need for intubation, and mechanical ventilation.[3] The SpO_2 value has been demonstrated to be a reliable surrogate for partial pressure of oxygen in the arterial blood (PaO_2),[4,5] and the SpO_2/FiO_2 ratio does not require any blood tests. The SpO_2/FiO_2 ratio is a non-invasive assessment of respiratory dysfunction that can be quickly obtained at the bedside. Measured at the time of presentation, the SpO_2/FiO_2 ratio has been demonstrated to be an independent indication of ARDS development.[6] The ability to quickly determine required level of care for vulnerable patients is essential to prevent poor outcomes, particularly in resource-limited environments. The COVID-19 pandemic led to ED crowding and a decrease in ventilator and ICU availability.[7] A validated prognostic indicator tool akin to the systematic inflammatory response syndrome or Sequential Organ Failure Assessment criteria for sepsis[8] is vital for ED use to identify COVID-19 patients at highest risk of ventilator and ICU need. The SpO_2/FIO_2 ratio predictive value has previously been validated in ARDS,[6] and early measurement may serve as an indicator and triage tool in COVID-19 with regard to respiratory failure/ventilation risk and ICU need.

Our objective in this study was to evaluate ED SpO_2/FIO_2 ratios in COVID-19 patients and correlate them with subsequent respiratory failure, necessitating the need for ICU level of care and/or mechanical ventilation during hospitalization. Use of this ratio may help hospital systems more efficiently use resources and effectively prepare for a patient's need for ICU care or mechanical ventilation.

MATERIALS AND METHODS

Study Design and Participant Selection

This was a retrospective study that evaluated admission encounters from both Maine Medical Center (MMC) and Southern Maine Health Care (SMHC). These institutions work closely together, with MMC being the region's tertiary care center with over 70,000 annual ED visits and a total of 45 multipurpose ICU beds. The SMHC is a community hospital within close proximity to MMC, averaging ≈55,000 total ED visits and nine ICU beds. COVID-19 patients who were ≥18 years old and required admission to either hospital met inclusion criteria. Encounters were collected between March–December 28, 2020; thus, no patients had been vaccinated against COVID-19. Patients were excluded if they did not require admission. This study was performed under approval of the institutions' review boards.

Data Variables

We performed retrospective chart review to identify patient demographics, diagnoses, level of hospital care, and hospital outcomes data from electronic health records. The FiO_2 values were calculated using nasal cannula flow rate.[9] We recorded the patient's lowest and highest SpO_2 and FiO_2 values in the ED and calculated SpO_2/FiO_2 ratios.

Outcomes

The primary outcome was the need for mechanical ventilation. Secondary outcomes included ICU level of care, ventilator days, in-hospital complications, escalation of care following initial triage, ICU length of stay (LOS), hospital LOS, and in-hospital mortality.

Analysis

We analyzed data using RStudio 2020 (RStudio Inc, Boston, MA). Descriptive statistics were presented as frequency and percentage. Normally distributed continuous data were reported as mean with SDs, and ordinal non-normally distributed continuous data were described with medians with interquartile ranges. We used multivariable logistic regression to assess the association between either low or high SpO_2/FiO_2 ratios within the ED, anticoagulation use, asthma, coronary artery disease (CAD), congestive health failure (CHF), chronic obstructive pulmonary disease (COPD), diabetes, hyperlipidemia, hypertension, and gastroesophageal reflux disease (GERD), or the need for mechanical ventilation, adjusted for age and body mass index (BMI). Bivariable analysis of categorical variables was done using the $\chi 2$ test, and nonparametric variables by the Kruskal-Wallis test. Regression models controlled for both age and BMI.

RESULTS

A total of 539 patients, with a mean age 67.6 ± 18.6 years, met inclusion criteria. Patients were stratified into two cohorts based on the need for mechanical ventilation (Table 1). As shown in the table, patients who required mechanical ventilation during their hospital stay were statistically younger in age ($P = 0.001$), had a higher BMI ($P < .001$), and there was a higher percentage of patients who were obese ($P = 0.03$) and morbidly obese ($P < .001$). Shortness of breath, cough, and fever were the most common presenting symptoms, with a median temperature of 99°F. The average white blood count was higher in patients who

Table 1. Baseline characteristics of patients with coronavirus 2019.

Demographic data	Mean ± SD, median, range or n (%)		*P*-value
	Not mechanically ventilated n = 451	Mechanically ventilated n = 88	
Age (median, IQR)	72, 26	66, 19.75	0.001
BMI (median, IQR)	28.9, 9.4	32.3, 10.9	<.001
Gender			
Female	217 (48%)	31 (35%)	0.03
Male	234 (52%)	57 (65%)	0.03
Race			
Asian	11 (2%)	5 (6%)	0.03
Black	31 (7%)	5 (6%)	0.73
Native Hawaiian or other Pacific Islander	1 (0.2%)	0 (0%)	0
Unknown/not reported	2 (0.4%)	2 (2%)	0.003
More than one race	3 (0.6%)	0 (0%)	0.47
White	397 (88%)	73 (83%)	0.20
Other	6 (1%)	3 (3%)	0.13
Ethnicity			
Hispanic or Latino	9 (2%)	3 (3%)	0.56
Not Hispanic or Latino	440 (98%)	84 (95%)	0.10
Unknown/not reported	2 (0.4%)	1 (1%)	0.46
Origin			
Home	282 (63%)	54 (61%)	0.72
Nursing home	61 (14%)	9 (10%)	0.31
Skilled nursing home	31 (7%)	0 (0%)	0.01
Rehab	1 (0.2%)	2 (2%)	0.03
Other*	76 (17%)	23 (26%)	0.05
Comorbid conditions			
Alcohol use	23 (5%)	8 (9%)	0.14
Anticoagulation therapy	52 (12%)	13 (15%)	0.44
Asthma	66 (15%)	14 (16%)	0.81
Cerebrovascular accident	41 (9%)	4 (5%)	0.22
COPD	71 (16%)	16 (18%)	0.64
Chronic heart failure	67 (15%)	13 (15%)	1
Chronic kidney disease	73 (16%)	12 (14%)	0.64
Cancer	57 (13%)	9 (10%)	0.44
Coronary heart disease/heart failure	105 (23%)	19 (22%)	0.84
Current smoker	30 (7%)	2 (2%)	0.08
Dementia	75 (17%)	5 (6%)	0.01
Diabetes mellitus	156 (35%)	38 (43%)	0.15
GERD	132 (29%)	26 (30%)	0.85
Myocardial infraction	39 (9%)	5 (6%)	0.36
Hypertension	282 (63%)	57 (65%)	0.72
Hyperlipidemia	222 (49%)	49 (56%)	0.23
Morbidly obese	14 (3%)	11 (13%)	<.001
Obese	81 (18%)	25 (28%)	0.03

(*Continued on next page*)

Table 1. Continued.

Demographic data	Mean ± SD, median, range or n (%)		*P*-value
	Not mechanically ventilated n = 451	Mechanically ventilated n = 88	
Presenting symptoms			
Fever	176 (39%)	34 (39%)	1
Myalgia	72 (16%)	15 (17%)	0.82
Arthralgias	21 (5%)	2 (2%)	0.22
Headache	50 (11%)	4 (5%)	0.09
GI symptoms	140 (31%)	17 (19%)	0.02
Cough	229 (51%)	54 (61%)	0.09
Shortness of breath	253 (56%)	57 (65%)	0.12
Other	233 (52%)	43 (49%)	0.61
Average temperature in the ED ± SD (Fahrenheit)	97.1 ± 12.4, 99.1, 7.3–104.5	98.1 ± 10, 99, 37–103	0.48
WBC count in the ED (median, IQR)	6.2, 4.7	8, 7.4	<.001
Diagnoses			
ARDS	24 (5%)	57 (65%)	<.001
Pneumonia	183 (41%)	60 (68%)	<.001
Neurological diagnoses	128 (28%)	40 (45%)	0.002
Renal diagnoses	129 (29%)	55 (63%)	<.001
Liver diagnoses	44 (10%)	23 (26%)	<.001
Heart diagnoses	168 (37%)	56 (64%)	<.001
Pulmonary diagnoses	280 (62%)	69 (78%)	0.004
Shock	10 (2%)	46 (52%)	<.001
Respiratory failure	153 (34%)	75 (85%)	<.001
Renal failure	29 (6%)	22 (25%)	<.001
ICU			
Patients who required ICU care at any point	75 (17%)	84 (95%)	<.001
Required more than one ICU admissions	2 (0.4%)	6 (7%)	<.001
ICU LOS (median, IQR)	2, 3	13, 16	<.001
Intubated			
Patients who were intubated	0 (0%)	84 (95%)	<.001
Days intubated	n/a	2, 4	
Non-procedure based intubation	0 (0%)	51 (58%)	<.001
Mechanical ventilators			
Ventilator days (median, IQR)	n/a	9, 13	
Required reintubation	n/a	7 (8%)	
Escalation of care from initial triage	60 (13%)	56 (64%)	<.001
Hospital LOS (median, IQR)	6, 6	17.5, 19	<.001
Discharge disposition			
Home or self-care	193 (43%)	8 (9%)	<.001
Home with services	97 (22%)	17 (19%)	0.53
Hospice/palliative care unit	11 (2%)	1 (1%)	0.52
Mental health/psychiatric hospital	8 (2%)	0 (0%)	0.18
Nursing home	17 (4%)	1 (1%)	0.16

(*Continued on next page*)

Table 1. Continued.

Demographic data	Mean ± SD, median, range or n (%)		*P*-value
	Not mechanically ventilated n = 451	Mechanically ventilated n = 88	
Other	62 (14%)	34 (39%)	<.001
Rehab	15 (3%)	24 (27%)	<.001
Skilled nursing facility	48 (11%)	3 (3%)	0.02
In-hospital mortality	36 (8%)	28 (32%)	<.001

*Other includes homeless, transfers in, group home, Primary care physician follow up, mental health facility.
BMI, body mass index; *IQR*, interquartile range; *COPD*, chronic obstructive pulmonary disease; *GERD*, gastroesophageal reflux disease; *WBC*, white blood count; *ED*, emergency department; *ARDS*, acute respiratory disease syndrome; *GI*, gastrointestinal; *ICU*, intensive care unit; *LOS*, length of stay.

required ventilation ($P = <0.001$) (Table 1). Patients requiring mechanical ventilation had higher diagnoses of ARDS ($P < .001$), pneumonia ($P < .001$), shock ($P < .001$), respiratory and renal failure ($P < .001$), and worse hospital outcomes with an in-hospital mortality of 32% vs 8% ($P < .001$) and a median hospital LOS of 17.5 vs 6 days ($P < .001$).

The SpO_2/FiO_2 ratios in the ED and their associations with mechanical ventilation or need for ICU care are presented in Table 2. A highest obtained ED SpO_2/FiO_2 ratio of 300 or below was statistically associated with a requirement for mechanical ventilation during hospitalization. A lowest obtained ED SpO_2/FiO_2 ratio of 300 or below was statistically associated with a requirement for ICU care during hospitalization. There was no statistically significant relationship between ED SpO_2/FiO_2 ratios above >300 and mechanical ventilation or ICU level of care.

Chronic obstructive pulmonary disease was a confounding factor for COVID-19 patients who required mechanical ventilation (adjusted R^2 value = 0.1132; $P < .001$). No statistically significant associations were identified between the following co-morbidities: anticoagulation use; asthma (adjusted $R^2 = 0.096$, $P = 0.75$); CAD (adjusted $R^2 = 0.102$; $P = 0.07$); CHF (adjusted $R^2 = 0.096$; $P = 0.95$); diabetes (adjusted $R^2 = 0.10$; $P = 0.07$); hyperlipidemia (adjusted $R^2 = 0.11$; $P = 0.08$); hypertension (adjusted $R^2 = 0.096$; $P = 0.58$); and GERD (adjusted $R^2 = 010$; $P = 0.28$) for the requirement of mechanical ventilation.

DISCUSSION

This study demonstrated that the highest obtained ED SpO_2/FiO_2 ratio of 300 or below correlated with the need for mechanical ventilation during hospitalization. Additionally, a lowest obtained ED SpO_2/FiO_2 ratio of 300 or below was associated with a requirement for ICU-level care. Although COPD was a confounding factor for patients requiring mechanical ventilation, other co-morbidities were not independently associated with higher rates of mechanical ventilation and the ED SpO_2/FiO_2. This suggests that the SpO_2/FiO_2 ratio can be used as a prognostic indicator to stratify severity of illness in patients with COVID-19 during their initial evaluation in the ED. Since the SpO_2/FiO_2 ratio is non-invasive and can be quickly obtained and trended during a patient's evaluation, this ratio could be an important factor in patient triage and disposition.

Multiple prognostic indicators have been proposed in the previous literature to help stratify ARDS severity and predict outcomes.[10–13] The PaO_2:FiO_2 (P:F) ratio is a widely used measure of ARDS severity; however, multiple studies have shown that the P:F ratio is not an independent predictor of mortality.[10–13] Another prognostic tool, the oxygenation index, (OI [$FIO_2/PaO_2 \times$ mean airway pressure $\times$ 100]) has been demonstrated to be an independent risk factor for mortality in adults with ARDS,[11,12] but it requires mechanical ventilation and arterial blood gas analysis for calculation. Oxygen saturation index (OSI [$FIO_2 \times$ mean airway pressure $\times$ 100)/SaO_2]) is a measure that correlates to OI and is an independent predictor of clinical outcomes.[12] Although OSI calculation does not require blood analysis, it still requires mechanical ventilation. Another prognostic tool, the Lung Injury Prediction Score (LIPS), has applicability in the ED.[13] However, the LIPS tool requires a detailed past medical history (e.g, alcohol use disorder) and the patient's pH, requiring a blood gas. Although all these tools provide some prognostic value, each has limitations, resulting in barriers to deployment for triaging patients in the ED.

In contrast, the SpO_2/FiO_2 ratio requires no blood tests and is quickly and easily obtained at the bedside. Measured at the time of presentation, it has been shown to be an independent indication of ARDS development.[6] This study suggests that the SpO_2/FIO_2 ratio may offer an estimate of disease severity in patients with COVID-19 before progression to overt respiratory failure, serving as a triage tool to identify those at greatest risk for needing mechanical ventilation and critical care. The SpO_2/FiO_2 ratio can be used as a tool or part of a protocol to assess whether a patient

Table 2. SpO_2/FiO_2 ratios and their association with intensive care unit or mechanical ventilation needs.

Variable SpO_2/FiO_2 ratios*	No mechanical ventilation N (%)	Required mechanical ventilation N (%)	95% CI	OR	*P*-value
Lowest ED SpO_2/FiO_2					
0–100	18 (4)	13 (18)	2.4–10.9	5.1	<.001
101–200	5 (1)	3 (4)	0.75–12.6	3.1	0.05
201–300	37 (9)	14 (20)	1.2–4.7	2.4	0.005
301–400	113 (27)	19 (27)	0.6–1.8	1.0	0.86
401–500	251 (59)	22 (31)	0.2–0.5	0.31	<.001
Highest ED SpO_2/FiO_2					
0–100	7 (2)	7 (10)	2.2–19.2	6.5	<.001
101–200	4 (1)	3 (4)	1.0–21.2	4.6	0.05
201–300	14 (3)	11 (15)	1.7–8.1	3.7	0.002
301–400	106 (25)	20 (28)	0.72–2.2	1.3	0.47
401–500	293 (69)	30 (42)	0.2–0.6	0.3	<.001
Variable SpO_2/FiO_2 ratios*	**No ICU admission N (%)**	**ICU admission N (%)**	**95% CI**	**OR**	***P*-value**
Lowest ED SpO_2/FiO_2					
0–100	8 (2)	23 (17)	3.8–20	8.8	<.001
101–200	1 (0.3)	7 (5)	2.3–158	19.2	<.001
201–300	27 (8)	24 (18)	1.4–4.5	2.5	0.001
301–400	94 (26)	36 (26)	0.6–1.5	0.93	0.66
401–500	228 (64)	47 (34)	0.2–0.5	0.32	<.001
Highest ED SpO_2/FiO_2					
0–100	3 (1)	11 (8)	2.8–10	10.3	<.001
101–200	0 (0)	7 (5)	2.3–19	19.2	<.001
201–300	11 (3)	14 (10)	1.3–2.8	2.80	0.01
301–400	88 (25)	38 (28)	0.78–1.2	1.21	0.66
401–500	256 (72)	67 (49)	0.26–0.39	0.39	<.001

*For patients who had ED SpO_2/FiO_2 values.
CI, confidence interval; *OR*, odds ratio; *ED*, emergency department; *ICU*, intensive care unit.

meets transfer criteria within a hospital system. Many regional health systems operate under a "hub and spoke" model where a large central institution supports a network of smaller hospitals. Rapid identification of patients at risk for decompensation and with need for higher level care would facilitate access to limited critical care resources while also decreasing the incidence of over-triage to the hub hospital.

LIMITATIONS

The study is retrospective with inherent limitations in controlling confounding variables. The cohort was limited to one hospital system, and thus cannot account for practice variations in other healthcare systems. The hospitals evaluated in this study may have had different criteria for ICU admission. Additionally, FiO_2 values were based largely on nasal cannula flow rates; limiting to high flow nasal cannula would permit more accurate FiO_2 but would also limit applicability. At the time of data collection, no patients were vaccinated, thus limiting the applicability of findings to populations with some form of COVID-19 vaccination.

CONCLUSION

In summary, ED SpO_2/FiO_2 ratios correlate with mechanical ventilation and ICU requirements during hospitalization for COVID-19 infection. These results support ED SpO_2/FiO_2 as a triage tool and predictor of hospital resource requirements for patients admitted with COVID-19. Further study is required with a prospective analysis assessing accuracy of the SpO_2/FiO_2 ratio in

predicting mechanical ventilation and need for ICU-level care.

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Geographic Location and Corporate Ownership of Hospitals in Relation to Unfilled Positions in the 2023 Emergency Medicine Match

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Introduction: In the 2023 National Resident Matching Program (NRMP) match, there were 554 unfilled emergency medicine (EM) positions before the Supplemental Offer and Acceptance Program (SOAP). We sought to describe features of EM programs that participated in the match and the association between select program characteristics and unfilled positions.

Methods: The primary outcome measures included the proportion of positions filled in relation to state and population density, hospital ownership type, and physician employment model. Secondary outcome measures included comparing program-specific attributes between filled and unfilled programs, including original accreditation type, year of original accreditation, the total number of approved training positions, length of training, urban-rural designation, hospital size by number of beds, resident-to-bed ratio, and the percentage of disproportionate share patients seen.

Results: The NRMP Match had 276 unique participating EM programs with 554 unfilled positions. Six states offered 52% of the total NRMP positions available. Five states were associated with two-thirds of the unfilled positions. Public hospitals had a statistically significant higher match rate (88%) when compared to non-profit and for-profit hospitals, which had match rates of 80% and 75%, respectively ($P < 0.001$). Programs with faculty employed by a health system had the highest match rate of 87%, followed by clinician partnerships at 79% and private equity groups at 68% ($P < 0.001$ overall and between all subgroups).

Conclusion: The 2023 match in EM saw increased rates in the number of residency positions and programs that did not fill before the SOAP. Public hospitals had higher match rates than for-profit or non-profit hospitals. Residency programs that employed academic faculty through the hospital or health system were associated with higher match rates. [West J Emerg Med. 2024;25(3)332–341.]

INTRODUCTION

Emergency medicine (EM) has historically been a highly competitive specialty, filling all or nearly all the available residency positions as part of the Main Residency Match (match) organized by the National Residency Matching Program (NRMP). After a record number of applicants in 2021, the past two years have seen a decline in the number of student applicants while the number of available EM residency positions has continued to increase, ultimately resulting in a rise in unfilled programs and positions. In the 2022 NRMP match, there were 219 unfilled EM positions among 69 programs before the Supplemental Offer and Acceptance Program (SOAP), and in 2023 that figure approximately doubled to 554 unfilled positions among 131 programs. Many are concerned that the dramatic increase in pre-SOAP unfilled positions represents a decline in the desirability and competitiveness of the specialty.[1]

This is an observational study describing features of EM residency programs that participated in the 2023 NRMP match and the association between select program characteristics and unfilled positions. It is unclear whether certain characteristics including state-based geographic location and population density, hospital financing models, faculty physician employment models, or specific program characteristics such as the size of program or length of training are associated with higher rates of unfilled positions. Transparency of factors associated with unfilled positions will guide the specialty's response to the match and program accreditation requirements with objective data. Prior studies have examined similar factors but provided limited detail and nuance on the topic of corporate ownership, which we expound upon in our study.[2,3]

Population Health Research Capsule

What do we already know about this issue?
Prior studies examined program features and ownership predictors of unfilled positions but without deeper analysis of corporate ownership trends and associations.

What was the research question?
What program features and hospital or faculty ownership are associated with the unfilled 2023 match?

What was the major finding of the study?
Public, for-profit, and non-profit matched 88%, 80%, and 75% ($P < 0.001$). Program faculty employed, clinician partnership, and private equity matched 87%, 79%, and 68% ($P < 0.001$).

How does this improve population health?
Understanding factors for match success help ensure stable inputs to the emergency medicine workforce.

METHODS

Study Design and Setting

In this observational study we used publicly available datasets to analyze the match results for EM residency programs participating in the 2023 NRMP Match based on STROBE guidelines.[4] The institutional review board determined this study to be exempt. All EM residency programs and the positions they offered that participated in the 2023 NRMP Match were included in the study.

Variables and Measurements

We obtained a list of EM residency programs and their number of offered and filled positions from the NRMP. Each NRMP ID was linked to the program's Accreditation Council for Graduate Medical Education (ACGME) Program ID, which provided information about the year of accreditation, program length, number of approved positions, and training sites. We also obtained a list of ACGME programs that were formally accredited by the American Osteopathic Association (AOA) and the year of earliest AOA accreditation type. The ACGME Site ID for each primary site was linked to the hospital's Centers for Medicare and Medicaid Services (CMS) Certification Number and the 2023 CMS Inpatient Prospective Payment System Final Rule Data, which includes information about hospital ownership type, urban-rural location, number of hospital beds, resident-to-bed ratio, and percentage of disproportionate share hospital (DSH) patients. Hospitals were linked to the health systems that operate them. Information about the physician group staffing each hospital's emergency department and the ownership type of those groups as of March 2023 was obtained from Ivy Clinicians.[5] We defined physician groups as "private equity" if there was a majority-ownership interest by a private equity firm. "Clinician partnerships" were defined as being majority owned by physicians. This included independent faculty physician groups affiliated with a health system, equal-partnership democratic groups, groups where certain clinicians may own a larger percentage of shares, and groups with minority-interest ownership by a private equity firm. We defined physician groups as "health system" if they were

employed directly by the physician organization of the hospital, health system, medical school, or academic medical center.

Outcomes Measures

The primary outcome measures included the proportion of positions filled by state and population density, hospital ownership type, and physician employment model. Secondary outcome measures compared other program-specific attributes between filled and unfilled programs, including original accreditation type, year of original accreditation, year of ACGME accreditation, the total number of ACGME-approved training positions, length of training, urban-rural designation, hospital size by number of beds, resident-to-bed ratio, and the percentage of DSH patients seen. A program was classified as unfilled if there were one or more unmatched positions across any of its NRMP IDs; programs with zero unfilled positions across any of its NRMP IDs were classified as filled.

Statistical Methods

We performed all data extraction, transformation, and analysis using RStudio version 2023.03.0 + 386 running R version 4.2.3 (RStudio, PBC, Boston, MA). We described continuous variables using medians and interquartile ranges. Categorical variables were described using frequency and percentages. We compared continuous variables using the Wilcoxon rank-sum test. We compared categorical variables using Pearson chi-squared testing with Bonferroni post-hoc analysis where more than two groups were compared. *P*-values less than 0.05 were considered to be statistically significant.

RESULTS

Characteristics of Study Subjects

As of March 2023, there were 283 ACGME-accredited EM residencies; however, five of these were military programs that do not historically participate in the NRMP match, and there were two additional programs that did not participate in the 2023 match. There were 11 EM programs with dual NRMP IDs, where one of the IDs may be used to offer a single position to a special type of applicant, such as international/private-funded positions, research positions, or for three-year MD path residents.[6] A total of 276 EM programs participated in the match, offering 3,010 positions in 43 states plus the District of Columbia and Puerto Rico. There were 131 programs (48%) with 554 positions (18%) that were unfilled before the SOAP.

Geography

Six states offered 52% of the total NRMP EM positions available: New York (338), California (285), Michigan (236), Florida (234), Pennsylvania (234), and Texas (184). There was significant variation in the number of residency positions available per state population. Among the six states that offered the largest number of residency positions, Michigan had the most NRMP positions per population at 23.5 residents per million citizens in the 2020 census, while Texas had only 6.1 residents per million citizens. Five states were associated with two-thirds of the unfilled positions: Michigan (92); New York (83); Pennsylvania (78); Ohio (56); and Florida (49). There was also significant variation in the percentage of unmatched positions by state (Table 1).

Hospital Ownership

The majority (63%) of residency EM positions were offered by 177 programs at non-profit hospitals (1,880/3,010), while 68 public hospital programs offered 28% of positions (831/3,010), and 31 for-profit hospital programs offered 10% of positions (299/3,010). There was a statistically significant difference in the percentage of unmatched positions by hospital ownership type ($P < 0.001$) (Table 2). Public hospitals had a statistically significant higher match rate (88%), compared to non-profit and for-profit hospitals, which had match rates of 80% and 75%, respectively ($P < 0.001$). There was no difference in match rates between non-profit and for-profit hospitals. Seventeen health systems operated three or more residency programs, of which 11 were non-profit, three were for-profit, and two were public. The health system offering the largest number of residency programs was HCA Healthcare (19 programs, 189 positions, 70% match rate).

Group Ownership and Employment Model

Among EM faculty group ownership and employment models, half of EM residency positions (52%) had program faculty that were employed by health systems (1,574/3,010, 134 programs), with 31% having clinician partnership faculty (941/3,010, 87 programs), and 16% of positions having private equity-employed faculty (495/3,010, 55 programs). Five employer groups met the definition of majority private equity ownership. These groups included American Physician Partners, Envision Physician Services, SCP Health, Sound Physicians, and TeamHealth.

There was a statistically significant difference in the percentage of unmatched positions by the employment model of faculty physicians ($P < 0.001$) (Table 3). Programs with faculty employed by a health system had the highest match rate of 87%, followed by clinician partnerships at 79% and private equity groups at 68% (Table 3). Thirteen physician groups operated three or more residency programs. The physician groups staffing the largest number of residency programs were Envision Physicians Services (24 programs, 230 positions, 71% match rate) and TeamHealth (21 programs, 197 positions, 75% match rate).

Table 1. Residency match results by state and emergency medicine positions per state population.

State	Number of programs	NRMP Quota	NRMP unmatched	Percent matched	Percent unmatched	2020 population (millions)	Residents per population (millions)
Alabama	2	18	1	94%	6%	5.1	3.5
Arizona	5	51	5	90%	10%	7.4	6.9
Arkansas	2	16	9	44%	56%	3	5.3
California	24	285	22	92%	8%	39	7.3
Colorado	1	17	0	100%	0%	5.8	2.9
Connecticut	2	37	0	100%	0%	3.6	10.2
Delaware	2	18	6	67%	33%	1	17.7
District of Columbia	2	22	0	100%	0%	0.7	32.7
Florida	22	234	49	79%	21%	22.2	10.5
Georgia	5	58	6	90%	10%	10.9	5.3
Illinois	12	144	9	94%	6%	12.6	11.4
Indiana	1	21	0	100%	0%	6.8	3.1
Iowa	1	10	0	100%	0%	3.2	3.1
Kansas	1	10	4	60%	40%	2.9	3.4
Kentucky	2	25	0	100%	0%	4.5	5.5
Louisiana	4	42	0	100%	0%	4.6	9.1
Maine	1	10	0	100%	0%	1.4	7.2
Maryland	2	23	0	100%	0%	6.2	3.7
Massachusetts	5	72	2	97%	3%	7	10.3
Michigan	25	236	92	61%	39%	10	23.5
Minnesota	3	32	0	100%	0%	5.7	5.6
Mississippi	3	28	9	68%	32%	2.9	9.5
Missouri	5	51	11	78%	22%	6.2	8.3
Nebraska	1	12	0	100%	0%	2	6.1
Nevada	3	25	11	56%	44%	3.2	7.9
New Hampshire	1	6	0	100%	0%	1.4	4.3
New Jersey	12	122	27	78%	22%	9.3	13.2
New Mexico	1	12	0	100%	0%	2.1	5.7
New York	31	388	83	79%	21%	19.7	19.7
North Carolina	7	85	22	74%	26%	10.7	7.9
Ohio	17	158	56	65%	35%	11.8	13.4
Oklahoma	5	33	8	76%	24%	4	8.2
Oregon	1	11	0	100%	0%	4.2	2.6
Pennsylvania	23	234	78	67%	33%	13	18
Puerto Rico	2	16	1	94%	6%	3.2	5
Rhode Island	2	22	3	86%	14%	1.1	20.1
South Carolina	5	55	4	93%	7%	5.3	10.4
Tennessee	5	48	5	90%	10%	7.1	6.8
Texas	15	184	15	92%	8%	30	6.1
Utah	1	12	0	100%	0%	3.4	3.5
Vermont	1	6	0	100%	0%	0.6	9.3

(*Continued on next page*)

Table 1. Continued.

State	Number of programs	NRMP Quota	NRMP unmatched	Percent matched	Percent unmatched	2020 population (millions)	Residents per population (millions)
Virginia	6	63	13	79%	21%	8.7	7.3
Washington	1	17	0	100%	0%	7.8	2.2
West Virginia	2	16	3	81%	19%	1.8	9
Wisconsin	2	25	0	100%	0%	5.9	4.2

NRMP, National Resident Matching Program.

Program and Hospital-specific Attributes

When comparing filled and unfilled programs by accreditation history and hospital-level characteristics, unfilled programs were more likely to be smaller in size based on the number of positions offered ($P < 0.001$), previously accredited by the AOA ($P < 0.001$), and started in more recent years ($P < 0.001$). There was no difference in filled vs unfilled programs by program length ($P = 0.78$). Unfilled

Table 2. Association of hospital ownership type on unfilled emergency medicine positions.

Health system	Ownership type	Number of residency programs	NRMP positions available	NRMP positions matched	Unmatched positions (%)
By hospital ownership type ($P < 0.001$, Pearson chi-squared test)					
	For profit	31	299	224	25.1%
	Non-profit	177	1880	1502	20.1%
	Public	68	831	730	12.2%
	Total	276	3010	2456	18.4%
By health system/type (operating 3+ EM residencies)					
Ascension Health	Non-profit	7	64	42	34.4%
Baylor Scott & White Health	Non-profit	3	28	23	17.9%
Bon Secours Mercy Health	Non-profit	3	28	15	46.4%
Corewell Health	Non-profit	5	50	36	28.0%
HCA Healthcare	For profit	19	189	132	30.2%
Henry Ford Health System	Non-profit	4	40	18	55.0%
Jefferson Health	Non-profit	5	59	42	28.8%
Michigan Medicine	Public	3	30	23	23.3%
NewYork-Presbyterian	Non-profit	3	43	42	2.3%
Northwell Health	Non-profit	3	39	34	12.8%
NYC Health + Hospitals	Public	6	85	72	15.3%
RWJ Barnabas Health	Non-profit	3	29	23	20.7%
Tenet Healthcare	For profit	4	44	40	9.1%
Trinity Health	Non-profit	6	41	18	56.1%
Universal Health Services	For-profit	3	30	24	20.0%
University of California	Public	5	67	67	0.0%
UPMC	Non-profit	3	28	24	14.3%
	Total	85	894	675	24.5%

Overall, the proportions of filled/unfilled positions did vary by hospital ownership type (X2 = 34.126, df = 2, $P < 0.001$). Post-hoc Bonferroni comparisons between hospital types showed that public hospitals had a lower proportion of unfilled positions compared to both for-profit and non-profit hospitals (raw and adjusted *P*-values <0.001), while there was no difference in the proportion of positions filled between for-profit and non-profit hospitals (raw $P = 0.05$, adjusted $P = 0.16$).
NRMP = National Resident Matching Program.
UPMC, University of Pittsburgh Medical Center.

Table 3. 2023 emergency medicine match rates by faculty physician group/type.

Physician group	Group type	Number of residency programs	NRMP positions available	NRMP positions matched	Unmatched positions (%)
By residency faculty physician group type ($P < 0.001$, Pearson chi-squared test)					
Health system (HS)		134	1574	1375	13%
Clinician partnership (CP)		87	941	744	21%
Private equity (PE)		55	495	337	32%
	Total	276	3010	2456	18.4%
By residency faculty group (operating 3+ EM residencies)					
American Physician Partners	PE	4	26	6	77%
ApolloMD	CP	4	36	23	36%
Envision Physician Services	PE	24	230	163	29%
Integrative Emergency Services	CP	3	29	24	17%
Northwell Health	HS	3	39	34	13%
Physician Affiliate Group of New York	CP	7	98	84	14%
RWJ Barnabas Health	HS	3	29	23	21%
SCP Health	PE	4	28	14	50%
TeamHealth	PE	22	205	150	27%
University of California	CP	5	67	67	0%
UPMC	HS	3	28	24	14%
US Acute Care Solutions	CP	7	57	28	51%
Vituity	CP	11	115	89	23%
	Total	100	987	729	26%

Overall, the proportions of filled/unfilled positions did vary by residency faculty physician group type ($X2 = 99.007$, $df = 2$, $P < 0.001$). Post-hoc Bonferroni comparisons between group types showed that programs with health system employed faculty had the lowest proportion of unfilled positions, followed by clinician partnership faculty, while residencies with private equity employed faculty had the highest proportion of unfilled positions (raw and adjusted p-values for all pairwise comparisons <0.001).
NRMP, National Resident Matching Program; *UPMC*, University of Pittsburgh Medical Center.

programs tended to be in less urban areas ($P = 0.03$), at hospitals with a smaller number of beds ($P < 0.001$), lower resident-to-bed ratios ($P < 0.001$), and fewer disproportionate share patients ($P < 0.001$) (Table 4).

DISCUSSION

We examine the factors and program characteristics associated with unfilled positions in the EM match. Five states were associated with two-thirds of the unfilled positions. Public hospitals had a statistically significant higher match rate (88%) when compared to non-profit and for-profit hospitals, which had match rates of 80% and 75%, respectively ($P < 0.001$). Public hospitals include those owned by government entities (local, state, federal government) or the Veterans Health Administration. Non-profit and for-profit hospitals are privately owned and differentiated by their tax status (discussed further below). Programs with faculty employed by a health system had the highest match rate of 87%, followed by clinician partnerships at 79% and private equity groups at 68% ($P < 0.001$ overall and between all subgroups). Our analysis confirms and expands findings from recent studies. One study identified six characteristics of unfilled programs (in descending order of predictive strength): unfilled positions in the 2022 match; smaller program size; Mid-Atlantic location; prior AOA accreditation; East North Central location; and private equity majority ownership of physician faculty group.[3] Another study of combined 2022 and 2023 match data found programs at risk of not filling had accreditation within the prior five years, had a for-profit primary clinical site, and were in geographic areas with high numbers of positions offered.[2]

Residency Growth Trends

The number of unmatched positions in the EM match was driven by a dramatic increase in the number of EM programs

Table 4. Comparing attributes of filled/unfilled programs in 2023 emergency medicine match.

	Filled (n = 145)	Unfilled (n = 131)	Total	*P*-value
Original accreditation type				<0.001[a]
ACGME	141 (97%)	84 (64%)	225 (82%)	
AOA	4 (3%)	47 (36%)	51 (19%)	
Year of original accreditation				<0.001[b]
Median	1995	2010	2003	
Q1, Q3	1982, 2009	1993, 2018	1988, 2016	
Year of ACGME accreditation				<0.001[b]
Median	1995	2017	2008	
Q1, Q3	1982, 2011	2006, 2019	1990, 2017	
Total approved ACGME positions				<0.001[b]
Median	39	30	36	
Q1, Q3	30, 54	22, 36	24, 44	
Length of training				0.78[a]
3 years	116 (80%)	103 (79%)	219 (80%)	
4 years	29 (20%)	28 (21%)	57 (21%)	
Urban-rural				0.03[a]
Large urban area	89 (61%)	64 (49%)	153 (55%)	
Other urban area	55 (38%)	61 (47%)	116 (42%)	
Rural area	1 (1%)	6 (5%)	7 (3%)	
Number of hospital beds				<0.001[b]
Median	571	359	450	
Q1, Q3	382, 730	260, 534	318, 680	
Resident-to-bed ratio (per 100 beds)				<0.001[b]
Median	47	29	38	
Q1, Q3	30, 70	16, 45	21, 63	
Disproportionate share hospital patients [%]				<0.001[b]
Median	39	33	36	
Q1, Q3	31, 52	28, 43	30, 47	

[a]Pearson chi-squared test.
[b]Wilcoxon rank-sum test.
ACGME, Accreditation Council for Graduate Medical Education; *AOA*, American Osteopathic Association; *Q*, quartertile.

and positions offered over the past decade, as well as a more recent decrease in applicants over the prior two years. Between 2014–2023, there was a 29% increase in the number of EM programs and a 46% increase in the number of postgraduate year (PGY)-1 positions offered in the match, suggesting that the growth of positions is not only related to the creation of new programs but also the expansion of existing programs. In recent years, EM has experienced the largest growth rate of PGY-1 positions across all medical specialties.[7] The match rate is also impacted by a decrease in the number of applicants over time. Applicants in EM peaked in 2021 at 4,391 applicants. It is unclear whether this record high, representing a 16% increase over the year before, was an outlier. The overall five-year trend is an 8% decrease in applicants contrasted with the 23% increase in positions.[8] This unprecedented growth has outstripped the number students applying to train in EM and played a large role in the number of unfilled spots in 2023.

Between 2013–2020, there was significant growth of EM residencies in states that already had multiple EM training programs. A number of states nearly doubled the number of training programs in that time frame: New York (21 to 31), Pennsylvania (12 to 21), and California (14 to 22), while others grew even more Ohio (9 to 18), Michigan (11 to 25), and Florida (5 to 19).[9,10] New programs are disproportionately growing in urban areas, whereas some rural states do not have any EM training programs.[10] Only seven EM residency programs are located in rural areas, six

of which did not fill.[11] Our data demonstrates that many of the unfilled spots in 2023 occurred in states that had the highest absolute number of resident positions as well as number of residents per capita population. No state-level regulations exist to limit the number of residency training programs. While some have called on the ACGME to restrict the number of EM training positions, it is currently against ACGME policy and a violation of state and federal antitrust law for the ACGME to implement a national workforce policy to establish the number of practicing physicians.[12] The ACGME can create and adjust standards for accreditation to optimize the learning environment. Some have expressed concern regarding the academic quality of some of the newer programs. One study found that nearly 25% of programs were given "with warning" accreditation on initial accreditation compared to less than 3% of programs on continued accreditation.[7,13]

Debate exists over who is responsible for the increased growth of residency programs. A new residency program requires a sponsoring institution, which the ACGME defines as an "organization or entity that assumes ultimate financial and academic responsibility for a program." Sponsoring institutions may include universities, medical schools, hospitals, healthcare delivery systems, or physician group practices.[14] Currently, a review of the ACGME listings reveals that all EM residency programs are sponsored by hospitals and health systems, with none being sponsored by physician staffing groups.[13] The role and motivation of the physician groups who serve as faculty for new residency programs that are sponsored by hospitals and health systems may vary. Graduate medical training programs offer financial benefits to hospitals and recruitment benefits to hosting institutions and staffing groups.[15] New program growth could be driven at the physician group, hospital or health system level, or both. For example, HCA Healthcare has a transparent objective to expand GME positions stating, "With 270+ residency and fellowship programs, HCA Healthcare plans to continue to grow the largest GME community in the United States."[16] It is reasonable to surmise that faculty groups feel pressure to start and staff new programs to align with the health system's intent to maintain contracts. Hospitals that created GME programs after 2015, known as "GME-naive," have a strong incentive to increase the number of residents at their site within five years of starting because CMS calculates their training cap after the fifth year.[17]

Unfilled spots may represent market forces rightsizing the number and geographic distribution of residency slots, although the complexities of GME funding and training caps create regulatory barriers to market corrections.[9] Unfilled positions do not receive GME funding, which could lead to residency closures without alternate sources of funding.[18] When anesthesia experienced a similar plight of decreasing fill rates in the 1990s, a cumulative drop of 77% of applicants over a six-year period resulted in 16% of all anesthesia residencies in the country closing their doors.[11] However, market corrections will not occur if unfilled spots in the initial match are subsequently filled in the SOAP, which occurs a few days later. Most of the unfilled EM positions in the 2022 Match subsequently filled in the SOAP.[19] Discussion continues on how best to maintain the quality and stability of the EM workforce.[1]

Corporations and Graduate Medical Education

We observed significant differences in match rates by hospital ownership type with public hospitals having the fewest unmatched positions. Non-profit hospitals continue to make up the majority of EM training sites, and there was no statistical difference in match rates between non-profit and for-profit hospitals. Over the past 20 years, there has been increased consolidation and corporatization in healthcare including EM practice and training.[20–22] Many fear that increased for-profit and investor sponsorship of residency programs may result in lower quality training or the commoditization of GME.[23,24] While there has been increased scrutiny on corporate investment in healthcare and medical education, and some studies on health or workforce outcomes in other specialties, no such studies exist in EM.[20,25,26] The proportion of EM residencies created at for-profit hospitals has increased considerably.[7] Prior to 2016, only 5% of EM residency programs had primary sites at for-profit hospitals (10 total), compared to 30% (21/71) of new programs being based at for-profit hospitals. While hospitals are frequently differentiated by non-profit or for-profit status, this differentiation based on tax status has limitations in capturing the business incentives of the institution.[27]

Our data shows that public hospitals were associated with the highest match rates. There was no difference between for-profit and non-profit hospitals with regard to match rates. A prior study similarly did not find a statistically significant different greater risk of not filling at for-profit sites (compared to non-profit or government sites) but did find a 50% greater risk of not filling when examining 2022 and 2023 match data.[2] We did find significant variation between groups within the same tax designation. For example, of the 17 health systems that operate three or more programs, Trinity Health, a non-profit health system, had the highest percentage of unmatched positions at 56% (six programs total, 23/41 unmatched) and the University of California, a public health system, had 0 unfilled positions (five programs total, 67 positions). The health system operating the largest number of EM residencies is HCA Health, a for-profit health system, which offered 189 positions at 19 programs, of which 30% were unmatched. Tenet Healthcare, another for-profit health system, which offered 44 positions at four programs, had a match rate above the national average, filling 91% of its positions. Hence, although public hospitals had a higher match rate overall, there is significant variability.

Much scrutiny has focused on corporate, specifically private equity (PE), ownership and investment in EM. Among the different types of non-physician corporate investors, PE has undergone particular criticism due to significant expansion within EM, evidence of poor outcomes in other areas of healthcare, and short-term profit incentives.[28] Private equity and publicly traded company control of the emergency physician staffing market increased from 8.6% to 22% from 2009 to 2019.[26] Private equity-acquired hospitals now account for 8% of all nongovernmental hospitals.[29] Our data shows that 503/3,010 (17%) of EM residency positions in the 2023 match were staffed by physician groups that are majority owned by PE. To our knowledge, there has never been an outcomes comparison study between employment models within residency training programs to predict success in practice after graduation. Employment models of physicians are changing with increased consolidation in healthcare. Emergency medicine-bound students have expressed concern about corporate influence in EM, but it is unclear the relative contribution of this on student recruitment especially in light of other factors.[30] Academic faculty can be employed in multiple employment models such as by a medical school, a health system, a large national group, a regional group, or a single ownership group. Emergency medicine programs with the highest fill rates in the match were associated with employment models in which faculty were directly employed by the hospital, health system, or medical school. There was significant variability, however, between employers and employment types.

LIMITATIONS

This analysis has several important limitations. There are many reasons a medical student may rank and matriculate at a residency program. Unique characteristics of a program that may influence a particular applicant's interest and rank list were not captured for analysis. The number of applicants interviewed and ranked by programs are additional factors that impact match rates, which were not measured. The past two years did not include in-person applicant interviews, which may have also impacted match rates.

Additionally, the relationships between hospitals, health systems, physician faculty groups, and individual residency programs are complex and evolving, and this must be considered when interpreting results. For example, one health system may employ physicians under multiple models such as direct employment or a third-party staffing group. The current health system or staffing group at the program in this analysis may not have been the same one present when the residency started due to mergers and acquisitions. Since this analysis there have been major changes in the emergency physician staffing landscape including the closure of American Physicians Partners and Chapter 11 Bankruptcy of Envision, which operated four and 24 residencies in the 2023 EM match, respectively.[31]

There are no currently agreed upon definitions for classifying physician-group ownership structures. The varied spectrum of corporate investor (eg, PE) ownership stakes in EM groups from minority to whole complicates the creation of discrete categories. Our classification of health systems was not able to differentiate between the various complex relationships that comprise health systems, such as as whether the health system physician group is wholly owned by the health system and or they are owned by a medical school, academic medical center, or hospital. Most fundamentally, ownership only serves as a proxy for other important features such as physician autonomy and educational quality.

CONCLUSION

The 2023 match in EM saw increased rates in the number of training slots and programs that did not fill before the SOAP. Public hospitals had higher match rates than for-profit or non-profit hospitals overall, but there was significant variability within hospitals and health systems. Residency programs that employed academic faculty directly through the hospital or health system were associated with higher match rates.

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Imaging in a Pandemic: How Lack of Intravenous Contrast for Computed Tomography Affects Emergency Department Throughput

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Introduction: During the coronavirus 2019 pandemic, hospitals in the United States experienced a shortage of contrast agent, much of which is manufactured in China. As a result, there was a significantly decreased amount of intravenous (IV) contrast available. We sought to determine the effect of restricting the use of IV contrast on emergency department (ED) length of stay (LOS).

Methods: We conducted a single-institution, retrospective cohort study on adult patients presenting with abdominal pain to the ED from March 7–July 5, 2022. Of 26,122 patient encounters reviewed, 3,028 (11.6%) included abdominopelvic CT with a complaint including "abdominal pain." We excluded patients with outside imaging and non-ED scans. Routine IV contrast agent was administered to approximately 74.6% of patients between March 7–May 6, 2022, when we altered usage guidelines due to a nationwide shortage. Between May 6–July 5, 2022, 32.8% of patients received IV contrast after institutional recommendations were made to limit contrast use. We compared patient demographics and clinical characteristics between groups with chi-square test for frequency data. We analyzed ED LOS with nonparametric Wilcoxon rank-sum test for continuous measures with focus before and after new ED protocols. We also used statistical process control charts and plotted the 1, 2 and 3 sigma control limits to visualize the variation in ED LOS over time. The charts include the average (mean) of the data and upper and lower control limits, corresponding to the number of standard deviations away from the mean.

Results: After use of routine IV contrast was discontinued, ED LOS (229.0 vs 212.5 minutes, $P = <0.001$) declined by 16.5 minutes (95% confidence interval −10, −22).

Conclusion: Intravenous contrast adds significantly to ED LOS. Decreased use of routine IV contrast in the ED accelerates time to CT completion. A policy change to limit IV contrast during a national shortage significantly decreased ED LOS. [West J Emerg Med. 2024;25(3)342–344.]

INTRODUCTION

Abdominopelvic computed tomography (CT) is routinely ordered from the emergency department (ED) to evaluate for abdominal pain.[1] Historically, IV contrast has been used to highlight differences between soft tissues that would otherwise look the same. Intravenous (IV) contrast for CT is often sourced from overseas, and current estimates are that about half of hospitals in the United States get most of their IV contrast agent from GE Healthcare. Much of the contrast dye is manufactured at GE's plant in Shanghai. During the COVID-19 related lockdowns in China the plant was closed or operating at reduced capacity for weeks. As a result, many hospitals had a significantly decreased supply of IV contrast, which forced them to decrease utilization by up to 80%.

Anticipating continued deficiencies in the supply of IV contrast, Mayo Clinic Arizona in May 2022 initiated critical protocols to limit contrast use to potentially life-threatening conditions. This decreased utilization within the ED created a unique circumstance in which we had the opportunity to explore the theoretical benefit of omitting IV contrast material from routine ED abdominopelvic CT to determine whether it would significantly decrease ED length of stay (LOS), which in our institution we measure as the patient's total time in the department. Length of stay is a benchmark used by the Centers for Medicare and Medicaid Services as a hospital quality metric.[2] Additionally, shortened duration of LOS has been shown to decrease the rate that patients leave against medical advice, while increasing patient satisfaction, and potentially improving treatment outcomes.[3]

METHODS

Prior to the contrast shortage alert, the IV contrast agent iohexol was routinely administered to ED patients in conjunction with CT examinations of the abdomen and pelvis. Starting May 6, 2022, our ED in collaboration with the radiology department agreed to discontinue IV contrast material for routine CT except in two specific scenarios: patients requiring abdominal imaging who had a body mass index (BMI) <25; and patients with a BMI >25 in whom there was an acute, time-dependent concern that required IV contrast to further diagnose.

We designated the "before intervention period" as the 60 days prior to May 6, and the "after intervention period" as the 60 days after May 6. Since the study was focused on process rather than patients, the normal requirement for institutional review board oversight was waived. We included in the study patients who presented to the ED with abdominal pain and underwent abdominopelvic CT at the discretion of the treating attending emergency physician. The primary outcome was ED LOS, which was defined as the length of time between when the patient registered for care in the ED and the time of ED disposition (admit or discharge time).

Median and interquartile range (IQR) values were expressed for all continuous measures between groups (before vs after periods). We compared patient demographics and clinical characteristics between groups with chi-square test for frequency data and nonparametric Wilcoxon rank-sum test for continuous measures. The primary outcome was ED LOS. We analyzed data using statistical process control charts (with 1, 2 and 3 sigma control limits), and we adjusted confidence limits using an XmR chart, which helps to determine how a process changes over time. The XmR control chart is recommended for LOS and real-world ED operational data.[4] Control charts were run for all scans and separated out by contrast administration for both time periods. *P*-values <0.05 were considered statistically significant. We used R version 4.1.2 ggQC package (RStudio, Boston, MA) for statistical analysis.

Population Health Research Capsule

What do we already know about this issue?
Intravenous contrast is used to highlight differences between soft tissues that would otherwise look the same.

What was the research question?
Does decreased use of contrast for computed tomography (CT) improve ED length of stay (LOS)?

What was the major finding of the study?
If there is a shortage of IV contrast for CT, using contrast on fewer patients may improve patient throughput due to shortened LOS.

How does this improve population health?
If there is a shortage of IV contrast for CT, using less contrast may improve patient throughput due to shortened LOS.

RESULTS

There were 26,122 patient encounters within the study period, of which 3,028 (11.6%) met the study criteria: complaint at triage of abdominal pain; age >18; and indications for CT exclusive of ureterolithiasis. Median age was 60 years (IQR 40–72). Following protocol change, there was a 41.8% absolute decrease in abdominopelvic CT studies that used IV contrast : 74.6% (1,120/1,502) before vs 32.8% (500/11,526) after; $P < 0.001$). There was also a 16.5-minute decrease in LOS (95% confidence interval −10, −22) from 229.0 vs 212.5 minutes (Table).

DISCUSSION

We believe that radiology can significantly impact patient throughput.[5] Our findings suggest that decreased use of IV contrast in non-essential imaging of the abdomen and pelvis is associated with a decrease in ED LOS, thereby improving ED throughput. While 16.5 minutes may seem like a brief length of time, in this patient sampling it reduced LOS by about 7.2% (229 vs 212.5 minutes) and reduced aggregate LOS by a combined total of 420 hours over the course of nine weeks. This time savings multiplied by the millions of patients who present to the ED annually for abdominal pain can translate into a large magnitude of time saved, further decreasing the strain on the ED and potentially improving patient satisfaction.[6] As our study was performed at an institution with high nursing staff levels (2–3 patients per nurse) and tech ratios (six patients per tech), thereby optimizing time to IV access and kidney function test results,

Table. Before vs after restrictions on use of intravenous contrast for abdominal/pelvic computed tomography, demonstrating the impact on length of stay in the emergency department.

	Before (n = 1,502)	After (n = 1,526)	Total (N = 3,028)	*P*-value
Total LOS (minutes)				<0.001
Mean (SD)	239.6 (89.2)	226.3 (96.3)	232.9 (93.1)	
Median	229.0	212.5	220.0	
Q1, Q3	176.0, 293.0	156.3, 281.0	167.0, 287.0	
Range	13.0 – 672.0	7.0 – 877.0	7.0 – 877.0	
Contrast received				<0.001
No	382 (25.4%)	1026 (67.2%)	1408 (46.5%)	
Yes	1120 (74.6%)	500 (32.8%)	1620 (53.5%)	

LOS, length of stay; *Q*, quartile; *SD*, standard deviation.

we hypothesize there would be even more pronounced improvement in LOS at facilities that are short staffed.

Additionally, discontinuation of contrast can help to reduce incidence of need for IV-line placement, and the risk for allergy/anaphylaxis. In conversations with the radioloy department, the radiologists emphasized that they felt more confidence in the accuracy of their diagnoses with the use of contrast and that non-urgent findings such as carcinoma would more likely be missed without contrast. They suggested that reduced use of IV contrast would be appropriate in settings where artificial intelligence has improved pathology recognition or in the event of another shortage of contrast agent. More research will be needed to investigate the clinical effect of discontinuing IV contrast in this setting.

LIMITATIONS

There are several limitations to our study. After reviewing the data at other sites (Mayo Clinic Rochester, Mayo Clinic Florida, and Mayo Clinic Health System) we decided to make this a single-center study as other sites were not affected in the same way by the shortage, and they had a more gradual rollout of IV contrast restrictions. While we noted a reduction in LOS, we were unable to clearly parse out whether it resulted from decreased need for IV access and lab results, or decreased time in radiology department. Additionally, our study encompassed a limited time frame of only about 60 days, after which IV contrast agent became more available. Lastly, more research is needed to further analyze the potential need for repeat imaging or possible return visits to the ED as a result of not using IV contrast.

CONCLUSION

In this single-center study, we found that an institutional policy change reducing the use of contrast in abdominal-pelvic CT during the COVID-19 pandemic was significantly associated with shorter length of stay in the ED.

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The Utility of Dot Phrases and SmartPhrases in Improving Physician Documentation of Interpreter Use

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Background: Patients with limited English proficiency (LEP) experience significant healthcare disparities. Clinicians are responsible for using and documenting their use of certified interpreters for patient encounters when appropriate. However, the data on interpreter use documentation in the emergency department (ED) is limited and variable. We sought to assess the effects of dot phrase and SmartPhrase implementation in an adult ED on the rates of documentation of interpreter use.

Methods: We conducted an anonymous survey asking emergency clinicians to self-report documentation of interpreter use. We also retrospectively reviewed documentation of interpreter-services use in ED charts at three time points: 1) pre-intervention baseline; 2) post-implementation of a clinician-driven dot phrase shortcut; and 3) post-implementation of a SmartPhrase.

Results: Most emergency clinicians reported using an interpreter "almost always" or "often." Our manual audit revealed that at baseline, interpreter use was documented in 35% of the initial clinician note, 4% of reassessments, and 0% of procedure notes; 52% of discharge instructions were written in the patients' preferred languages. After implementation of the dot phrase and SmartPhrase, respectively, rates of interpreter-use documentation improved to 43% and 97% of initial clinician notes, 9% and 6% of reassessments, and 5% and 35% of procedure notes, with 62% and 64% of discharge instructions written in the patients' preferred languages.

Conclusion: There was a discrepancy between reported rates of interpreter use and interpreter-use documentation rates. The latter increased with the implementation of a clinician-driven dot phrase and then a SmartPhrase built into the notes. Ensuring accurate documentation of interpreter use is an impactful step in language equity for LEP patients. [West J Emerg Med. 2024;25(3)345–349.]

INTRODUCTION

As of 2019, over 65 million people in the United States (US) speak a language other than English, with approximately 20% of households reporting speaking English less than "very well," also known as limited-English proficiency (LEP).[1] In the US, presidential Executive Order 13166, enacted in 2000, ensures that LEP patients are offered interpretation services at healthcare facilities receiving federal assistance.[2,3] The lack of access to language-concordant care contributes to healthcare disparities among LEP patients.[4]

In the emergency department (ED), LEP patients were more likely to have unplanned revisits within 72 hours[5] with limited evidence suggesting differences in triage or admission decisions depending on interpreter use.[6] Recent data demonstrates increased unnecessary testing and hospital admission with longer lengths of stay among LEP patients who did not receive professional interpreting services.[7,8]

Documentation of interpreter use is often used as a proxy for interpreter use. Several groups of researchers studied the rate of interpreter-use documentation in the hospital. One found that 41% (30/74) of patients had a consent form in their native language or that an interpreter had signed it.[8]

Interventions have been implemented to improve documentation of interpreter use. Bender et al found that when they placed flyers in the ED and made pre-work shift announcements, documentation of interpreter use increased from a baseline rate of 5% to 25%.[9] In 2021, a study among patients admitted to a pediatric service found that using a dot phrase increased interpreter use from 64% to 81%, and interpreter-use documentation increased from 69% to 98%.[10] To our knowledge, there have been no studies investigating the use of a dot phrase (text inserted with keyboard shortcuts) or a SmartPhrase (abbreviations or words used to pull long phrases into a physician's note) in an adult ED to improve documentation of interpreter use. We assessed the effects of a dot phrase and a SmartPhrase in an adult ED on the rates of documentation of interpreter use. We hypothesized these interventions would increase documentation rates.

Population Health Research Capsule

What do we already know about this issue?
Patients with limited English proficiency experience healthcare disparities. Using interpreters reduces unnecessary testing and hospitalizations for this population.

What was the research question?
Does implementing a dot phrase and SmartPhrase increase documentation of interpreter use?

What was the major finding of the study?
Documentation of interpreter use in the history and physical rose from 35% to 43% (dot phrase) and then to 97% (SmartPhrase).

How does this improve population health?
An intervention to improve documentation of interpreter use helps ensure language equity for limited English proficiency patients.

METHODS

We conducted this study at a Level I academic trauma center in an adult ED, where interpreters are available over the phone 24/7 and in person during designated hours. First, we gathered patients' medical record numbers (MRN) from interpreter services that documented an interpreter had been used. A pre-intervention retrospective chart review was conducted to assess the baseline rate of interpreter-use documentation in the electronic health record (EHR). Second, we surveyed emergency clinicians to assess their perspective on interpreter use and documentation. Third, we implemented a dot phrase and then a SmartPhrase and retrospectively reviewed charts for documentation of interpreter use. Both instruments were being developed at the same time, but the dot phrase was completed more quickly and implemented first. Documentation of interpreter use was captured within the history and physical (H&P), reassessments, procedure notes, and discharge instructions (DCI), which includes a verbal discussion, written instructions, and attachments. We excluded charts from the study if the patient only spoke or preferred to speak in English, left without being seen, MRNs were not found, or if it it was a duplicate record. There was no prior training on documentation of interpreter use. We analyzed data using descriptive statistics. This study was deemed exempt by our institutional review board.

Pre-Intervention

We verified MRNs from the interpreter service data in the EHR. A number generator was used to randomize and identify patients for chart review. To minimize clinician-specific practice patterns, we audited one chart per day from July–September 2021 from various shift times to estimate the pre-intervention rate of interpreter use documentation.

Clinician Survey

We emailed an anonymous survey to 128 ED attendings, fellows, residents, and nurse practitioners regarding interpreter-use documentation after the pre-intervention data was collected. One follow-up email was sent. We created a survey of 14 multiple-choice questions hosted on Qualtrics (Qualtrics, Provo, UT). The survey included demographics, questions about interpreter use, documentation, and ways to improve documentation.

Dot Phrase

A dot phrase is a block of text inserted using a keyboard shortcut proceeded by a dot that facilitates clinician's documentation. Clinicians can input the phrase ".EDinterpreter" for the statement "A [phone, in-person] [language options] interpreter was used on [date and time], [INTERPRETER ID #]" to be added in the EHR. The dot phrase was available on July 1, 2022. All charts from interpreter services data were audited between July 1–October 14, 2022.

SmartPhrase

We embedded a SmartPhrase into the H&P and procedure notes creating a "hard stop" where clinicians could not sign their notes until the SmartPhrase was completed. This could be bypassed by deleting the SmartPhrase. If a non-English language was selected, the SmartPhrase would prompt to choose the patient's preferred language. The SmartPhrase was available on November 1, 2022. All charts from interpreter services data were audited between November 1–February 1, 2023.

RESULTS

Pre-Intervention

Of 91 audited charts, Spanish (61%) was the most preferred language, followed by Cantonese/ Mandarin/ Taishanese (37%), and Russian (2%). Use of an interpreter was documented in 35% of H&Ps, 4% of reassessments, and in 0% of procedure notes. Within the discharge instructions, 6% of charts indicated discussing instructions using an interpreter; 52% of written DCIs and 89% of attachments were provided in the patient's native language (Figure 1).

Clinician Survey

Of 128 emergency clinicians who received the survey, 67 (52%) initiated and 65 (51%) completed it. Of the respondents, 46% were residents, 37% attendings, 9% NPs, and 8% fellows. Clinicians reported use of an interpreter "almost always" or "often" 66% and 25% of the time when interacting with LEP patients. Additionally, 23% and 8% of clinicians reported "almost always" or "often" documenting use of an interpreter in the H&P (Figure 2a). Clinicians reported "almost always" documenting use of an interpreter in the reassessment (3%), procedure (15%), and DCI (8%) portions of the note (Figure 2b, 2c, 2d). When asked what can make documentation easier, 41% suggested additions to the ED note template with 29% recommending a dot phrase.

Dot Phrase

Of 866 audited charts, we analyzed 809 (93%). Spanish (67%) was the most preferred language, followed by Cantonese/Mandarin/Taishanese (32%), and Russian (1%). Forty-three percent of H&Ps, 9% of reassessments, and 5% of procedure notes had documentation of interpreter use. Documentation of interpreter use during discharge remained at 6%. The written portion and attachments of the DCI were in the patient's native language in 62% and 94% of charts.

SmartPhrase

Of 779 audited charts, we analyzed 646 (83%). Spanish (64%) was the most preferred language, followed by Cantonese/Mandarin/Taishanese (35%), and Russian (0.62%). Ninety-seven percent of H&P, 6% of the reassessments, and 35% of procedure notes had documentation of interpreter use. Regarding the verbal DCI, 4% documented interpreter use. The written portion and attachments were in the patient's native language in 64% and 94% of charts (Figure 1).

DISCUSSION

Documentation rates of interpreter use increased after implementation of a dot phrase and a SmartPhrase. After implementing the SmartPhrase, almost 100% of the H&Ps and 35% of procedure notes documented interpreter use. Because the SmartPhrase was embedded only in H&Ps and

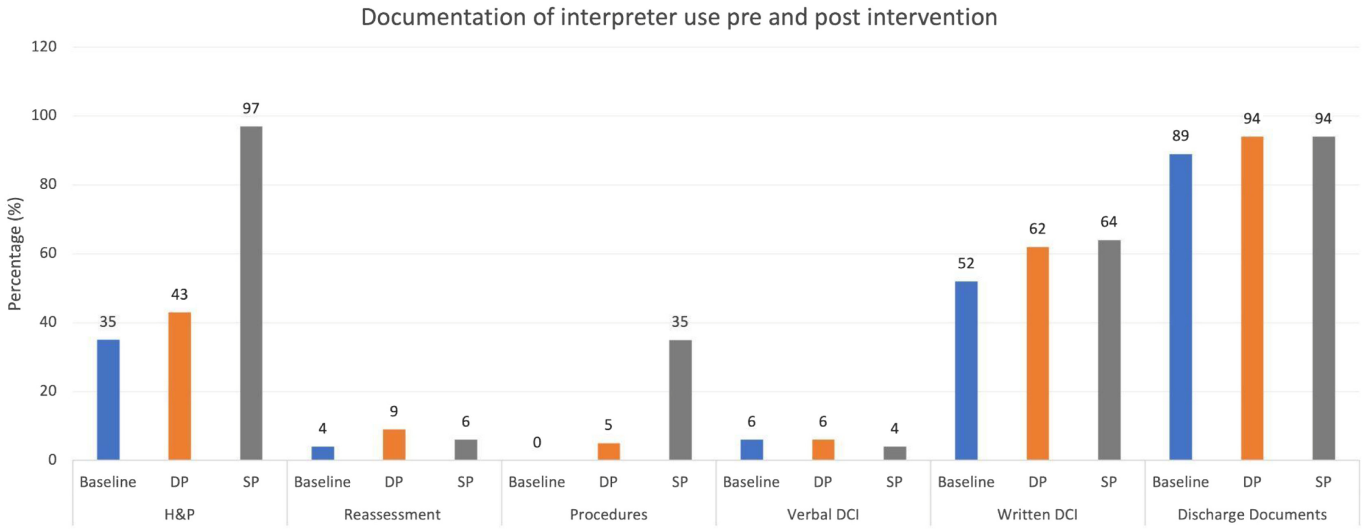

Figure 1. Percentage of patient charts with documentation of interpreter use at baseline (blue), after the creation of the dot phrase (orange), and after the creation of the SmartPhrase (gray).
H&P, history and physical; *DCI*, discharge instructions; *DP*, dot phrase; *SP*, SmartPhrase and procedure note implementation.

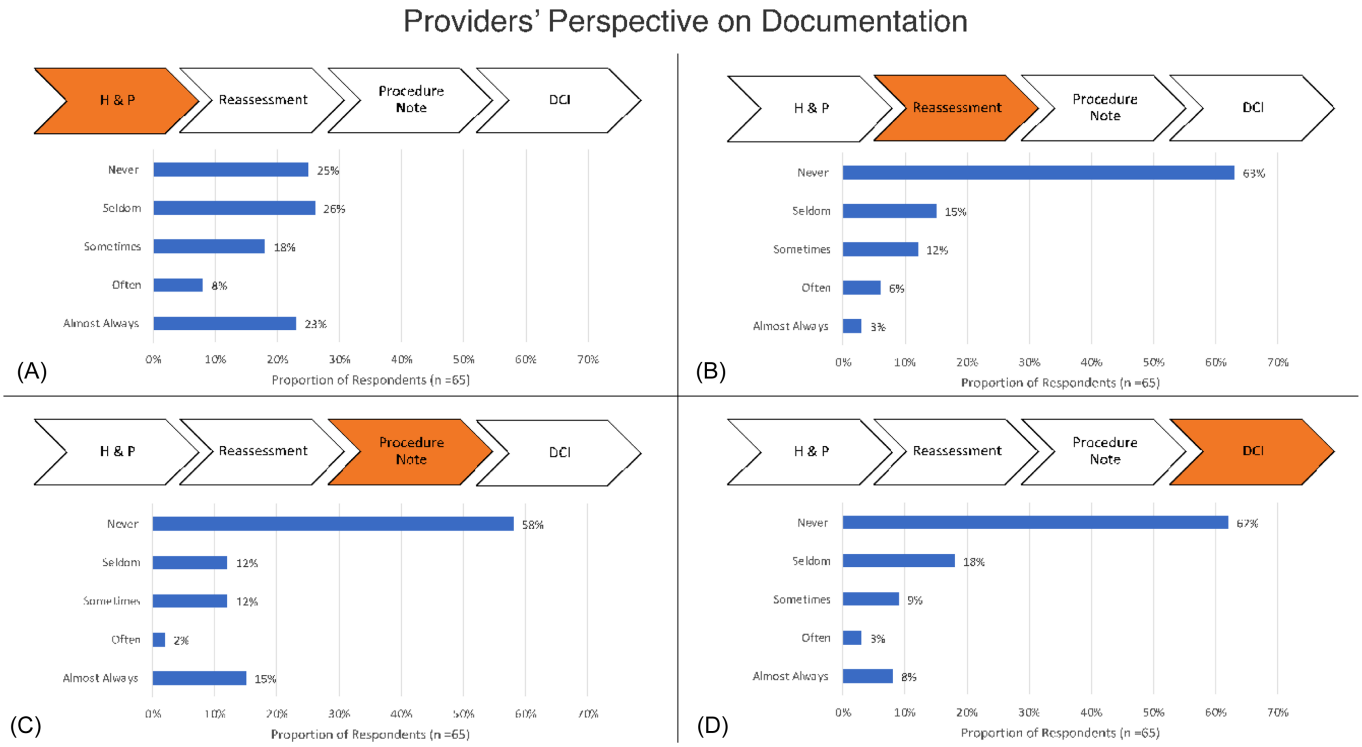

Figure 2. (a) Emergency clinicians' perspective on documentation of interpreter use in the history and physical. (b) Emergency clinicians' perspective on documentation of interpreter use in the reassessment. (c) Emergency clinicians' perspective on documentation of interpreter use in the procedure note. (d) Emergency clinicians' perspective on documentation of interpreter use in the DCI.
H&P, history and physical; *DCI*, discharge instructions.

procedure notes, we did not expect increases in the DCI and reassessments. The general rates of interpreter-use documentation in this study and previous studies vary. Behairy et al found that at their children's hospital documentation of interpreter use was 0%,[11] whereas Taira et al found documentation of interpreter use in their public ED to be 4.6%.[12] To our knowledge, this is one of the first studies on the impact of a dot phrase and a SmartPhrase on documentation of interpreter use in an adult ED.

There was a discrepancy between reported rates of interpreter use and documentation of interpreter use. Despite 66% of clinicians reporting "almost always" using an interpreter, only 23% reported "almost always" documenting their use in the H&P. The same discrepancy was seen among reassessments (3%), procedure notes (35%), and DCIs (8%) where clinicians reported they "almost always" documented their use. While we did not specifically ask clinicians when they use an interpreter (while gathering the H&P, etc, setting documentation as a proxy for interpreter use, many clinicians speaking to their patients with an interpreter would not have the documentation to support their claim. Lastly, clinicians may have used an ad hoc interpreter (family member or a member of the healthcare team), as the survey did not specify use of professional interpretation. This may account for some of the discrepancy between the reported and actual rates of interpreter use per interpreter services data.

Next, we hope to assess the impact of improved documentation on patient care.

LIMITATIONS

This was a single-institution study and results may not be generalizable. Variability in documentation among emergency clinicians, and in time and day of shift were not captured. Since only one chart per day was reviewed for pre-intervention data, documentation rates may have been more influenced by time of day than post-intervention rates, affecting the differences in pre-/post-intervention changes. We did not track the data of dot phrase and SmartPhrase use. Further, despite the SmartPhrase leading to a "hard stop," clinicians could delete the SmartPhrase. However, we included both the dot phrase and SmartPhrase as interventions since clinicians could add the dot phrase into other elements of the EHR when they used an interpreter (eg, reassessments).

CONCLUSION

Documentation of interpreter use is varied. There was a discrepancy between reported rates of interpreter use and interpreter-use documentation. Implementation of a dot phrase and a SmartPhrase improved documentation of

interpreter use, suggesting its feasibility to improve clinician documentation.

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Best Practices for Treating Blind and Visually Impaired Patients in the Emergency Department: A Scoping Review

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Introduction: Blind and visually impaired individuals, an under-represented population of the emergency department (ED), possess comorbidities and have a higher chance of in-hospital sequelae, including falls. This potentially vulnerable population, if not treated mindfully, can be subject to decreased quality of care, recurrent and/or longer hospitalizations, persistence of health issues, increased incidence of falls, and higher healthcare costs. For these reasons, it is crucial to implement holistic practices and train clinicians to treat blind and visually impaired patients in the ED setting.

Methods: We identified and used a comprehensive article describing best practices for the care of blind and visually impaired patients to establish the ED-specific recommendations presented in this paper. A scoping review of the literature was then performed using PubMed to identify additional articles to support each recommendation. To ensure that recommendations could be implemented in a representative, scalable, and sustainable manner, we consulted an advocate for the blind to help refine and provide additional suggestions.

Results: We identified 14 recommendations that focus on communication strategies, ED resource access, and continuity of care. The main recommendation is for the clinician to support the unique healthcare needs of the visually impaired individual and maintain the patient's autonomy. Another recommendation is the consistent use of assistive devices (eg, canes, guide dogs) to aid patients to safely ambulate in the ED. Also identified as best practices were discharge education with the use of a screen reader and timely follow-up with a primary care physician.

Conclusion: While we summarize a variety of recommendations in this article, it is important to implement only the strategies that work best for the patients, personnel, and environment specific to your ED. After implementation, it is vital to refine (as frequently as needed) the interventions to optimize the strategies. This will enable the provision of exceptional and equal care to blind and visually impaired patients in the ED. [West J Emerg Med. 2024;25(3)350–357.]

INTRODUCTION

The blind and visually impaired (VI) are a small but highly marginalized population in the United States and around the world.[1,2] There are approximately nine million VI people in the US, with blind people making up slightly less than 1% of the population. Globally, about 2% of children are considered VI.[3] Estimates in the US are expected to double by 2050, with the VI population projected to be more prevalent in racial minorities and in the southern US. The reason for this increase is multifactorial but may be due to an ever-increasing aging population and differential access to preventative services among minority groups.[4,5] Data is limited on the exact number of VI patients who are seen in the emergency department (ED). However, approximately 0.2% of patients admitted to US hospitals are considered VI.[6] States that have not expanded Medicaid coverage see higher rates of VI patients in their EDs.[7] Patients with other disabilities, such as those in the deaf and hard-of-hearing (DHH) community, are also more likely to seek ED care compared to those not in the DHH community.[8–12]

Although VI patients represent a relatively small proportion of patients seen in the ED and admitted to the hospital, they have significantly worse outcomes: They are admitted and readmitted more often, incur higher healthcare costs, and may have a higher in-hospital mortality rate.[6,13,14] Visually impaired patients are more likely to experience multiple morbidities, thus further increasing their risk of needing ED care.[15] Falls and their sequelae, such as hip fractures, are among the most common reasons for blind patients to be seen in the ED.[16–18] Pediatric VI patients are particularly likely to incur orthopedic injuries and are also more likely to have fractures upon presentation.[19] Hospitalized patients who are VI are also more likely to experience delirium,[20] a well-known risk factor for morbidity and mortality.[21] These injuries and conditions among the VI occur in other countries[22] and to other disabled groups.[12,23] In the US, these issues are further compounded by the intersections of race and age.[2] Black patients and patients insured by Medicare (ie, those ≥65 years old) are the most likely to have extended hospital stays.[13]

Optimal care for all patients in the ED remains an ongoing challenge; care of VI patients presents unique challenges that offer a number of opportunities. A mindful approach to care of VI patients requires that EDs and clinicians pursue best practices, support staff, impactful education, and specialized considerations. As with many populations, the needs of VI patients impact their experience during ED care. In this article, we present best practice considerations. This scoping review is intended to prompt improved practice and to further discussion to optimize ED care for VI patients.

METHODS

We performed a scoping review to identify PubMed articles related to blindness and VI in the ED, with particular emphasis on assessing the experiences of VI patients in the ED. Articles were included if they met one or more of the following criteria: centered on the experiences of disabled people, particularly VI people, in healthcare; discussed the experiences or epidemiology of disabled patients in EDs or hospitals regardless of geographic region; provided best practice recommendations for the care of VI patients regardless of specialty; and discussed outcomes of disabled patients in the ED or hospital. We excluded articles discussing the care of acute blindness or VI, as the focus of this review was on patients with pre-existing visual impairment. Due to the overall lack of data on this topic, guidelines from other specialties (eg, ophthalmology) were included and adapted to the ED setting.

We used the Americans with Disabilities Act (ADA) Checklist by Marshall and Joffee (2006) as the basis of our recommendations, as it provides a comprehensive list of best practices for all healthcare clinicians. From this paper, we selected 15 recommendations most relevant and applicable to the ED setting (Table). Recommendations were supplemented using focus group and survey data found on PubMed. The search phrase "(visually impaired) AND (accessibility)) AND (emergency department)" resulted in 28 results. We found one relevant study by Carmichael et al (2023), in which 12 disabled individuals were interviewed (six of whom were VI). Due to a lack of data specific to VI patients, the search was expanded to include the experiences of patients with other physical and cognitive disabilities, which yielded an additional study by Morris et al (2021).

We evaluated trends in ED use among disabled patients to contextualize the recommendations provided. Finally, we used articles by the National Federation of the Blind (NFB) to ensure that the voices of VI authors and academics were well represented and to inform several recommendations (eg, language). Most of the data were observational and retrospective. We also consulted a subject matter expert who was born blind and dedicated her career to advocating for other VI people to ensure that we were best representing the needs of VI patients. Using this data, we identified actionable recommendations and best practices.

RESULTS

We performed PubMed searches to identify supporting articles for all 14 recommendations (see Table). Articles were selected using the previously described inclusion and exclusion criteria. Excluding the ADA Checklist by Marshall and Joffee, which was used to develop each recommendation, we found four articles supporting recommendation one. Three articles were found supporting recommendation two. Five articles were found supporting recommendation three, and one article was found supporting recommendation four. We found three articles supporting recommendation five, six articles supporting recommendation six, and four articles supporting

Table. Summary of recommendations for interacting with visually impaired patients in the emergency department.

Recommendations	Rationale	References
Use optimal language: disability-first often preferred.	Better represents the patient's lived experiences	24–27, 32
Introduce yourself every time you enter the room (consider placing signage to alert staff).	Ensures patient is aware of who is in the room at all times and may help prevent delirium	28–30, 32
Tell the patient what you're going to do before doing it, including before leaving the room.	Ensures maximal patient autonomy and may help prevent delirium	29, 31–35
Listen to the patient's caregiver(s), if applicable, but only after gathering as much information from the patient as you can.	Caregivers can provide important insight into the patient's life	32, 36
If available at your facility, ask whether the patient would like an advocate.	VI patients are part of a socially and medically vulnerable community	32, 33, 37, 38
Accommodate the needs of the patient, but do not over-focus on visual impairment during the HPI.	Most VI patients do not present for concerns associated with their VI	29, 31–33, 36, 39, 40
Place the patient in quietest part of the ED.	May help prevent delirium	32, 35, 41–43
Ensure the patient has access to mobility equipment (eg, cane, guide dog) at all times.	Ensures maximal patient autonomy and may help prevent delirium	29, 32, 33, 35
Ensure the patient has access to personal technology (eg, phone, smartwatch, etc).	Ensures maximal patient autonomy and may help prevent delirium	30, 32
Ensure the patient knows where the call light is and how to use it.	Ensures maximal patient autonomy and may help prevent delirium	30, 32
Use the correct strategies when guiding a patient.	Helps ensure patient safety	31, 32
Clearly note the patient's visual impairment in the medical record (ICD-9: 369; ICD-10: H54).	Helps ensure all healthcare workers are aware of the patient's VI and can provide relevant accommodations	30, 32
Advocate for Medicaid expansion at the state and medical society (eg, AAEM) level, and encourage patients to apply.	May help decrease frequency of ED visits	7, 32
Help the patient establish care with a PCP.	Helps to prevent recurrent ED visits	32, 44, 45

HPI, history of present illness; *ED*, emergency department; *VI*, visually impaired; *ICD*, International Classification of Diseases, Rev 9 or 10; *AAEM, American Academy of Emergency Medicine; PCP, primary care physician.*

recommendation seven. Three articles were found supporting recommendation eight. One article was found supporting recommendation 9–13. Finally, we found two articles supporting recommendation 14. All supporting articles and which recommendations they informed can be found in Table.

DISCUSSION

Communication Strategies

Optimal Language

The use of person-first (eg, person who is blind) and disability-first (eg, blind person) language is a contentious issue. Academics consider person-first language to be more dignifying as it places focus less on the disability and more on the individual.[24,25] However, many blind people and blind advocates strongly disagree with person-first language as it may inadvertently stigmatize disability. Blind advocates also argue that disability-first language more accurately represents disabled experiences.[25–27] This contention further emphasizes the importance of listening to disabled patients and using the terminology they prefer. If a blind patient prefers to be called a "blind patient" or a "patient who is blind," that preference should be accommodated like any other. Disability-first language will be used in this paper for brevity and, more importantly, because it is generally preferred by the VI community.

Entering and Exiting

Consent is an integral component of patient care, and all efforts should be made by emergency clinicians and patient care staff to obtain informed consent at all times.[28] However, the way that consent is obtained cannot be uniformly applied to all patients. For example, blind patients cannot see who is entering their room, so they may not immediately be able to tell whether the person who just walked in is a doctor, nurse, family member, etc. Thus, it is imperative for each person entering a blind patient's room to verbally inform the patient of their name and role every time they enter the room.[29] This is especially important in the ED, an often hectic and disorienting place for all patients, and particularly for those with disabilities.[30] Just as important as announcing when you walk into a patient's room is announcing when you or

others involved in patient care leave the room.[29] If this is not done, the patient may attempt to speak to someone who they logically assume is still in the room only to be met with silence. This is not only potentially embarrassing but disorienting.[31,32]

Informed Consent

Informed consent discussions also must be tailored for VI patients. In addition to the typical discussions to gain consent, VI patients benefit from the clinician maintaining an ongoing dialogue during a procedure, explaining what will be done next and providing clear, actionable instructions when necessary.[29,33] Adding this extra layer of communication can be instrumental in ensuring patient safety and adherence, and the overall efficacy of the medical intervention for blind patients. Furthermore, it serves to maintain respect for their autonomy, helps foster a cooperative environment, and minimizes surprise or discomfort during the procedure, a particularly important consideration in an ED setting where the pace of care is often rapid and potentially anxiety-inducing.[34,35]

Mindfulness of Unique Needs

Navigating Caregivers

If a caregiver is not present, you may ask the patient or check the patient's chart for a potential caregiver's contact information. However, do not assume a patient has or requires a caregiver because they are VI. During the course of treatment of a VI patient, the caregiver (if applicable) may be able to provide helpful information or context regarding the patient.[36] For example, the caregiver may provide information about the patient's baseline independence and Activities of Daily Living—the skills needed to independently care for oneself. This information can be helpful during the course of treatment in the ED, as well as upon discharge to customize instructions to the patient. However, it is important to remember that caregivers are an adjunct to patient care and not the patients themselves. Thus, be sure to gather as much information from the patient as possible as well as from their caregiver.[29,32] This helps maintain a respectful and autonomous patient-clinician relationship.

Using a Patient Advocate

Patient advocates can play a significant role in the holistic care of a patient.[37,38] During the course of treatment for a VI patient, it is important to ask the patient whether they have an advocate, which can be done as early as the triage process. If the patient does not already have an advocate or cannot think of someone, it is important to work collaboratively with the patient to identify an advocate, if they would like one. There are several potential people who can be advocates including family and friends of the patient, work colleagues, caregivers, social workers, and hospital volunteers (eg, premedical students and navigators).[32,33]

The role of an advocate may vary; therefore, it is critical to establish clear roles and responsibilities for the advocate. One of their key responsibilities can be to accompany the patient in the waiting room. If the advocate is an employee of the hospital or familiar with the ED, it can be helpful for the advocate to discuss the overall ED process. This will provide predictability of what to expect and clarify the ED process for the patient.[37] After the waiting room, the advocate can also provide support during transport to the room and in meeting healthcare personnel and explaining the work up and procedures for labs or imaging. Finally, during disposition, the advocate can appropriately advocate on behalf of the patient for resources required following discharge or during the admission process. The overall roles and responsibilities can vary by patient and ED setting, but it is important for the patient and the advocate to establish a mutual understanding.

History of Present Illness Considerations

When gathering the history of present illness (HPI) on a VI patient, emergency clinicians should strive to treat the patient as similarly to other patients as possible. For example, looking at the patient directly when you are speaking, as you would for other patients, is considerate and thoughtful.[29,31–33] It is also important to recognize that VI exists on a spectrum from slightly decreased visual acuity to a complete lack of vision, and most people typically considered blind have some level of visual function.[39] Acknowledging this spectrum, clinicians should attempt to discern the patient's unique needs to provide optimal care. It is also important *not* to presume lower cognitive ability or other disabilities due to visual impairment.[36] In interactions with the patient, be considerate of their visual impairment, but do not overly focus on it. Remember, ED visits for blindness and low vision are exceedingly rare[40]; thus, a blind patient is unlikely to be seeking emergency care for their blindness. Treat the blind patient as you would your other patients as much as possible, and do not overly placate the patient. For example, if the blind patient needs to sign a consent form, you can make the necessary accommodations such as reading the form out loud.[29,32,33]

Placement Strategies and Accessibility

Optimal Location for Patients in the ED

It is common for people who are VI to have heightened sensory sensitivity, particularly to sound.[41,42] This is especially true for people with early vision loss.[43] Therefore, making considerations for adapting the care environment can contribute to a more comfortable patient experience. For example, placing the patient in the quietest part of the ED can help.[32,35] This may also help prevent delirium, particularly if a patient needs to stay in the ED for a prolonged period of time.

Ensure Access to Assistive Devices

Accessibility to personal assistive devices, such as mobility equipment, should be considered.[32] These devices, like canes or guide dogs, are considered an extension of the person and are legally recognized as medical equipment under the ADA. For patients with a guide dog, clinicians and other healthcare staff should understand that the dog has a specific job and, thus, should not be bothered or inhibited. Healthcare staff are not required to directly care for a guide dog but may assist with care tasks if the patient requests and time permits. By ensuring that VI patients have continual access to these aids, we can help facilitate independent navigation and mobility, which serves to preserve their autonomy and reduces potential distress during their stay.[29,33,35]

Phones or smartwatches can also help bridge gaps in healthcare equity by serving several functions. For example, VI patients often use speech-to-text software or navigational aids, which they may access through their personal devices.[30] Many hospitals offer apps or online tools to track appointments, view lab results, or communicate with clinicians. Ensuring access can, therefore, facilitate communication with medical staff and contribute to a more comprehensive understanding of their care. Finally, personal devices enable patients to maintain contact with their social networks, friends, or family, which can help promote emotional well-being during a potentially stressful hospital stay.[30] Some patients may rely on their devices for entertainment or distraction, which can make the stressful ED environment easier to cope with. In all, maintaining access to personal technology is not merely a convenience for VI patients; it plays a crucial role in ensuring equity and inclusivity by fostering a more patient-centered approach to care and empowering them in the management of their healthcare.[30,32] Finally, ensuring that patients are aware of the location and operation of the call light can further empower them and facilitate immediate communication, especially in emergency situations.[30,32] These simple strategies may also help prevent delirium in VI patients who are already at higher risk.

Guiding Patients

If a VI patient needs to move somewhere (eg, to use the bathroom), and is stable enough to ambulate, it is important to know how to best assist the patient. Allowing ambulatory patients to walk also provides them with autonomy. Guiding can be a daunting task for those who have never done it, but this task is relatively simple. First, the healthcare staff should ask the patient whether they would like a guide and whether they would like to bring their assistive device (ie, cane or guide dog). If they say yes, allow them to stand; then, the healthcare worker should stand next to the patient and tap the patient's arm. The patient will then take the person's arm or elbow and will be ready to be guided. The healthcare worker should walk at a normal pace. If the worker is passing through a tight area, they should simply move their elbow behind their back and hold it there. This will signal the patient to walk behind the staff member. When it's safe for the patient to return to the clinician or healthcare worker's, the worker should move their elbow back to their side; this will signal it is safe to return to walking by the worker's side. Although unlikely in the ED, if the healthcare worker encounters a ledge or stairs, they should inform the patient and pause when they get to the area. This will give the patient enough time to gain stable footing. After, walk up or down the stairs at a normal pace. If the ED staff member encounters a door, open the door and ensure the patient has a hand on the door. This will ensure they are able to control when the door closes. If the patient is using the bathroom, assist them in finding the toilet and sink; then leave the bathroom and give the patient privacy. When finished, the patient will let the staff member know, and they can be guided back to their room.[31,32]

Ensuring Quality Continuance of Care

Optimal Documentation

When treating a blind patient, it is important to note visual impairment as early as possible and as clearly as possible in the chart and/or on the wristband that the person is wearing, for example.[30,32] The ideal time to note visual impairment would be during the intake or triage process. The International Classification of Diseases, Rev 9 and 10 codes for Blindness and Low Vision are 369 and H54, respectively. This would enable the downstream healthcare workers to appropriately adjust their care to a patient with visual impairment.

Upon recognizing that the patient is blind, the patient's chart should be updated to clearly reflect the visual impairment, as per hospital or ED protocol. If your healthcare setting does not have a protocol, you can seek to establish a standardized protocol. Before implementing, consider that the protocol should be implementable across both electronic and paper health records. One example could be an "eye" icon in an electronic health record (EHR) or a colored sticker for paper charts. Additionally, the same-colored sticker can also be applied as a patient wristband. Finally, ensure that the protocol does not overlap or conflict with another existing department/hospital protocol. For example, if your hospital uses a yellow wristband to signify a fall-risk patient, it is best to use an alternate color to signify a patient with visual impairment. Similar signage used for "fall-risk" or infection precautions can be used on the patient's door, if admitted.[32]

Discharge Considerations

During discharge, patients are often given paper copies of their discharge instructions. However, this is not accessible for VI patients. Thus, it is important to find alternative means of providing this information.[29,32,33] Many EHR systems

have websites or apps patients can use to access their health information. For example, Epic (Epic Systems Corporation, Verona, WI) uses the MyChart system, which is screen-reader accessible. Screen readers are software natively installed or downloaded onto devices that use the device's microphone to read out loud what is on screen. The MyChart app can be used with IOS and Android screen readers, Voiceover and Talkback, respectively, and the website can be accessed with JAWS and NVDA, the two most commonly used Windows screen readers. Although it's impossible to test every EHR, you can reach out to your information technology department to determine whether your system is screen-reader accessible, and if not, to advocate for updates to be made so all patients can access their health records and discharge instructions.

Support Medicaid Expansion

States that have expanded Medicaid coverage see a decreased rate of ED visits among disabled patients. This is likely because it decreases the financial burden for disabled patients to seek preventative care.[7] Importantly, this may also decrease clinician burden. We recommend advocating for Medicaid expansion in your state. This can be done in many ways, such as contacting your member of congress or representatives at your medical society (eg, American Academy of Emergency Medicine). Additionally, hospital financial services or social workers may be able to assist patients in applying to Medicaid.[32]

Connect Patients to a Primary Care Physician

It is known that access to a primary care physician (PCP) is associated with significantly reduced ED visits.[44] For VI patients who have a myriad of unique needs, it is especially important to connect them with a PCP before they are discharged.[32] This has also been found to decrease recurrent ED visits among disabled patients.[45]

LIMITATIONS

This review is limited by the lack of data on VI patients in the ED. It is also important to note that disabled individuals' experiences are varied and highly personal, so the recommendations provided in this paper are general. All data used in this review are retrospective and observational and, thus, subject to the limitations inherent to those study types. More research is needed to determine the shortcomings of ED care of VI patients.

CONCLUSION

There are a variety of impactful interventions that can improve ED care for visually impaired patients. These interventions are reproducible, not resource-intensive, and profoundly helpful for VI patients in the ED. Like many ED interventions, these recommendations are not static or comprehensive but rather serve the purpose of furthering a much-needed conversation. These recommendations should also be further studied to determine their patient-centered impact, ideally in partnership with national and state organizations representing VI people. Optimal care in the ED for visually impaired patients is optimal care for all patients. Please consider implementing some or all of these interventions and approaching the care of VI ED patients mindfully and intentionally.

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Association Between Sexually Transmitted Infections and the Urine Culture

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Introduction: Bacterial urinary tract infections (UTI) and some sexually transmitted infections (STI) can have overlapping signs and symptoms or nonspecific findings, such as pyuria on urinalysis. Furthermore, results from the urine culture and the nucleic acid amplification test for an STI may not be available during the clinical encounter. We sought to determine whether gonorrhea, chlamydia, and trichomoniasis are associated with bacteriuria, information that might aid in the differentiation of STIs and UTIs.

Methods: We used multinomial logistic regression to analyze 9,650 encounters of female patients who were aged ≥18 years and who underwent testing for STIs. The ED encounters took place from April 18, 2014–March 7, 2017. We used a multivariable regression analysis to account for patient demographics, urinalysis findings, vaginal wet-mount results, and positive or negative (or no) findings from the urine culture and testing for *Neisseria gonorrhoeae, Chlamydia trachomatis,* or *Trichomonas vaginalis.*

Results: In multivariable analysis, infection with *T vaginalis*, *N gonorrhoeae,* or *C trachomatis* was not associated with having a urine culture yielding 10,000 or more colony-forming units per milliliter (CFU/mL) of bacteria compared with a urine culture yielding less than 10,000 CFU/mL or no urine culture obtained. The diagnosis of a UTI in the ED was not associated with having a urine culture yielding 10,000 or more CFU/mL compared with a urine culture yielding less than 10,000 CFU/mL.

Conclusion: After adjusting for covariates, no association was observed between urine culture results and testing positive for trichomoniasis, gonorrhea, or chlamydia. Our results suggest that having a concurrent STI and bacterial UTI is unlikely. [West J Emerg Med. 2024;25(3)358–367.]

Keywords: *chlamydia; emergency department; emergency medicine; gonorrhea; Trichomonas; urinary tract infection.*

INTRODUCTION

Urinary tract infection (UTI) is one of the most common bacterial infections diagnosed in the emergency department (ED).[1,2] Symptoms of UTI are the reason for approximately 1% of all ambulatory visits and result in 2–3 million ED visits in the US each year.[2] Urine culture results can take more than a day, and the urinalysis findings can cause diagnostic uncertainty about the existence of a bacterial UTI. Adding to the problem is that the incidence of some sexually transmitted infections (STI) such as gonorrhea, chlamydia, and trichomoniasis is increasing in the US,[3,4] and clinical manifestations of UTIs and STIs may overlap. These overlapping signs and symptoms may lead to underdiagnosing STIs in patients with urinary

concerns and overtreating for STIs in patients with genital concerns.[5–9] Previous study findings have shown that STIs are associated with sterile pyuria and other non-specific findings on urinalysis.[5,9,10] Diagnostic confusion may be most common when trichomoniasis is identified in the ED by urinalysis or wet mount and the clinician must consider whether the urine inflammatory changes are caused by *Trichomonas vaginalis* only or by a concurrent bacterial UTI.

In this analysis, we sought to determine whether infection with gonorrhea, chlamydia, and trichomoniasis was associated with specific urine culture results. Specifically, we attempted to determine the frequency of STIs and having a urine culture yield 10,000 or more colony-forming units per milliliter (CFU)/mL) of bacteria. The research question we sought to answer was as follows: For a woman suspected of having or found to have gonorrhea, chlamydia, or trichomoniasis during the ED encounter who has genitourinary concerns, are the inflammatory changes observed on urinalysis most likely caused only by the STI, or is concurrent bacteriuria (eg, UTI) contributing?

Population Health Research Capsule

What do we already know about this issue?
There is an overlap in the signs, symptoms, and findings on urinalysis for women with urinary tract infections (UTIs) and sexually transmitted infections (STIs).

What was the research question?
For a woman suspected of having or found to have an STI, are the inflammatory changes observed on urinalysis most likely caused only by the STI, or could she have concurrent bacteriuria?

What was the major finding of the study?
After adjusting for covariates, no association was observed between urine culture results and testing positive for an STI, suggesting concurrent STI and bacterial UTI are unlikely.

How does this improve population health?
Concurrent STIs and bacterial UTIs are unlikely.

METHODS

Dataset

We used an existing dataset of 75,000 ED encounters of patients ≥18 years in age from a single health system.[11–22] All patients in the dataset received testing for gonorrhea, chlamydia, or trichomoniasis or underwent both urinalysis and urine culture. Patients undergoing only urinalysis, regardless of STI testing, were not included in the dataset. All ED encounters took place April 18, 2014–March 7, 2017. The dataset was created by the institution's information technology team who extracted retrospective data from the electronic health records (EHR). For our analysis, we included women who were not admitted to the hospital and who had a nucleic acid amplification test (NAAT) for gonorrhea, chlamydia, or trichomoniasis or had a vaginal wet mount. Data on the NAAT swab site were not available. Individual patients could have more than one ED encounter. Our project was approved by the institutional review board with an exemption from full review, and informed consent was waived. Articles have been published using the original dataset.[11–22]

Patients in the dataset were identified as having trichomoniasis if the parasite was seen with urine microscopy (a method having very low sensitivity but high specificity), vaginal wet mount (moderate sensitivity and high specificity), or NAAT (high sensitivity and specificity).[22–24] To avoid multicollinearity in the multivariable analysis, we consolidated findings from vaginal wet mount and urine microscopy for *T vaginalis* into a single variable labeled *T vaginalis* infection status known during the ED encounter. The *T vaginalis* NAAT (Aptima, Hologic, Inc, Marlborough, MA) result, or the *Neisseria gonorrhoeae* or *Chlamydia trachomatis* NAAT (Aptima), was considered separately because the result was not obtained until after the ED visit. Women may have tested positive for *T vaginalis* by more than one test during their encounter, and any patient with a positive *T vaginalis* test was considered to be infected with *T vaginalis.* All STI testing was performed at the discretion of the treating clinician.

We reported the vaginal wet mount as not performed if the patient had no results from the vaginal wet mount for white blood cells (WBC), yeast, *T vaginalis*, or clue cells. The vaginal wet mount WBCs were analyzed as 0–10/11 or more cells per high-power field (HPF).[16] For the vaginal wet mount, yeast, clue cells, and *T vaginalis* were reported by the clinical laboratory as present or absent.

We considered a urinalysis to have been performed if any component test from the urinalysis was reported. The urine sample was reported to have been collected by the following methods: clean catch/voided; missing or not documented by nursing; or "other" (eg, bladder catheter, straight catheter, ileostomy, nephrostomy, suprapubic, or urostomy). From the urinalysis, we considered the following variables: bacteria (0–4+); blood (0–3+); glucose (positive or negative); ketones

(positive or negative); leukocyte esterase level (0–3+); mucus (0–4+); nitrites (positive or negative); protein (positive or negative); red blood cells (RBC) (0–101 cells/HPF); *Trichomonas* (positive or negative); WBC clumps (positive vs negative); WBCs (0–101 cells/HPF); and yeast (present or absent). If a range of urine RBCs and WBCs was reported, we used the median of the range in the analysis, and if more than 100 cells/HPF were reported, we used the result "101 cells/HPF" for analysis. All urine tests were ordered at the discretion of the treating clinician.

We included the following demographic and triage information if it was available during the ED encounter: method of ED arrival; marital status; age; race; and the triage Emergency Severity Index. Age in years was converted to a categorical variable to account for the nonlinear relationship with STIs.[25]

Women were considered to have a UTI diagnosis if they had a specific ED code on the *International Classification of Diseases, 9th or 10th Rev (ICD-9/ICD-10)* (Supplement 1). Women were considered pregnant if they had a documented positive pregnancy test or a specific *ICD-9* or *ICD-10* code (Supplement 1).

Statistical Analysis

We summarized continuous variables as median and interquartile range, with analysis of variance F tests used to test associations. We reported categorical variables as counts and percentages, with a χ^2 test used to test associations. We perfomed multinomial logistic regression analysis accounting for multiple demographic, clinical, and diagnostic testing variables, with the Wald test used to determine P values. Multivariable analyses were performed for patients who had complete data for all model covariates. Odds ratios and 95% confidence intervals were calculated from the multivariable model. A P value less than .05 was considered significant. We conducted statistical analyses with statistical software JMP Pro 14 (JMP Statistical Discovery, LLC, Cary, NC) and SAS version 9.4 (SAS Institute, Inc, Cary, NC).

RESULTS

Among the 75,000 ED encounters in the original dataset, 16,755 women met our inclusion criteria. A summary of the clinical encounters is shown in Table 1. Among the 1,631 patient encounters with a positive test result for gonorrhea, chlamydia, or both, 1,443 (88.5%) had urinalysis, 443 (27.2%) had urine culture, and 438 (26.9%) had both urinalysis and urine culture. Among the 1,354 women with *T vaginalis* identified on vaginal wet mount and 418 women with a positive NAAT result for *T vaginalis*, 1,203 (88.8%) and 374 (89.5%) patients, respectively, had urinalysis. Table 2 shows encounters with a positive STI test result and the results of the urine culture. Among the 443 patients with gonorrhea, chlamydia, or both who had a urine culture result, 341 (77.0%) had less than 10,000 CFU/mL of bacteria, and 102 (23.0%) had 10,000 or more CFU/mL of bacteria in the urine culture.

In total, 1,804 patient encounters had a positive test result for *Trichomonas* by urine microscopy, vaginal wet mount, or NAAT. Of these, 1,612 (89.4%) had a urinalysis test result, 548 (30.4%) had a urine culture performed, and 538 (29.8%) had both a urinalysis and urine culture result. A total of 9,650 clinical encounters had complete observations for all model covariates and were included in the multivariable analysis (Table 3). This number included 2,414 patient encounters with less than 10,000 CFU/mL of bacteria, 722 patients with 10,000 or more CFU/mL of bacteria, and 6,514 patients with no urine culture performed.

The following variables were significantly more likely to be associated with a urine culture with 10,000 or more CFU/mL compared with less than 10,000 CFU/mL: higher bacteriuria on urinalysis; higher amount of blood in the urine nitrite-positive urine presence of urinary WBC clumps; higher urinary WBC count; and fewer WBCs on the vaginal wet mount (all $P \leq 0.01$; Table 3). These variables had a significantly lower likelihood of being associated with a urine culture with ≥10,000 CFU/mL: no *T vaginalis* NAAT result (compared with a negative *T vaginalis* NAAT) and protein in the urine (both $P \leq 0.01$; Table 3). The following variables were significantly more likely to be associated with ≥10,000 CFU/mL of bacteria in the urine culture (compared with no urine culture performed): married/life partner (vs single); higher bacteriuria on urinalysis; higher urine leukocyte esterase level; nitrite-positive urine, protein in the urine, presence of urinary WBC clumps, UTI diagnosed in the ED, and higher urinary WBC count (all $P \leq 0.02$; Table 3). These variables had a significantly lower likelihood of being associated with a urine culture with ≥10,000 CFU/mL (compared with no urine culture performed): no *T vaginalis* NAAT result (compared with a negative *T vaginalis* NAAT), protein in the urine, and no vaginal wet mount clue cells (compared with present) (all $P \leq 0.01$; Table 3). *Neisseria gonorrhoeae* or *C trachomatis detected by NAAT,* or known *T vaginalis* infection in the ED, was not associated with a urine culture yielding 10,000 or more CFU/mL. Additionally, UTI diagnosed in the ED was not associated with a urine culture yielding 10,000 or more CFU/mL compared with less than 10,000 CFU/mL.

DISCUSSION

Both UTIs and STIs can have overlapping signs and symptoms and can cause inflammatory changes in the urine. Distinguishing between UTI and STI can be challenging in the ED.[5,6,26] We sought to assess the relationship between bacteriuria and STIs. Our research question was as follows: For a woman suspected of having or found to have gonorrhea, chlamydia, or trichomoniasis during the ED

Table 1. Demographics and clinical characteristics by urine culture result.

Characteristic	Total (N = 16,755)	No urine culture (n = 12,372)	Urine culture, <10,000 CFU/mL (n = 3,534)	Urine culture, ≥10,000 CFU/mL (n = 849)	P value
Age, y, no. (%)					.002[a]
18–28	10,524 (62.8)	7,769 (62.8)	2,201 (62.3)	554 (65.3)	
29–39	4,328 (25.8)	3,252 (26.3)	894 (25.3)	182 (21.4)	
≥40	1,903 (11.4)	1,351 (10.9)	439 (12.4)	113 (13.3)	
Race, no. (%)	(n = 16,683)	(n = 12,311)	(n = 3,523)		<.001[a]
Black	14,855 (89.0)	11,090 (90.1)	3,017 (85.6)	748 (88.1)	
Not Black	1,828 (11.0)	1,221 (9.9)	506 (14.4)	101 (11.9)	
Marital status, no. (%)	(n = 16,708)	(n = 12,336)	(n = 3,526)	(n = 846)	<.001[a]
Married or life partner	1,488 (8.9)	1,050 (8.5)	359 (10.2)	79 (9.3)	
Separated, divorced, or widowed	670 (4.0)	460 (3.7)	168 (4.8)	42 (5.0)	
Single	14,550 (87.1)	10,826 (87.8)	2,999 (85.1)	725 (85.7)	
Pregnant, no. (%)					<.001[a]
No	13,105 (78.2)	9,725 (78.6)	2,681 (75.9)	699 (82.3)	
Yes	3,650 (21.8)	2,647 (21.4)	853 (24.1)	150 (17.7)	
ESI, no. (%)	(n = 15,793)	(n = 11,810)	(n = 3,365)	(n = 798)	0.06[a]
1 and 2	353 (2.2)	255 (2.2)	77 (2.3)	21 (2.6)	
3	11,937 (74.7)	8,777 (74.3)	2,574 (76.5)	586 (73.4)	
4 and 5	3,683 (23.1)	2,778 (23.5)	714 (21.2)	191 (23.9)	
Mechanism of ED arrival, no. (%)	(n = 16,663)	(n = 12,309)	(n = 3,507)	(n = 847)	0.46[a]
EMS or police	1,122 (6.7)	815 (6.6)	244 (7.0)	63 (7.4)	
Public transportation or on foot	852 (5.1)	630 (5.1)	170 (4.8)	52 (6.1)	
Private vehicle	14,689 (88.2)	10,864 (88.3)	3,093 (88.2)	732 (86.4)	
Urine specimen source, no. (%)					<.001[a]
Clean catheter/voided urine	3,309 (19.7)	0 (0.0)	2,703 (76.5)	606 (71.4)	
Other	71 (0.4)	0 (0.0)	51 (1.4)	20 (2.4)	
Not documented or missing	13,375 (79.8)	12,372 (100.0)	780 (22.1)	223 (26.3)	
NAAT for *Chlamydia trachomatis,* no. (%)					<.001[a]
Negative	14,985 (89.4)	11,123 (89.9)	3,127 (88.5)	735 (86.6)	
Positive	1,303 (7.8)	958 (7.7)	266 (7.5)	79 (9.3)	
No test result	467 (2.8)	291 (2.4)	141 (4.0)	35 (4.1)	
NAAT for *Neisseria gonorrhoeae*, no. (%)					<.001[a]
Negative	15,819 (94.4)	11,745 (94.9)	3,292 (93.2)	782 (92.1)	
Positive	477 (2.8)	342 (2.8)	104 (2.9)	31 (3.7)	
No test result	459 (2.7)	285 (2.3)	138 (3.9)	36 (4.2)	
NAAT for *Trichomonas vaginalis,* no. (%)					<.001[a]
Negative	4,505 (26.9)	3,409 (27.6)	854 (24.2)	242 (28.5)	
Positive	418 (2.5)	293 (2.4)	94 (2.7)	31 (3.7)	
No test result	11,832 (70.6)	8,670 (70.1)	2,586 (73.2)	576 (67.8)	

(*Continued on next page*)

Table 1. Continued.

Characteristic	Total (N = 16,755)	No urine culture (n = 12,372)	Urine culture, <10,000 CFU/mL (n = 3,534)	Urine culture, ≥10,000 CFU/mL (n = 849)	P value
Diagnosed with UTI in the ED, no. (%)					<.001[a]
No	14,849 (88.6)	11,456 (92.6)	2,900 (82.1)	493 (58.1)	
Yes	1,906 (11.4)	916 (7.4)	634 (17.9)	356 (41.9)	
Treatment of gonorrhea and chlamydia, no. (%)					0.82[a]
No	13,593 (81.1)	10,051 (81.2)	2,855 (80.8)	687 (80.9)	
Yes	3,162 (18.9)	2,321 (18.8)	679 (19.2)	162 (19.1)	
Vaginal wet mount, WBCs/HPF, no. (%)					<.001[a]
11–100	5,296 (31.6)	3,716 (30.0)	1,287 (36.4)	293 (34.5)	
≤10	10,868 (64.9)	8,233 (66.5)	2,119 (60.0)	516 (60.8)	
Not performed	591 (3.5)	423 (3.4)	128 (3.6)	40 (4.7)	
Vaginal wet mount, yeast, no. (%)					0.21[a]
Present	1,027 (6.1)	762 (6.2)	217 (6.1)	48 (5.7)	
None	14,538 (86.8)	10,765 (87.0)	3,036 (85.9)	737 (86.8)	
Not performed	1,190 (7.1)	845 (6.8)	281 (8.0)	64 (7.5)	
Vaginal wet mount, clue cells, no. (%)					<.001[a]
None	8,826 (52.7)	6,449 (52.1)	1,908 (54.0)	469 (55.2)	
Present	6,941 (41.4)	5,232 (42.3)	1,386 (39.2)	323 (38.0)	
Not performed	988 (5.9)	691 (5.6)	240 (6.8)	57 (6.7)	
Leukocyte esterase (urine)					<.001[b]
No. (missing)	14,616 (2,139)	10,381 (1,991)	3,403 (131)	832 (17)	
Median (IQR)	0.0 (0.0–1.0)	0.0 (0.0–1.0)	1.0 (0.0–2.0)	2.0 (1.0–3.0)	
Range	0.0–3.0	0.0–3.0	0.0–3.0	0.0–3.0	
Nitrite (urine), no. (%)	(n = 14,818)	(n = 10,505)	(n = 3,480)	(n = 843)	<.001[a]
Negative	14,257 (96.2)	10,236 (97.4)	3,417 (98.5)	604 (71.6)	
Positive	561 (3.8)	269 (2.6)	53 (1.5)	239 (28.4)	
WBCs (urine)					<.001[b]
No. (missing)	10,692 (6,063)	7,199 (5,173)	2,699 (835)	794 (55)	
Median (IQR)	5.0 (2.5–13.0)	3.0 (2.5–12.5)	8.0 (2.5–16.0)	31.5 (10.0–101.0)	
Range	0.0–101.0	0.0–101.0	0.0–101.0	0.0–101.0	
Bacteria (urine)					<.001[b]
No. (missing)	10,688 (6,067)	7,194 (5,178)	2,700 (834)	794 (55)	
Median (IQR)	1.0 (0.0–1.0)	1.0 (0.0–1.0)	1.0 (0.0–1.0)	1.0 (1.0–2.0)	
Range	0.0–4.0	0.0–4.0	0.0–4.0	0.0–4.0	
Blood (urine)					<.001[b]
No. (missing)	14,604 (2,151)	10,361 (2,011)	3,411 (123)	832 (17)	
Median (IQR)	0.0 (0.0–1.0)	0.0 (0.0–1.0)	0.0 (0.0–1.0)	1.0 (0.0–2.0)	
Range	0.0–3.0	0.0–3.0	0.0–3.0	0.0–3.0	

(*Continued on next page*)

Table 1. Continued.

Characteristic	Total (N = 16,755)	No urine culture (n = 12,372)	Urine culture, <10,000 CFU/mL (n = 3,534)	Urine culture, ≥10,000 CFU/mL (n = 849)	P value
Glucose (urine), no. (%)	(n = 14,809)	(n = 10,500)	(n = 3,467)	(n = 842)	0.39[a]
Negative	14,216 (96.0)	10,092 (96.1)	3,322 (95.8)	802 (95.2)	
Positive	593 (4.0)	408 (3.9)	145 (4.2)	40 (4.8)	
Ketones (urine), no. (%)	(n = 14,786)	(n = 10,477)	(n = 3,467)	(n = 842)	<.001[a]
Negative	12,220 (82.6)	8,740 (83.4)	2,808 (81.0)	672 (79.8)	
Positive	2,566 (17.4)	1,737 (16.6)	659 (19.0)	170 (20.2)	
Mucus (urine)					0.88[b]
No. (missing)	10,692 (6,063)	7,202 (5,170)	2,696 (838)	794 (55)	
Median (IQR)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	
Range	0.0–4.0	0.0–4.0	0.0–4.0	0.0–4.0	
Protein (urine), no. (%)	(n = 14,800)	(n = 10,494)	(n = 3,464)	(n = 842)	<.001[a]
Negative	10,553 (71.3)	7,716 (73.5)	2,366 (68.3)	471 (55.9)	
Positive	4,247 (28.7)	2,778 (26.5)	1,098 (31.7)	371 (44.1)	
RBCs (urine)					<.001[b]
No. (missing)	10,693 (6,062)	7,196 (5,176)	2,701 (833)	796 (53)	
Median (IQR)	2.5 (2.0–12.5)	2.5 (1.0–12.5)	2.5 (2.0–12.5)	5.0 (2.3–22.8)	
Range	0.0–101.0	0.0–101.0	0.0–101.0	0.0–101.0	
WBC clumps (urine), no. (%)	(n = 10,578)	(n = 7,116)	(n = 2,672)	(n = 790)	<.001[a]
None	10,118 (95.7)	6,915 (97.2)	2,549 (95.4)	654 (82.8)	
Present	460 (4.3)	201 (2.8)	123 (4.6)	136 (17.2)	
Yeast (urine), no. (%)	(n = 10,628)	(n = 7,154)	(n = 2,684)	(n = 790)	0.04[a]
Present	280 (2.6)	171 (2.4)	80 (3.0)	29 (3.7)	
None	10,348 (97.4)	6,983 (97.6)	2,604 (97.0)	761 (96.3)	
T vaginalis status during ED encounter, no. (%)	(n = 16,308)	(n = 11,987)	(n = 3,478)	(n = 843)	<.001[a]
No wet mount performed	720 (4.4)	451 (3.8)	216 (6.2)	53 (6.3)	
Negative[c]	14,176 (86.9)	10,554 (88.0)	2,922 (84.0)	700 (83.0)	
Positive	1,412 (8.7)	982 (8.2)	340 (9.8)	90 (10.7)	

[a]χ^2 test.
[b]Analysis of variance *F* test.
[c]Negative vaginal wet mount and urine microscopy (if performed).
CFU, colony-forming units; *ED*, emergency department; *EMS*, emergency medical services; *ESI*, Emergency Severity Index; *HPF*, high-power field; *NAAT*, nucleic acid amplification test; *RBCs*, red blood cells; *UTI*, urinary tract infection; *WBCs*, white blood cells.

encounter who has genitourinary concerns, are the inflammatory changes observed on urinalysis most likely caused only by the STI, or is concurrent bacteriuria (eg, UTI) contributing? Our results show that infection with gonorrhea, chlamydia, or trichomoniasis was not associated with also having a urine culture yielding ≥10,000 CFU/mL of bacteria compared with <10,000 CFU/mL or no urine culture performed. An important finding was that when *T vaginalis* was identified during the ED encounter on urine microscopy or vaginal wet mount, there was no significant association with bacteria in the urine culture. When an emergency clinician is evaluating a woman with genitourinary concerns and an STI is suspected or actually identified, as is the case on urine microscopy or vaginal wet mount for *T vaginalis,* bacteriuria is not more likely to coexist. Our findings support recommendations for screening for both UTIs and STIs in appropriate patients.[7,8] For instance, women undergoing pelvic examination who were also diagnosed with a UTI in the ED were subsequently found to have high rates of STIs.[7] However, emergency clinicians frequently do not screen for STIs in women with dysuria who are diagnosed with a UTI.[8] Furthermore, our findings support those of smaller studies.[6,27]

Table 2. Positive STI test results by urine culture.[a]

Urine culture result, CFU/mL	Positive for gonorrhea, chlamydia, or both on NAAT (n = 1,631)	Positive for *Trichomonas vaginalis* by test method		
		Urine microscopy (n = 275)	Vaginal wet mount (n = 1,354)	NAAT (n = 418)
No urine culture	1,188 (72.8)	186 (67.6)	943 (69.6)	293 (70.1)
0 – <10,000	341 (20.9)	71 (25.8)	326 (24.1)	94 (22.5)
10,000 – <100,000	15 (0.9)	5 (1.8)	16 (1.2)	6 (1.4)
>100,000	87 (5.3)	13 (4.7)	69 (5.1)	25 (6.0)

[a]Data is presented as No. (%). Women may have tested positive for *T vaginalis* by more than 1 test.
CFU, colony-forming units; *NAAT*, nucleic acid amplification test; *STI*, sexually transmitted infection.

Table 3. Multinomial logistic regression using urine culture result as the outcome variable (N = 9,650).

Variable	Comparison group	Reference	≥10,000 CFU/mL vs <10,000 CFU/mL		≥10,000 CFU/mL vs no urine culture done	
			OR (95% CI)	*P* value[a]	OR (95% CI)	*P* value[a]
Age, y[b]	29–39	18–28	0.82 (0.65–1.04)	0.10	0.83 (0.67–1.04)	0.11
	≥40	18–28	0.86 (0.63–1.17)	0.33	0.99 (0.74–1.34)	0.97
Marital status	Married or life partner	Single	1.32 (0.95–1.83)	0.10	1.43 (1.05–1.95)	0.02
	Separated, divorced, or widowed	Single	1.04 (0.66–1.64)	0.87	1.28 (0.83–1.99)	0.26
Pregnant	Yes	No	0.80 (0.62–1.02)	0.08	1.02 (0.80–1.29)	0.89
ESI	3	1 and 2	1.42 (0.74–2.72)	0.30	1.32 (0.71–2.47)	0.38
	4 and 5	1 and 2	1.42 (0.72–2.80)	0.31	1.30 (0.68–2.48)	0.43
NAAT for *Chlamydia trachomatis*	Positive	Negative	0.97 (0.70–1.35)	0.86	0.87 (0.64–1.18)	0.37
	No test result	Negative	0.87 (0.17–4.55)	0.87	1.27 (0.26–6.35)	0.77
NAAT for *Neisseria gonorrhoeae*	Positive	Negative	0.86 (0.52–1.42)	0.56	0.86 (0.53–1.37)	0.52
	No test result	Negative	1.20 (0.23–6.31)	0.83	1.23 (0.25–6.13)	0.80
NAAT for *Trichomonas vaginalis*	Positive	Negative	0.90 (0.53–1.52)	0.69	0.95 (0.58–1.55)	0.83
	No test result	Negative	0.73 (0.59–0.90)	.004	0.77 (0.63–0.94)	0.01
Race	Black	Non-Black	1.27 (0.95–1.70)	0.10	0.92 (0.70–1.22)	0.56
RBCs (urine)	1-Unit increase		1.00 (0.99–1.00)	0.40	1.00 (1.00–1.00)	0.66
Mechanism of ED arrival	EMS/police	Private vehicle	0.90 (0.62–1.29)	0.56	1.00 (0.71–1.42)	0.99
	Public transportation/ on foot	Private vehicle	1.06 (0.71–1.58)	0.77	1.17 (0.80–1.71)	0.41
Diagnosed with UTI in the ED	Yes	No	1.17 (0.94–1.45)	0.16	2.05 (1.68–2.51)	<.001
Treatment of gonorrhea and chlamydia	Yes	No	0.79 (0.62–1.02)	0.07	0.85 (0.67–1.07)	0.17
T vaginalis status during ED encounter	No wet mount performed	Negative[c]	0.77 (0.17–3.53)	0.73	0.50 (0.12–2.14)	0.35
	Positive	Negative[c]	0.87 (0.63–1.20)	0.41	0.76 (0.56–1.04)	0.08
Bacteria (urine)	1-Unit increase	None	1.13 (1.05–1.23)	<.001	1.19 (1.10–1.28)	<.001

(*Continued on next page*)

Table 3. Continued.

Variable	Comparison group	Reference	≥10,000 CFU/mL vs <10,000 CFU/mL		≥10,000 CFU/mL vs no urine culture done	
			OR (95% CI)	*P* value[a]	OR (95% CI)	*P* value[a]
Blood (urine)	1-Unit increase	None	1.15 (1.04–1.27)	.006	1.03 (0.94–1.13)	0.58
Glucose (urine)	Positive	Negative	0.91 (0.59–1.42)	0.68	0.98 (0.65–1.49)	0.93
Ketones (urine)	Positive	Negative	1.03 (0.80–1.31)	0.83	1.13 (0.90–1.42)	0.31
Leukocyte esterase (urine)	1-Unit increase	None	0.98 (0.88–1.09)	0.66	1.16 (1.05–1.29)	<.001
Mucus (urine)	1-Unit increase	None	0.99 (0.92–1.06)	0.81	0.98 (0.92–1.05)	0.62
Nitrite (urine)	Positive	Negative	15.7 (10.8–22.76)	<.001	5.72 (4.45–7.34)	<.001
Protein (urine)	Positive	Negative	0.71 (0.57–0.88)	.002	0.76 (0.62–0.93)	<.001
WBC clumps (urine)	Present	None	1.54 (1.10–2.15)	0.01	1.89 (1.39–2.56)	<.001
Yeast (urine)	Present	None	1.18 (0.70–1.98)	0.53	1.33 (0.82–2.18)	0.25
WBCs (urine)	1-Unit increase	None	1.02 (1.02–1.02)	<.001	1.02 (1.02–1.02)	<.001
Vaginal wet mount, clue cells	Present	None	0.91 (0.75–1.11)	0.35	0.78 (0.65–0.94)	<.001
	Not performed	None	0.33 (0.06–1.70)	0.19	0.53 (0.12–2.43)	0.42
Vaginal wet mount, WBCs/HPF	11–100	≤10	0.68 (0.55–0.84)	<.001	0.84 (0.69–1.02)	0.09
	Not performed	≤10	1.01 (0.36–2.88)	0.98	0.96 (0.35–2.64)	0.94
Vaginal wet mount, yeast	Present	None	0.96 (0.64–1.42)	0.82	0.77 (0.53–1.12)	0.17
	Not performed	None	2.68 (0.50–14.45)	0.25	3.50 (0.74–16.59)	0.11

[a]Covariate Wald test from the multinomial logistic regression model.
[b]Age was grouped as 18–28, 29–39, and ≥40 years.
[c]Negative test result by vaginal wet mount and urine microscopy (if performed).
CFU, colony-forming units; *ED*, emergency department; *EMS*, emergency medical services; *ESI*, Emergency Severity Index; *HPF*, high-power field; *NAAT*, nucleic acid amplification test; *OR*, odds ratio; *RBCs*, red blood cells; *UTI*, urinary tract infection; *WBC*, white blood cell.

A study by Prentiss et al showed that among adolescent girls with urinary tract symptoms in the ED, 9% had an STI, 57% had a UTI, and 6% had both an STI and a UTI.[6] Clinician accuracy was 83% for STIs and 71% for UTIs, whereas only 23% correctly diagnosed patients with both UTI and STI.[6] Shapiro et al[27] found that among 92 women with urinary tract symptoms, STI rates were not different between women with a positive vs a negative urine culture (10^2 CFU/mL). Additionally, a retrospective study of ED patients found that patients who were treated for a UTI, tested positive for gonorrhea, chlamydia, or trichomoniasis, and had pyuria were significantly more likely to have a negative urine culture than a positive urine culture.[9] Reliance on positive urine nitrite and pyuria to treat for UTI in patients with confirmed or suspected STI may result in overtreatment with antibiotics. However, patients with an STI and a positive urine culture had significantly higher urine leukocytes than those with negative culture results.[9]

We also found that clinical encounters in which patients were diagnosed with a UTI in the ED were not more likely to have a urine culture of ≥10,000 CFU/mL of bacteria compared with <10,000 CFU/mL Possibly, patients who were diagnosed with a UTI but who had <10,000 CFU/mL were more likely to have an STI, but this association was not examined in the current study. Because the diagnosis of a UTI was not part of our inclusion criteria, not all women with a UTI diagnosis are represented in our cohort. We were able to study only women who had both a urinalysis and urine culture, not just a urinalysis. Therefore, the association between a UTI diagnosis and bacteriuria deserves further investigation.

LIMITATIONS

Although our study used a large dataset, it has some limitations. First, not all women from our dataset underwent urinalysis, urine culture, vaginal wet mount, and NAAT for STIs. Furthermore, not all women diagnosed with a UTI underwent STI testing or a vaginal wet mount. Second, modeling *T vaginalis* in the ED has inherent limitations because the urinalysis and vaginal wet-mount results are available to the clinician during the encounter, but they lack high sensitivity, whereas NAAT is highly sensitive and specific but typically does not yield results during the patient encounter. Third, women undergoing STI testing who also had a urine culture may have been more likely to be concerned about urinary symptoms, which could have biased our analysis to those women with genitourinary concerns.

Because we were unable to include history and physical examination findings in our analysis, we could not differentiate between patients with more genital concerns and those having more urinary symptoms. Alternatively, some women included in the analysis may have had asymptomatic bacteriuria or an asymptomatic STI, although this possibility is thought to be less likely. We did not attempt to differentiate between contaminated urine cultures and those yielding classic uropathogens.[5]

Fourth, our dataset represented a limited geographical area in the US, and the patients were predominantly Black; therefore, our results may not be generalizable to other locations and races. Fifth, the data did not include pediatric patients or men; so our results cannot be extrapolated to those groups. Sixth, patients who were treated presumptively for STIs without specific testing were excluded from analysis, and this could have resulted in selection bias. Finally, inherent limitations exist to using a dataset extracted from the institution's EHR and *ICD* codes.

CONCLUSION

In our regression analysis, positive gonorrhea, chlamydia, and trichomoniasis test results were not associated with bacteriuria yielding ≥10,000 CFU/mL compared with <10,000 CFU/mL or no urine culture obtained.

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Changing Incidence and Characteristics of Photokeratoconjunctivitis During the COVID-19 Pandemic

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Introduction: Photokeratoconjunctivitis (PKC) is primarily caused by welding. However, inappropriate use of germicidal lamps, which have been widely used following the COVID-19 outbreak, can also cause PKC. Our goal in this study was to investigate the incidence of and changes in the causes of PKC during the coronavirus 2019 (COVID-19) pandemic.

Methods: We conducted a single-center, retrospective observational study. The health records of patients who visited the emergency department in a tertiary care hospital from January 1, 2018–December 31, 2021 and were diagnosed with PKC, were reviewed. We then conducted an analysis to compare the characteristics of PKC before and after COVID-19 began and the features of PKC caused by welding and germicidal lamps.

Results: There were 160 PKC cases with a clear etiology before the COVID-19 pandemic and 147 cases during the COVID-19 pandemic. No significant differences in age and gender were detected between the two groups. The incidence of PKC induced by the use of germicidal lamps during the COVID-19 pandemic was significantly higher (10.2%) than the incidence before the pandemic (3.1%). The ratio of females to males in the germicidal lamp subgroup was significantly higher than the ratio in the welding subgroup. Limitations included incomplete information due to the retrospective nature of the study, underestimation of incidence, and possible recall bias.

Conclusion: In the era of COVID-19, clinicians should be aware of the hazards of germicidal lamps. Although the COVID-19 pandemic seems to show signs of easing, new infectious diseases that require protective measures could still emerge in the future. Therefore, injuries related to germicidal lamps deserve more public health attention. [West J Emerg Med. 2024;25(3)368–373.]

Keywords: *COVID-19; SARS-CoV-2; ultraviolet light; photokeratoconjunctivitis; germicidal lamp; welding.*

INTRODUCTION

Photokeratoconjunctivitis (PKC), or photophthalmia, is related to ultraviolet radiation (UVR) exposure. Exposure to ultraviolet B (UV-B) and ultraviolet C (UV-C) can damage the ocular surface, including the corneal or conjunctival epithelial cells.[1] The clinical manifestations include ocular pain or foreign body sensation, tearing, photophobia, and even blurred vision in severe cases. The photochemical reaction typically takes 6–12 hours to cause symptoms.[2] Therefore, patients often experience symptoms at night after daytime exposure, leading to emergency department (ED) visits at night.[3] Exposure to UVR can be classified into natural and artificial sources. Natural sources include direct or reflected sunlight during skiing or time spent at the beach.[4] Artificial sources include workplace welding flashes, which are the most common cause of PKC, and curing lights, printing machines, high-tech industrial processes, laser engravers, and germicidal lamps.[3]

The coronavirus disease 2019 (COVID-19) is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The COVID-19 outbreak began in December 2019 and was declared a pandemic by the World Health Organization in 2020.[5,6] To control the spread of this highly contagious virus, several preventative and control measures were implemented, including wearing masks, social distancing, hand hygiene, and use of personal protective equipment and disinfectants, such as diluted bleach solutions or 70% ethanol.[6,7] Ultraviolent radiation was investigated for irradiation of the coronavirus[8]; UVR disinfects by damaging DNA structures, including viral DNA. Different wavelengths have different disinfecting effects.[9] The potential hazard of germicidal lamps to the eyes was recognized before the COVID-19 pandemic.[10,11] However, germicidal lamp use increased significantly during the COVID-19 pandemic, and the increased usage may lead to more cases of PKC.

Changes in ophthalmic ED visits after the COVID-19 pandemic began were recently discussed. A decreased number of overall eye injuries was noted in several studies.[12,13] Additionally, several studies reported cases of PKC due to germicidal lamps after the COVID-19 pandemic began, and an eight-week comparison study suggested an upward trend.[14–16] However, long-term data about the causes of PKC after the COVID-19 pandemic is limited. In this study we aimed to investigate the incidence of and changes in the causes of PKC before and after the COVID-19 pandemic.

Population Health Research Capsule

What do we already know about this issue?
Photokeratoconjunctivitis (PKC) is mainly caused by welding. Germicidal lamps, which also cause PKC if improperly used, were widely used after the COVID-19 outbreak.

What was the research question?
What are the incidence of and changes in the causes of PKC during the COVID-19 pandemic (over a two-year period)?

What was the major finding of the study?
The incidence of PKC induced by use of germicidal lamps increased significantly after COVID-19 began (10.2% vs 3.1%).

How does this improve population health?
The potential injuries from germicidal lamps deserve more public health attention both during the COVID-19 era and for new infectious diseases in the future.

METHODS

Study Design

We divided patients into two groups: patients with PKC before the COVID-19 pandemic (between January 1, 2018–December 31, 2019) and patients with PKC after the COVID-19 pandemic began (between January 1, 2020–December 31, 2021). Demographic data, including gender, age, month, time, etiology, occupation, and exposure time, were collected.

Participants

Patients who visited the tertiary-care center ED in Taiwan between January 1, 2018–December 31, 2021 and were diagnosed with PKC were enrolled in the study. Photokeratoconjunctivitis was diagnosed according to the following criteria: UV exposure history within one day; typical symptoms, including ocular foreign body sensation, pain, photophobia, and tearing; and ophthalmic clinical findings, such as conjunctival hyperemia and corneal superficial punctate lesions. We excluded pediatric patients, given the possibility of uncooperative physical and ocular examination. Based on the causes of PKC mentioned in the medical records, patients were divided into three groups based on the etiology: germicidal lamps; welding; and other. Patients whose medical records specifically mentioned the use of germicidal lamps were assigned to the germicidal lamp group, patients whose medical records mentioned exposure to welding were assigned to the welding group, and those whose causes were unknown or related to direct or reflective sunlight were assigned to the others group. This study was approved by the Institutional Review Board

of Chi Mei Medical Center, Tainan, Taiwan (Applicant's No: 11108-010).

Outcome Measures

The primary outcome of the study was the incidence and causes of PKC before and after COVID-19 began. The secondary outcome was the characteristics of the germicidal lamp and welding groups.

Statistical Analysis

We analyzed data using SPSS Statistics for Windows, version 22 (IBM Corp, Armonk, NY). The Pearson chi-squared test and Fisher exact test were used to compare categorical variables. Continuous variables were compared using the Student *t*-test. The threshold for statistical significance was defined as a *P*-value less than 0.05.

RESULTS

Patient Characteristics

During the study period, 307 PKC patients were recruited. Fewer cases of PKC occurred after COVID-19 began (147 vs 160) compared with the number of PKC cases before the COVID-19 period. The mean patient ages were 41.85 ± 0.97 years (range, 20–71 years) before COVID-19 and 40.07 ± 1.09 years (range, 20–78 years) after COVID-19. No significant differences in age or gender were detected between the groups before and after COVID-19 began. A majority of patients went to the ED at night; 90% went to the ED between 8 PM–07:59 AM, and the most prevalent period was 12 AM–03:59 PM. The characteristics of the patients with PKC are summarized in Table 1.

Incidence and Demographic Data of Germicidal Lamp-related PKC

The total number of PKC cases slightly decreased after the COVID-19 pandemic began. The etiologies of PKC were different before and after COVID-19 began. The percentage of patients in the germicidal lamp group before COVID-19 (5, 3.1%) was lower than the percentage of patients in the germicidal lamp group after COVID-19 began (15, 10.2%); thus, the incidence of PKC in the germicidal lamp group increased significantly after COVID-19 began ($P = 0.03$). Within the germicidal lamp-related PKC subgroup, the mean ages were 39.20 ± 3.69 years (range, 31–51 years) and 42.73 ± 3.88 years (range, 21–78 years) before and after COVID-19 began, respectively, and no significant differences in age or gender were detected between the groups (Table 2). All patients in the germicidal lamp group went to the ED between 8 PM–07:59 AM.

Comparison Between the Welding and Germicidal Lamp Groups

Most patients with PKC were males (more than 90% before and after COVID-19 began), and most patients in the welding subgroup were males (Tables 1 and 3). However, the percentage of females in the germicidal lamp subgroup was higher than the percentage of females in the welding group ($P < 0.001$). The times patients went to ED were not significantly different between the germicidal lamp group and the welding group.

Table 1. Characteristics of patients with photokeratoconjunctivitis.

	Before COVID-19 (N = 160)	After COVID-19 (N = 147)	*P* value
Age: mean ± SD	41.85 ± 0.97	40.07 ± 1.09	0.22
Gender (%)			0.88
Male	154 (96.3)	141 (95.9)	
Etiology of PKC (%)			$P = 0.03$
Welding	144 (90.0)	118 (80.3)	
Germicidal lamp	5 (3.1)	15 (10.2)	
Other causes	11 (6.9)	14 (9.5)	
Time of ED visit (%)			0.89
00:00–03:59	100 (62.5)	93 (63.3)	
04:00–07:59	18 (11.3)	16 (10.9)	
08:00–11:59	2 (1.3)	2 (1.4)	
12:00–15:59	1 (0.6)	2 (1.4)	
16:00–19:59	2 (1.2)	3 (2.0)	
20:00–23:59	37 (23.1)	31 (21.1)	

COVID-19, coronavirus disease 2019; *ED*, emergency department; *PKC*, photokeratoconjunctivitis.

Table 2. Demographic data of patients with germicidal lamp-induced photokeratoconjunctivitis before and after COVID-19 began.

	Before COVID-19 (n = 5)	After COVID-19 (n = 15)	*P* value
Age: mean ± SD (range)	39.20 ± 3.69 (31–51)	42.73 ± 3.88 (21–78)	0.62
Gender (%)			0.35*
Male	2 (40.0)	10 (66.7)	
Time of ED visit (%)			0.51
00:00–03:59	2 (40)	10 (66.67)	
04:00–07:59	1 (20)	1 (6.67)	
08:00–11:59	0 (0)	0 (0)	
12:00–15:59	0 (0)	0 (0)	
16:00–19:59	0 (0)	0 (0)	
20:00–23:59	2 (40)	4 (26.67)	

*Fisher exact test.
COVID-19, coronavirus disease 19; *ED*, emergency department; *PKC*, photokeratoconjunctivitis.

Table 3. The comparison between the photokeratoconjunctivitis subgroups of germicidal lamp and welding.

	Germicidal lamp (n = 20)	Welding (n = 262)	*P* value
Age: mean ± SD (range)	41.85 ± 3.03 (21–78)	40.87 ± 0.79 (20–72)	0.74
Gender (%)			$P < 0.001$
Male	12 (60.0%)	261 (99.6%)	

Information About Individuals in the Germicidal Lamp Group

Information about patients in the germicidal lamp group is presented in Supplemental Tables 1 and 2). The exposure duration ranged from a few seconds to two hours. The domestic component accounted for 60% (3/5) of the PKC cases before COVID-19 and 40% (6/15) of the cases after COVID-19 began. Before COVID-19, the occupational component included medical personnel/staff (2/5). After COVID-19 began, the occupational component expanded to medical staff (3/15), workers in the restaurant and hotel industry (3/15), a cleaner (1/15), a school employee (1/15), and a construction industry worker (1/15).

DISCUSSION

In this study we compared the incidence and causes of PKC before and after COVID-19 began. We selected January 1, 2020, as the starting point for the observation period for two primary reasons. The first reason was the geographical proximity between Taiwan and Mainland China and the frequent business trips between the two nations. Secondly, based on the previous painful experience of the SARS outbreak in Taiwan in 2003, our government and people treated this incident with great caution at a very early stage. At a press conference on December 31, 2019, the Taiwan Ministry of Health and Welfare, announced epidemic information and initiation of a border quarantine in accordance with standard procedure.

The proportion of germicidal lamp-related PKC cases significantly increased after COVID-19 began. The increase in PKC cases is attributed to the increased number of germicidal lamp-related PKC cases and the decreased number of total PKC cases. The number of germicidal lamp-related PKC cases likely increased after COVID-19 began due to the increased use of these lamps for disinfection. Previous studies concerning germicidal lamp-related PKC cases after COVID-19 began are shown in Table 4. Leung reported three cases (six eyes) in Hong Kong and Sengillo reported seven cases (14 eyes) in the United States. Wang et al compared germicidal lamp-related PKC cases eight weeks before and eight weeks after COVID-19 began and reported the percentage of PKC due to disinfection increased significantly from 9.1% to 56.9% after COVID-19 began.[14] Wang et al also mentioned that the case number decreased substantially after good public health education. In Taiwan, germicidal lamps had product instructions and warnings about improper use. The news media also emphasized the hazards of germicidal lamps. Despite the spread of public education on the use of germicidal lamps, some patients were

Table 4. Summary of recent studies about germicidal lamp-induced photokeratitis after COVID-19 pandemic began.

Reference	Study population	Study design	Mean age	Gender	UV lamp type	Exposure time	Initial visual acuity	Final VA
Wang 2021[14]	109 cases in China	Retrospective	32.1 (range, 21–54)	M:F = 55:54	No record	Average: 16.7 minutes	0.25 ± 0.08 logMAR	0.05 ± 0.02 logMAR
Sengillo 2021[15]	7 cases (14 eyes) in USA	Case series	40 (range, 24–59)	M:F = 5:2	P3: 38 W UV-C germicidal lamp (AURA) P6: 38W UV-C germicidal lamp (Uvlizer)	10 minute- 4 hours in 5 cases, 2 without documentation	20/30 or better in 13/14 eyes (93%)	No record
Leung 2021[16]	3 cases (6 eyes) in Hong Kong	Case report	One is 17; no record about other two patients	M:F = 1:2	UV-C Effective illumination area: 40 m^2	15, 20, 60 minutes	All 3 were 6/12 bilaterally	All 3 were 6/6 bilaterally
Lin 2022	15 cases in Taiwan	Retrospective	42.7 (range, 21–78)	M:F = 10:5	No record	few seconds to 2 hours, 5 cases without documentation	No record	No record

UV, ultraviolet; *VA*, visual acuity; *M:F*, male to female; *logMAR*; logarithm of the minimum angle of resolution.

unaware of the dangers. However, public education may have prevented upward spikes in the incidence of PKC.

Our study also showed that the number of total PKC (160 before; 147 after) patients and the number of patients in the welding subgroup (144 before; 118 after) slightly decreased after COVID-19 began. There are several explanations for this decrease. First, patients did not go to the ED due to concerns about SARS-CoV-2.[17,18] Second, the outbreak forced many companies and factories to halt production (lockdown), which predominantly influenced short-term or part-time workers. According to a study by Yen et al,[3] long-term workers complied with safety regulations better than short-term workers and wore protective equipment more. Therefore, the welding cases decreased, and germicidal lamp-related PKC cases increased, leading to the significantly increased proportion of germicidal lamp-related PKC cases after COVID-19 began.

The domestic component in the germicidal lamp subgroup declined from 60% (3/5) before COVID-19 to 40% (6/15) after COVID-19 began. In contrast, workplace cases increased from 40% (2/5) before COVID-19 to 60% after COVID-19 (9/15) began. This finding implies that hospitals/clinics/nursing homes, restaurants, and hotels required more germicidal lamp use. In Taiwan, many hotels served as quarantine hotels, where germicidal lamps were frequently used for disinfection. In Leung's report, the three cases belonged to clustering at home.[16] In the study of Wang et al,[14] clustering played an important role. Our cases of germicidal lamp-related PKC were all sporadic rather than clustering episodes, which may indicate good public policies and staff safety education in most companies and workplaces.

There are some differences between welding-associated and germicidal lamp-related PKC. The wavelength emanating from germicidal lamps is mostly UV-C (254 nanometers), and the cornea, which absorbs most of the UV-C, is predominantly damaged.[9,19,20] The wavelength emanating from welding equipment is in the UV-B spectrum. Theoretically, the energy of UV-C is greater than the energy from UV-B and, therefore, causes more damage to the cornea at the same distance and exposure time. However, most previous studies reported visual acuity as a good prognosis in germicidal lamp-related PKC cases (Table 4). Because it is primarily men who work in the welding industry, the proportion of females in the germicidal-lamp group was significantly higher than the females in the welding group in our study and previous studies.[14]

LIMITATIONS

There were some limitations to our study. Due to its retrospective nature, some data (such as exposure time, visual acuity, brand, and wavelength of the machine) was incomplete. However, this missing data did not affect our results. Second, we may have underestimated the incidence of germicidal lamp-related PKC. Our study focused on the adult population; so pediatric patients should be taken into account in future research. In addition, we did not analyze patients without a clear PKC cause to maintain the rigor of our study. Thus, there might be recall bias. In our clinical experience, patients denied UVR or any other strong light exposure until they were specifically asked about exposure to germicidal lamps or UV-enabled dish dryers. If the medical staff did not directly ask patients about their exposure to certain machines, the exact cause of the PKC was difficult to determine. Third, the results may not be generalized to other nations because of differences in race, culture, education status, pandemic severity, and accessibility to UVR machines. Despite these limitations, we hope our study focuses more public attention on the related issues and potential hazards. The effects of news media and public safety education on the trend of germicidal lamp-related PKC after 2022 may require further studies to evaluate.

CONCLUSION

Germicidal lamp-related PKC increased during the COVID-19 era. We found that the incidence increased significantly over a two-year period from 3.1% before COVID-19 to 10.2% after COVID-19 began. While it appears that the COVID-19 pandemic is gradually subsiding, it is important to recognize that new infectious diseases may emerge in the future, necessitating protective measures. Therefore, clinicians should pay attention to this potential cause of PKC and take more accurate histories. The potential hazard of germicidal lamps is an important public health issue that should be emphasized to prevent further injury from this source of ultraviolet radiation.

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Operation CoVER Saint Louis (COVID-19 Vaccine in the Emergency Room): Impact of a Vaccination Program in the Emergency Department

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Introduction: Coronavirus 2019 (COVID-19) inequitably impacted minority populations and regions with limited access to healthcare resources. The Barnes-Jewish Emergency Department in St. Louis, MO, serves such a population. The COVID-19 vaccine is an available defense to help achieve community immunity. The emergency department (ED) is a potential societal resource to provide access to a vaccination intervention. Our objective in this study was to describe and evaluate a novel ED COVID-19 vaccine program, including its impact on the local surrounding underserved community.

Methods: This was a retrospective, post-protocol implementation review of an ED COVID-19 vaccination program. Over the initial six-month period, we compiled data on all vaccinated patients out of the ED to evaluate demographic data and the impact on underserved regional areas.

Results: We report a successful ED-based COVID-19 vaccine program (with over 1,000 vaccines administered). This program helped raise regional and state vaccination rates. Over 50% of the population that received the COVID-19 vaccine from the ED were from defined socially vulnerable patient populations. No adverse effects were documented.

Conclusion: Operation CoVER (COVID-19 Vaccine in the Emergency Room) Saint Louis was able to successfully vaccinate a socially vulnerable patient population. This free, COVID-19 ED-based vaccine program with dedicated pharmacy support, was novel in emergency medicine practice. Similar ED-based vaccine programs could help with future vaccine distribution. [West J Emerg Med. 2024;25(3)374–381.]

INTRODUCTION

Coronavirus 2019 (COVID-19) first impacted the United States in early 2020. By February 2021, more then 500,000 individuals had died in the US after becoming infected.[1–4] Various strategies were employed to limit the spread of the virus including community lockdowns, social distancing, contact tracing, and masking, with varied success and waning adherence over time.[5] The COVID-19 pandemic inequitably impacted minority populations and regions with limited access to healthcare resources.[6–8] The Barnes-Jewish Hospital Emergency Department (BJHED) in Saint Louis, MO, staffed by Washington University School of Medicine in St. Louis emergency physicians with dedicated pharmacy support serves such a population for the bi-state region of Missouri and Illinois.

One of the strongest defenses against this novel virus is vaccines. Development and more widespread distribution of vaccines began in Spring 2021. By September 2021, COVID-19 vaccination was estimated to prevent 56% of expected hospitalizations and 58% of expected deaths.[9] To achieve

community—or "herd"— immunity and thereby reducing the risk of community spread, approximately 67–90% of the population must achieve immunity, either by vaccination or infection. However, vaccine hesitancy, miseducation, and lack of access to vaccines are major barriers to achieving this herd immunity goal.[10–16] As the safety net for many communities, the emergency department (ED) provides a multitude of healthcare, educational, and social services.[17,18] We hypothesized that the ED could also play a pivotal role with vaccine education, distribution, and access for an underserved population. Prior studies have evaluated the theoretical benefit of using the ED as a potential vaccination resource site.[19–25] At the time of project initiation, the state of Missouri ranked nationally in the bottom 10 of states for population vaccination rates, presenting opportunity for improvement.[4]

We started offering COVID-19 vaccines to patients presenting to BJHED on July 21, 2021, initially both the Pfizer and Johnson & Johnson (J&J) vaccines. Of note, this initiation date was well into the delta variant surge of the pandemic. Additionally, vaccination was approved and available for the public through other public health sources. To our knowledge, this free COVID-19 vaccine program by emergency physicians with pharmacy support, based out of an ED, was novel in emergency medicine practice. We named our project: Operation CoVER (COVID-19 Vaccine in the Emergency Room) STL (Saint Louis).

Population Health Research Capsule

What do we already know about this issue?
The COVID-19 vaccine is an available defense to help achieve community immunity. The ED is a potential societal resource to provide access to a vaccination intervention.

What was the research question?
Our goal was to describe and evaluate a novel ED COVID-19 vaccine program, including its impact on the local surrounding underserved community.

What was the major finding of the study?
This ED-based COVID-19 vaccine program resulted in over 1,000 vaccines administered.

How does this improve population health?
The program helped raise regional/state vaccination rates. Over 50% of those who received the vaccine from the ED were from defined socially vulnerable patient populations.

METHODS

Collaboration on the ED vaccination implementation project between BJHED hospital administration, Washington University emergency physicians, and the pharmacy department began in Spring 2021. On a 24/7 basis, the ED team offers at-the-moment healthcare with confidentiality, patient-centered education, and access to follow-up resources (including completion of the initial vaccination series, if indicated). Such availability differed from other community resources. Barriers throughout the process were identified and resolved. These included Pfizer vaccine storage requirements (ultra-low temperature freezer [−80°C to −60°C]); avoidance of vaccine wastage (as once a vial was diluted, contents had to be used within six hours); hand delivery from inpatient pharmacy to the ED; administration of the vaccine within two hours from vial extraction; record-keeping of appropriate vial lot number; expiration date and injection site; and clinician/nurse training.

Vaccine education was provided to our physicians, nurse practitioners, physician assistants, and nurses. All were encouraged to offer every patient the COVID-19 vaccination. Signage, educational materials, and advertising were developed and distributed to raise awareness of free vaccination access in the ED. Scheduling subsequent doses to complete the initial vaccine series was facilitated by our discharge nurse coordinators. Weekly email reminders tracking vaccines administered were circulated to the Washington University emergency physician/nurse practitioner and physician assistant/resident group.

Based on regional vaccination rates and the healthcare access of our patient population, an assumption was made that approximately one-third of patients would arrive vaccinated. Also considering critical illness/trauma presentation, acute illness, vaccine hesitancy, and clinician forgetfulness, we anticipated another one-third of patients would not be available to consent for vaccination. Of the remaining patients, a vaccination goal rate of 5–10% (approximately 5–15 patients a day) was encouraged. This was discussed at length with pharmacy to support the component of vaccine storage, preparation, and administration in a timely fashion for the ED patient population.

All patients were required to consent to receiving the vaccine, which was documented electronically upon order entry by the clinician. Patients not eligible to receive the vaccine included those with a contraindication to the vaccine, an active COVID-19 infection, or those with a documented COVID-19 infection within the recent past (current recommendation of prior seven-day period). All vaccines were kept in a centralized pharmacy location to meet storage requirements of both the Pfizer and J&J vaccines. Pharmacy staff withdrew doses for the requested vaccine and hand delivered it to the ED bedside nurse along with vaccine vial

information (manufacturer, expiration date, lot number, and time of dose withdrawal) and a blank standardized COVID-19 vaccine card (issued by the US Centers for Disease Control and Prevention [CDC]).

The bedside nurse would administer the vaccine dose as soon as possible in view of the two-hour limit between vial withdrawal and administration. Nurses also provided patient education regarding potential side effects and adverse events after receiving the vaccine. Finally, nurses provided each vaccinated patient with education regarding follow-up requirements. Upon BJHED discharge, patients would receive vaccine information sheets and scheduling information for the second vaccine deadline, if applicable. Discharge nurse coordinators would receive a report of all patients who received their first vaccine in the series and would call patients to confirm they had a second vaccine completed or scheduled, as applicable.

This was a retrospective post-protocol implementation review of all BJHED patients receiving the COVID-19 vaccine through Operation CoVER STL between July 1, 2021–January 20, 2022. We report impact on vaccine efforts for various demographics of our region. Data was collected from the electronic health record. We analyzed additional CDC data to compare vaccine regional uptake. Specifically, the Social Vulnerability Index (SVI) was collected from CDC data, specific to our patient population's affected area. Socially vulnerable populations are especially at risk during a public health emergency due to factors such as socioeconomic status, household composition, minority status, access to transportation, housing type, and lack of resources.[5–7] The CDC uses this index to help determine where to leverage healthcare resources to help alleviate human suffering and economic loss (estimate supplies, need for emergency shelters, evacuation planning, required emergency personnel). The SVI database was important during the COVID-19 outbreak to determine which communities would be affected more and require additional support (ie, vaccine implementation).[26] The data is further divided into quartiles in which quartile "A" represents the lowest/least level of vulnerability and quartile "D" represents the highest/most. We obtained appropriate institutional review board approval (classified as "exempt") to conduct this retrospective study at our institution.

RESULTS

A total of 874 COVID-19 vaccine doses were administered between July 21, 2021–January 20, 2022 (average of 4.78 vaccine doses per day). The total number of impacted patients was 824 individuals. (A minority of patients used the ED for their second vaccine dose administration.) The mean patient age was 44.4 years old (±15.6 years). The distribution in race included 76% (626/824) Black, 27.2% (224/824) White, and 2.91% (24/824) American Indian, Asian, or "other" ethnicity patients (Table 1, Figure 1).

Table 1. Demographic data on patients who received the COVID-19 vaccine.

N = 874 vaccines administered; N = 824 patient	
Mean age (years)	44.4 ± 15.6
Mean ED duration (hours)	7.49 ± 5.05
Admitted (yes % [n])	21.6 [189]
Discharged from ED (Yes % [n])	78.4 [685]
Deceased (yes % [n])	0.11 [1]
Mean number of ED visits in prior 5 years	11
Gender (female % [n])	45.3 [396]
Race (% [n])	
Black	76.0 [626/824]
White	27.2 [224/824]
American Indian	0.73 [6/824]
Asian	0.24 [2/824]
Unable to answer	1.94 [16/824]
Mean weight (kg)	82.38 ± 24.1
Mean height (cm)	170.6 ± 10.64
Insurance status	
Self-pay % [n]	29.5 [258]
Insurance % [n]	70.5 [616]
MO Medicaid % [n]	22.3 [195]
MO managed care % [n]	10.1 [88]
Primary care provider	
Yes % [n]	51.4 [449]
No % [n]	48.6 [425]
COVID-19 vaccine given	
Pfizer % [n]	81.1 [709]
Johnson & Johnson % [n]	18.9 [165]
History of +COVID-19 prior to vaccination (Yes % [n])	8.7 [76]
COVID-19+ after vaccination (Yes % [n])	4.9 [43]
Time of vaccine given per shift	
1st shift (0700–1500) % [n]	42.4 [371]
2nd shift (1501–2300) % [n]	30.8 [269]
3rd shift (2301–0659) % [n]	26.0 [227]
Medications given	
EpiPen % [n]	0.23 [2]
Diphenhydramine % [n]	1.03 [9]
Steroids % [n] *(Methylprednisolone, prednisolone, prednisone, or dexamethasone)*	0.80 [7]
Patient address/home states	
Missouri	89.7 [784]
Illinois	9.61 [84]
Indiana	0.11 [1]

(*Continued on next page*)

Table 1. Continued.

N = 874 vaccines administered; N = 824 patient	
Kentucky	0.11 [1]
Mississippi	0.11 [1]
Tennessee	0.11 [1]
Texas	0.11 [1]
Unknown	0.11 [1]
CDC Data	
Missouri data	
Average percentage of the MO population that received 1 dose of any COVID-19 vaccine by 7/21/21	32.9%
Average percentage of the MO population that completed the vaccine series by 7/21/21	28.6%
Average percentage of the MO population that received 1 dose of any COVID-19 vaccine by 1/20/22	45.2%
Average percentage of the MO population that completed the series by 1/20/22	39.0%
County data	
Average percentage of the St. Louis City County population that received 1 dose of any COVID-19 vaccine by 7/21/21	48.2%
Average percentage of the St. Louis City County population that completed the series by 7/21/21	40.8%
Average percentage of the St. Louis City County population that received 1 dose of any COVID-19 vaccine by 1/20/22	69.3%
Average percentage of the St. Louis City County population that completed the series by 1/20/22	55.9%
Average percentage of the St. Louis County population that received 1 dose of any COVID-19 vaccine by 7/21/21	54.9%
Average percentage of the St. Louis County population that completed the series by 7/21/21	48.3%
Average percentage of the St. Louis County population that received 1 dose of any COVID-19 vaccine by 1/20/22	73.1%
Average percentage of the St. Louis County population that completed the series by 1/20/22	61.6%
Social Vulnerability Index (time frame: 7/21/21 – 1/20/22)	
A (0–0.25)	17%
B (0.2501–0.5)	32%
C (0.5001–0.75)	36%
D (0.7501–1.0)	16%

ED, emergency department; *MO*, Missouri; *COVID-19*, coronavirus 2019; *CDC*, US Centers for Disease Control and Prevention.

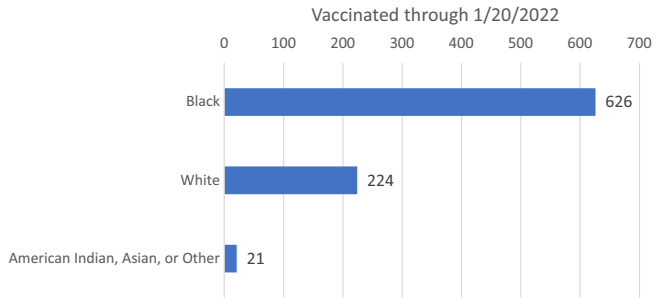

Figure 1. Number of Barnes-Jewish Hospital Emergency Department patients vaccinated by race.

The geographic distribution (based on listed home ZIP code) included 89.7% (784/874) of Missouri patients and 9.61% (84/874) of Illinois patients (Figure 2). Other represented states included Indiana, Kentucky, Mississippi, Tennessee, and Texas. Approximately 22% of vaccinated patients were admitted, and 78% were discharged from the ED. The mean number of ED visits in the prior five years per patient in the vaccinated cohort was 11 total ED visits.

At the time of their BJHED visit and vaccination, 29.5% (258/874) of patients lacked health insurance. Of the 70.5% (616/874) of patients with insurance, 22.3% (195/874) had Missouri Medicaid and 10.1% (88/874) had Missouri Managed Care, both of which provide medical insurance to lower income households. At the time of their BJHED visit, 51.4% (449/874) of patients had a known primary care physician.

During the studied time frame, 16% of the patients vaccinated by the BJHED vaccine program lived in areas of high social vulnerability (quartile D of the SVI), with an additional 37% residing in areas of medium-high social vulnerability (quartile C). Altogether, greater than 50% (51.3%) of the patients impacted by the BJHED vaccine administration program were from areas of medium-high and high social vulnerability (Figure 3). See included maps (Figure 2) demonstrating geographic impact on our region (Missouri and Illinois).

Data from Saint Louis City and Saint Louis County (the two largest surrounding regions) showed a 21.1% increase for St. Louis City and an 18.2% increase for St. Louis County for patients receiving at least one dose of the COVID-19 vaccine over the temporal period of Operation CoVER STL. We also reviewed data on adverse outcomes, specifically reviewing all medications provided during each patient encounter. Use of agents for anaphylactic reactions (epinephrine, corticosteroids, antihistamines) were limited in the patient cohort. Two patients received epinephrine 0.3 milligrams intramuscular injections during their ED stay; however, both were unrelated to the vaccine administration (one presented to the ED after an insect sting and another with angioedema as the presenting chief complaint, prior to receiving their COVID-19 vaccine at discharge). We were unable to assess

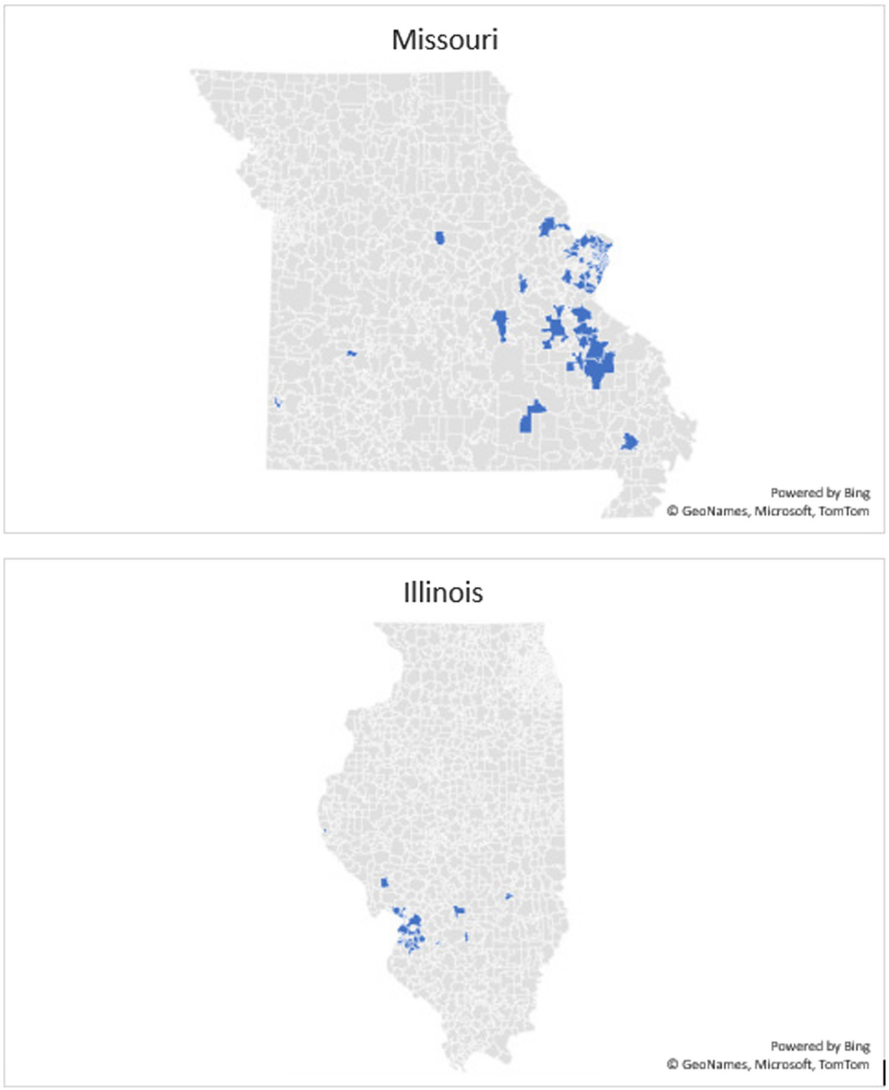

Figure 2. Geographic distribution of vaccinated Barnes-Jewish emergency department patients by listed ZIP code (for states of Missouri and Illinois).

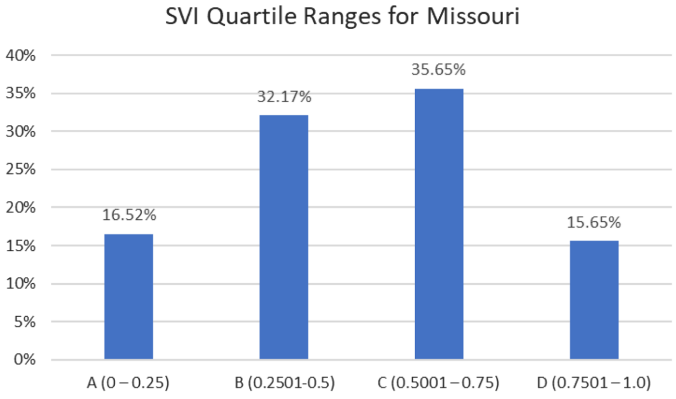

Figure 3. Social vulnerability index for impacted postal codes for vaccinated Barnes-Jewish emergency department patients (A is low/least vulnerable and D is high/most vulnerable).

for other potential adverse events such as pericarditis or local site irritation; however, we did not record any repeat visits in this patient cohort for these presenting diagnoses.

DISCUSSION

Operation CoVER STL is a novel, ED-based vaccination program that meets the needs of an underserved community with a high social vulnerability risk. The Washington University Department of Emergency Medicine serves as the locus of primary care for many of our regional patients. The BJHED census averages 185–240 patients daily, with upward of 80,000 adult patient visits per year. Emergency clinicians are adept at ordering, administering, and documenting vaccines; the most common example is the tetanus, diphtheria, and pertussis vaccine, which is administered almost daily in the ED for open-wound prophylaxis in trauma patients. We have previously been

involved with other public vaccination efforts including offering the influenza vaccine in prior "flu seasons," although with variable success.

The average number of ED visits per patients in this vaccinated cohort was 11 (over the prior five years), demonstrating the unique role the BJHED serves for healthcare in our regional community. Populations within our community are dependent on the BJHED to receive much of their healthcare, reflecting why Operation CoVER STL was impactful. This practice is similar among other large urban areas, with an ED fulfilling the role of central and essential "healthcare" delivery for an underserved patient population.

We evaluated CDC data on vaccination rates for COVID-19 vaccine uptake in Missouri during our ED-based initiative. On day 0 of Operation CoVER STL, 32.9% of the state population had received one dose of any COVID-19 vaccine and 28.6% of the state population had completed the COVID-19 vaccine series (two-dose regimen for mRNA vaccines). On January 20, 2022 (end data cohort date), this rate had increased to 45.2% of the state population having received one dose of any COVID-19 vaccine and 39.0% of the population having completed the COVID-19 vaccine series (Figure 4). Programs such as Operation CoVER STL helped along with other initiatives and programs to achieve this 12.3% increase in initial vaccination rates for the Missouri population (16.6% increase in completed vaccination series).

We were able to access data from the CDC to analyze and understand our impact on the region. The SVI data was assessed by the impacted ZIP codes associated to the ED visit. The ZIP codes of our patient cohort were in high-risk socially vulnerable regions, indicating approximately 52% of our vaccination recipients were from socially vulnerable populations. The SVI rates help demonstrate that many patients served by BJHED and Washington University emergency physicians are those with a higher impact from public health emergencies and reside in areas in need of additional support.

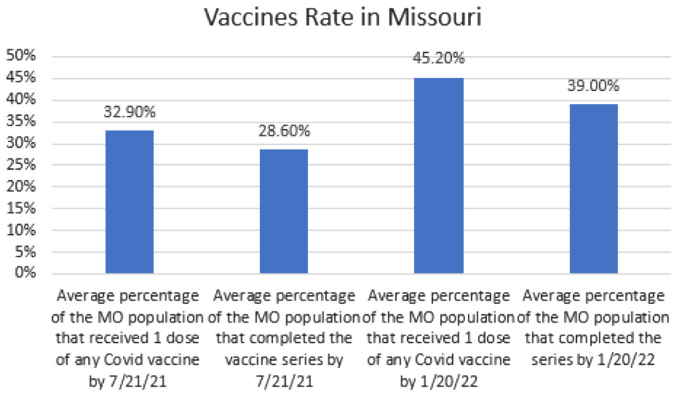

Figure 4. COVID-19 vaccination rates of uptake in Missouri during Operation CoVER STL.

We also looked at the racial distribution of Operation CoVER STL efforts. The distribution of vaccines provided in our cohort included 76% Black (626/824 patients) and 27.2% White (224/824 patients). This corresponds to the racial distribution of the geographic area served by the BJHED, which includes St. Louis city and the surrounding bistate regions of Missouri and Illinois. As of 2022, the census of St. Louis city demonstrated that "Black or African American alone" made up 44.8% of the city population and "White alone" made up 46.3% of the city population.[27] However, our hospital census numbers typically reflect a higher percentage of "Black or African American" patients using the BJHED to access healthcare. During the six-month period of this cohort, the BJHED provided care for 39,570 patients. The racial distribution of the ED population included 61.29% "Black" and 33.92% "White" (Table 2).This may again reflect the role the BJHED serves for specific populations in our city (higher SVI ZIP codes) who are socially vulnerable and why Operation CoVER STL did provide a unique public health resource.

We have also begun to look at clinician attitudes and support of this program through surveys to better understand

Table 2 Racial distribution of Barens-Jewish hospital emergency department population during Operation CoVER STL.

Row Labels	Count of race_primary	Count of race_primary2
American Indian or Alaska Native	0.36%	144
Asian	1.23%	485
Black	61.29%	24254
Declined	0.52%	206
Native Hawaiian or Other Pacific Islander	0.17%	68
Other	0.03%	11
Unable to answer	2.39%	944
Unkonwn	0.09%	34
White	33.92%	13424
(blank)	0.00%	
Grand Total	100.00%	39570

all parameters of this pilot. We hope our ED-based vaccination program can serve as a model for other EDs with similar socially vulnerable populations.

We have continued to offer Operation CoVER STL through our BJHED. We now offer the Pfizer vaccine and booster(s), if eligible. Of note, we did remove access to the J&J vaccine under CDC public guidance. We have expanded our vaccination efforts to include booster immunizations for eligible patients. As we approached the one-year anniversary of the start of this initiative, we had vaccinated over 1,236 patients as of January 20, 2023).

LIMITATIONS

This retrospective analysis is not without limitations including its observational nature and our single-center analysis. Vaccinations were given on a clinician-preference basis, and we relied heavily upon clinicians initiating the conversation of vaccines with patients. Of note, the public visual announcements of vaccine access in the ED waiting room, individual patient care areas, and restrooms did lead some patient to initiate the vaccine conversation with Washington Universiy emerg physicians. Vaccine hesitancy was not screened for or assessed in this study, but anecdotally was a common theme limiting vaccine uptake. With the retrospective, blinded design of our data cohort, we were unable to investigate individual factors impacting patient vaccination decisions. On January 20, 2022 (end data cohort date), only 39% of the Missouri population had completed a COVID-19 vaccine series (Figure 4), demonstrating that less than half of our state population had gone forward with a decision to vaccinate. We are aware of multiple emergency clinicians at our institution reporting patients refusing to receive the vaccine when offered as an additional benefit of their ED visit. Our original vaccination goal was set at 5–15 vaccines per day. We ended up administering 4.78 vaccine doses each day; thus, vaccine hesitancy could have impacted our daily rates.

Due to crowding issues, the BJHED has a prolonged wait time and length of stay. It is not uncommon for middle- to low-acuity patients to wait 4-6 hours in the triage area prior to having access to a clinician in an ED room. It is possible that these prolonged ED times could have impacted vaccination rates. Typically, an ED patient arrives with an acute "emergency" chief complaint. Some EDs may have faster evaluation and disposition times, during which time additional requirements (vaccine defrosting, administration) may negatively impact patient flow. However, with a longer ED length of stay, the ED staff may have more opportunities to engage with the patient to discuss specific concerns about vaccine administration. Furthermore, the patient may want to get as many potential available services to maximize care during their prolonged wait. Our large, academic ED has direct access to pharmacy with a dedicated ED clinical pharmacist. Smaller EDs without direct pharmacist access may be limited with a similar vaccine protocol design requiring pharmacy support. Finally, the patient population in our area is primarily urban, potentially limiting applicability to rural areas.

CONCLUSION

Here we report on the development and implementation of a successful ED-based COVID-19 vaccination program. Our program was able to vaccinate an underserved patient population by meeting the patients where they received their standard healthcare. This program can serve as a model for other emergency departments looking to impact their regions through vaccination efforts. Future studies should evaluate longevity of such programs, as well as public perception and clinician attitudes.

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Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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Sexually Transmitted Infection Co-testing in a Large Urban Emergency Department

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Introduction: The incidence of sexually transmitted infections (STI) increased in the United States between 2017–2021. There is limited data describing STI co-testing practices and the prevalence of STI co-infections in emergency departments (ED). In this study, we aimed to describe the prevalence of co-testing and co-infection of HIV, hepatitis C virus (HCV), syphilis, gonorrhea, and chlamydia, in a large, academic ED.

Methods: This was a single-center, retrospective cross-sectional study of ED patients tested for HIV, HCV, syphilis, gonorrhea or chlamydia between November 27, 2018–May 26, 2019. In 2018, the study institution implemented an ED-based infectious diseases screening program in which any patient being tested for gonorrhea/chlamydia was eligible for opt-out syphilis screening, and any patient 18–64 years who was having blood drawn for any clinical purpose was eligible for opt-out HIV and HCV screening. We analyzed data from all ED patients ≥13 years who had undergone STI testing. The outcomes of interest included prevalence of STI testing/co-testing and the prevalence of STI infection/co-infection. We describe data with simple descriptive statistics.

Results: During the study period there were 30,767 ED encounters for patients ≥13 years (mean age: 43 ± 14 years, 52% female), and 7,866 (26%) were tested for at least one of HIV, HCV, syphilis, gonorrhea, or chlamydia. We observed the following testing frequencies (and prevalence of infection): HCV, 7,539 (5.0%); HIV, 7,359 (0.9%); gonorrhea, 574 (6.1%); chlamydia, 574 (9.8%); and syphilis, 420 (10.5%). Infectious etiologies with universal testing protocols (HIV and HCV) made up the majority of STI testing. In patients with syphilis, co-infection with chlamydia (21%, 9/44) and HIV (9%, 4/44) was high. In patients with gonorrhea, co-infection with chlamydia (23%, 8/35) and syphilis (9%, 3/35) was high, and in patients with chlamydia, co-infection with syphilis (16%, 9/56) and gonorrhea (14%, 8/56) was high. Patients with HCV had low co-infection proportions (<2%).

Conclusion: Prevalence of STI co-testing was low among patients with clinical suspicion for STIs; however, co-infection prevalence was high in several co-infection pairings. Future efforts are needed to improve STI co-testing rates among high-risk individuals. [West J Emerg Med. 2024;25(3)382–388.]

Keywords: *emergency department; sexually transmitted infection; sexually transmitted disease; public health; human immunodeficiency virus; HIV; hepatitis C virus; syphilis; gonorrhea; chlamydia.*

INTRODUCTION

An estimated one in five individuals in the United States (US) are infected with a sexually transmitted infection (STI).[1,2] Between 2017–2021, the incidence of syphilis and gonorrhea increased and the incidence of chlamydia infections remained high.[2] With widespread use of antiretroviral treatment, the overall incidence of HIV has declined over the same period, but incidence has plateaued in certain high-risk groups, such as people who inject drugs.[3] While curative treatment for HCV became available in the US in 2011, the incidence of HCV doubled between 2013–2020.[4,5] Moreover, just 33% of those with chronic HCV have been cured, and less than 17% of young (<40 years), uninsured patients have achieved sustained viral clearance.[6] Low testing frequencies, patient unawareness of infection, poor access to traditional treatment settings (ie, primary care clinics) and re-infection following cure all contribute to these sub-optimal data.[6,7]

The emergency department (ED) is an important safety net for underserved, high-risk populations, making it a vital setting to deliver healthcare services to patients without access to primary care.[8,9] Emergency department-based infectious diseases screening programs have demonstrated success in identifying STIs and linking patients to treatment.[10–12] It is well known that contraction of one STI increases a patient's risk of co-infection with other STIs.[13,14] One ED-based study showed that among patients who received testing for STI, co-testing for a second STI was as low as 8%; however, this study did not report prevalence of infection/co-infection.[15] Other ED-based studies report prevalence of co-infection but only single STI pairings.[10,15–17] Understanding ED STI co-testing frequencies and prevalence of co-infections is imperative for optimizing public health infectious disease surveillance and treatment, particularly among patients without access to traditional primary care services. In this study, we aimed to describe co-testing and co-infection prevalence of HIV, hepatitis C virus (HCV), syphilis, gonorrhea, and chlamydia, in a large, academic ED.

Population Health Research Capsule

What do we already know about this issue?
Data on sexually transmitted infection (STI) testing and prevalence are limited in the emergency department (ED) setting.

What was the research question?
What is the prevalence of STI testing, co-testing and co-infection among ED patients.

What was the major quantitative finding of the study?
Co-testing for STIs was infrequent, but co-infection with chlamydia was high among patients with syphilis (21%) and gonorrhea (23%).

How does this improve population health?
This study highlights the need to improve STI co-testing rates among high-risk individuals.

METHODS

Overview

In 2018, the study institution implemented an opt-out, ED-based infectious diseases screening program that employed electronic health record (EHR) best practice alerts (BPA). Any patient being tested for gonorrhea/chlamydia was eligible for opt-out syphilis screening. Additionally, any ED patient 18–64 years of age who was having blood drawn for any clinical purpose, was eligible for opt-out HIV and HCV screening. Funding for lab tests was obtained by charging the patient's insurance, a billing strategy employed by similar screening programs and studies.[18] If a patient requested that their insurance not be charged, or they did not have insurance, testing was paid for by the program grant. Physicians (including all residents), nurse practitioners and physician assistants could order testing. The full details of these screening programs have been previously described.[10–12] An example BPA is available in Figure 1. In this study we examined STI testing/co-testing frequencies and infection prevalence in the ED. As data was initially collected for quality assurance purposes, the study was deemed not to be human subjects research by the Institutional Review Board Quality Improvement Self-Certification Tool.

Study Design and Setting

This was a retrospective, cross-sectional study of ED patients tested for HIV, HCV, syphilis, gonorrhea, or

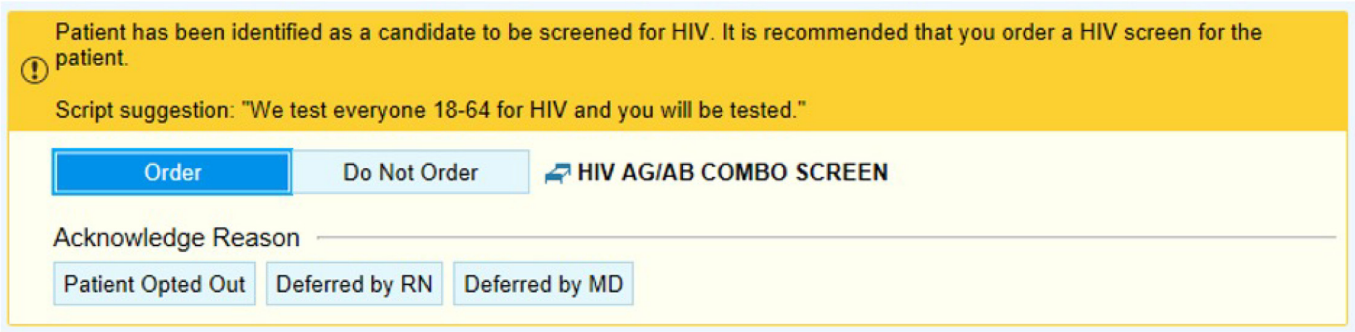

Figure 1. Example of a best practice alert inside the electronic health record.

chlamydia during the six-month period following implementation of the ED-based infectious diseases screening program. The study institution was a quaternary care, academic, Level I trauma center in Northern California that sees more than 80,000 patient visits annually.

Selection of Participants

We included data from all patients ≥13 years who had undergone testing for one or more of HIV, HCV, syphilis, gonorrhea, or chlamydia in the ED between November 27, 2018–May 26, 2019.

Measurements

We abtracted data from the EHR (Epic Systems Corp, Verona, WI) using computer-generated reports by querying patients who had received ED STI tests during the study period. We included demographic factors (age, gender, race, ethnicity) and results of STI testing. The data analyst responsible for procuring these reports was blinded to the hypothesis of the study. We defined STI co-testing as testing for two or more of the following STIs: gonorrhea, chlamydia, syphilis, HIV, and HCV. To prevent duplicate data, we included only a patient's first ED visit where they received HCV testing when calculating co-testing/co-infection prevalence. We examined subsequent testing that occurred in future ED visits to identify instances where broader STI testing could have identified infections earlier. Data was stored in de-identified datasets, and patients were given unique identifiers to maintain patient confidentiality.

HIV screening was performed using a HIV P24 antigen (Ag) and HIV-1/HIV-2 antibody (Ab) combination test with the ARCHITECT i1000SR immunoanalyzer (Abbott Laboratories, Abbott Park, IL), and diagnoses were confirmed using Bio-Rad Rapid Test Multispot HIV-1/HIV-2 Ab reflex testing (Bio-Rad Laboratories, Inc, Hercules, CA). Screening for HCV in the ED was performed using a chemiluminescent anti-HCV ARCHITECT i1000SR immunoassay, and diagnoses were confirmed by HCV ribonucleic acid viral load (VL) with Cobas HCV 4800 assay (Roche Molecular Systems, Pleasanton, CA). Patients were considered positive for HCV only if they had a detectable VL. Multiplex gonorrhea and chlamydia urine polymerase chain reaction testing was also performed via the Cobas 4800 assay. Patients were tested for *Treponema pallidum* IgM/IgG antibody (TPA) using Bio-Rad's multiplex flow immunoassay (MFI), Bioplex 2200.[19] Specimens with reactive TPA MFI results underwent reflexive confirmatory quantitative non-treponemal assay testing, using rapid plasma reagin. If test results were discordant, the specimen was tested reflexively using the *T pallidum* particle agglutination test as an additional confirmatory treponemal test.

Outcomes

The outcomes of interest included the prevalence of STI testing/co-testing and prevalence of STI infection/co-infection.

Analysis

We described data using descriptive statistics. Categorical variables were expressed as percentages and proportions, and continuous variables were expressed as means ± standard deviations. We performed all statistical analyses using Stata 15.1 (StataCorp LLC, College Station, TX).

RESULTS

Patient Characteristics

There were 30,767 ED patient encounters for patients aged ≥13 years during the study period. Of these, 7,866 (26%) were tested for at least one of HIV, HCV, syphilis, gonorrhea, or chlamydia. The mean age of patients was 43 ± 14 years, and 4,077 (52%) were female. The most common race was White (39%), and most patients were non-Hispanic (76%). Most patients tested had Medicaid insurance (56%). See Table 1 for full patient characteristics.

Prevalence of Sexually Transmitted Infection Testing/Co-Testing

The most commonly tested STIs were those with universal screening indications: HCV (24.5%, 7,539/30,767); and HIV (23.9%, 7,359/30,767). Gonorrhea/chlamydia (1.9%, 74) testing was more common than syphilis testing (1.4%,

Table 1. Characteristics of 7,866 emergency department patients who underwent testing for at least one sexually transmitted infection.

Characteristic	Value
Mean age (years)[1]	43 ± 14
Genderr	
Male	48% (3,789)
Female	52% (4,077)
Race/ethnicity[2]	
White	39% (3,034)
Black	22% (1,698)
Asian	7% (517)
Mixed/other	32% (2,517)
Ethnicity[3]	
Hispanic	24% (1,845)
Non-Hispanic	76% (5,933)
Sexuality (self-identified)[4]	
Heterosexual	93% (1,386)
LGBTQ	7% (105)
Housing status[5]	
Domiciled	91% (5,982)
Undomiciled	9% (614)
Insurance type	
Private	27% (2,162)
Medicare	13% (1,025)
Medicaid	56% (4,399)
Self/uninsured	4% (280)

[1]Reported as mean ± standard deviation.
[2]Data missing for 100 patients.
[3]Data missing for 88 patients.
[4]Data missing for 6,375 patients.
[5]Data missing for 1,270 patients.
LGBTQ, Lesbian, Gay, Bisexual, Transgender, Queer.

Table 2. Overall testing/co-testing proportions among emergency department (ED) patients tested for sexually transmitted infections during their first ED visit.

One STI tested	Testing proportion
HCV only	24.5% (7,539/30,767)
HIV only	23.9% (7,354/30,767)
Syphilis only	1.4% (420/30,767)
Gonorrhea	1.9% (574/30,676)
Chlamydia	1.9% (574/30,676)
Two STIs co-tested	**Co-testing proportion**
Gonorrhea + Chlamydia[1]	100% (574/574)
HCV + HIV	95% (7,240/7,650)
HCV + syphilis	4.4% (333/7,626)
HCV + Gonorrhea	4.4% (344/7,769)
HCV + Chlamydia	4.4% (344/7,769)
HIV + syphilis	4.5% (357/7,417)
HIV + Gonorrhea	4.6% (346/7,582)
HIV + Chlamydia	4.6% (346/7,582)
Syphilis + Gonorrhea	57% (361/633)
Syphilis + Chlamydia	57% (361/633)
Three STIs co-tested	**Co-testing proportion**
HCV + HIV + syphilis	2.1% (314/14,680)
HCV + HIV + Gonorrhea	2.2% (319/14,829)
HCV + HIV + Chlamydia	2.2% (319/14,829)
HCV + syphilis + Gonorrhea	2.0% (303/14,861)
HCV + syphilis + Chlamydia	2.0% (303/14,861)
HIV + syphilis + Gonorrhea	4.0% (306/7,736)
HIV + syphilis + Chlamydia	4.0% (306/7,736)
Four STIs co-tested	**Co-testing proportion**
HCV + HIV + Syphilis + Gonorrhea	286 (3.6%)
HCV + HIV + Syphilis + Chlamydia	286 (3.6%)
All five STIs co-tested	**Co-testing proportion**
HCV + HIV + syphilis + Gonorrhea + Chlamydia	286 (3.6%)

[1]Gonorrhea and chlamydia were always tested together.
STI, sexually transmitted infection; *HCV*, hepatitis C virus.

420/30,767). Of those who received testing for STIs, 6.5% (508/7,866) were tested for a single STI. Patients were tested for two or more STIs in 95.6% (7,521/7,866) of cases and three or more STIs in 5.6% (437/7,866) of cases. Patients were tested for HIV, HCV, syphilis, and gonorrhea/chlamydia in 3.6% (286/7,866) of cases. See Table 2 for overall co-testing.

Prevalence of Infection/Co-Infection

The seroprevalence of infection was highest for syphilis (44/420, 10.5% [95% CI 7.7–13.8]), followed by chlamydia (56/574, 9.8% [95% CI 7.4–12.5]), gonorrhea (35/574, 6.1% [95% CI 4.3–8.4]), HCV (373/7,470, 5.0% [95% CI 4.5–5.5]), and HIV (67/7,354, 0.9% [95% CI 0.7–1.2]). Among 67 patients who tested positive for HIV, HCV was the most common co-infection (seven patients, 10.4%). Among 373 patients who tested positive for HCV, HIV was the most common co-infection (seven, 0.9%). Among 44 patients who tested positive for syphilis, chlamydia was the most common co-infection (nine, 20.5%). Among 35 patients who tested positive for gonorrhea, chlamydia was the most common co-infection (eight, 22.9%). Among patients who tested positive for chlamydia, syphilis was the most common co-infection (nine, 16.1%). One patient was infected with three STIs (HCV, HIV, and syphilis). No patients were infected with more than three concurrent STIs. Overall co-infection data is available in Table 3.

Table 3. Infection and co-infection proportions for sexually transmitted infections.

Infection type	% (Proportion)
Syphilis infection	10.5% (44/420)
Chlamydia co-infection	20.5% (9/44)
HIV co-infection	9.1% (4/44)
Gonorrhea co-infection	6.8% (3/44)
HCV co-infection	2.3% (1/44)
Gonorrhea infection	6.1% (35/574)
Chlamydia co-infection	22.9% (8/35)
Syphilis co-infection	8.6% (3/35)
HIV co-infection	2.9% (1/35)
HCV co-infection	2.9% (1/35)
Chlamydia infection	9.8% (56/574)
Syphilis co-infection	16.1% (9/56)
Gonorrhea co-infection	14.3% (8/56)
HCV co-infection	1.8% (1/56)
HIV co-infection	0%
HIV infection	0.9% (67/7,354)
HCV co-infection	10.4% (7/67)
Syphilis co-infection	5.9% (4/67)
Gonorrhea co-infection	1.5 (1/67)
Chlamydia co-infection	0%
HCV infection	5.0% (373/7,470)
HIV co-infection	1.9% (7/373)
Chlamydia co-infection	0.3% (1/373)
Gonorrhea co-infection	0.3 % (1/373)
Syphilis co-infection	0.3% (1/373)

Gonorrhea and chlamydia were always tested together.
HCV, hepatitis C virus.

Potentially Missed Diagnoses

A total of 633 patients received targeted STI testing due to clinical concern during their first ED visit (tested for combo gonorrhea/chlamydia and/or syphilis). However, co-testing between syphilis and gonorrhea/ chlamydia occurred in only 57% (361/633) of these testing encounters. Only 63% (397/633) of these patients received HIV co-testing, and only 59% received HCV co-testing. Some patients received STI testing for one or more STIs, but not all five STIs (gonorrhea, chlamydia, syphilis, HIV, HCV), during their first ED visit. In this group with incomplete STI testing, we assessed whether patients received further STI testing in any of their next four documented ED visits within the study period and found the following testing counts and positive results: HCV, 81 (9 positive [11.1%]); HIV, 61 (1 positive [1.6%]); syphilis, 49 (3 positive [6.1%]); and gonorrhea/chlamydia, 55 (1 gonorrhea positive [1.8%]).

DISCUSSION

In our study we examined STI testing/co-testing and infection/co-infection prevalence in ED patients who were tested for at least one of HIV, HCV, syphilis, gonorrhea, or chlamydia. To our knowledge, this is the first ED-based study to report ED STI co-testing and co-infection frequencies for every combination of gonorrhea, chlamydia, syphilis, HIV, and HCV. Overall, STI co-testing was infrequent, but co-infection prevalence was high among several STI co-test pairings.

The HIV/HCV testing co-testing occurred frequently, likely related to the presence of the universal screening BPA. According to the US Centers for Disease Control and Prevention, approximately 21% of individuals with HIV in high-risk populations (ie, men who have sex with men, people who use drugs) are co-infected with HCV.[20] While published data is limited, previous ED-based studies found that 8–33% patients with HIV were co-infected with HCV.[21–24] In our study, 10.5% of patients with HIV were co-infected with HCV, but only 1.9% of patients with HCV were co-infected with HIV. Previous studies in this ED population found that patients shared some (male gender, unhoused status, history of illicit drug use, and Medicare insurance status) but not all risk factors for infection.[25,26] It is possible that co-infection proportions may differ among patients with HCV and HIV due to some other unmeasured risk factor. Alternatively, given the immunosuppressive properties of HIV, patients who are exposed to HCV may be more likely to progress to a chronic infection.[27]

Among patients with gonorrhea, 23% were co-infected with chlamydia. Conversely, only 14% of those infected with chlamydia were co-infected with gonorrhea. This differential co-infection pattern has been previously reported in at least one other ED-based study (gonorrhea+, chlamydia+: 44%; chlamydia+, gonorrhea+: 17%).[28] Among patients with syphilis, we also observed a high prevalence of chlamydia co-infection (21%). In our study, there was a BPA that prompted clinicians to test patients for syphilis who were undergoing gonorrhea/chlamydia testing, and co-testing occurred in just 57% of patients. Previous studies report the prevalence of syphilis and gonorrhea/chlamydia co-testing (9–39%); however, we could not find any ED-based studies that reported proportions of co-infection.[29] Similarly, we found that patients who were tested for syphilis and/or gonorrhea/ chlamydia, co-testing for HIV and HCV occurred infrequently. Given that patients with syphilis, gonorrhea, and chlamydia had the highest prevalence of co-infection with other STIs. These instances represent potential missed opportunities for diagnosis and linkage to care.

In our study, there were several patients who tested positive for specific STIs in subsequent ED visits and were not tested for these STIs in their initial visit. It is possible that patients contracted the STI exposure after the index ED visit, and had they been tested at the index visit they may have been

negative. However, it is also possible that these diagnoses were present at the index visit and were missed, suggesting that increased co-testing can lead to increased diagnosis of clinically significant co-infections with the potential to reduce transmission in the community.

LIMITATIONS

This was a retrospective study with data obtained from the EHR at a single institution; thus, our findings may not be generalizable to all settings. Our study had multiple BPAs in place that likely influenced clinician co-testing behavior. We did not report chief complaints, making it difficult to differentiate patients with true clinical indication for testing, and patients who were being screened as part of a screening protocol. Since testing for syphilis and gonorrhea/chlamydia was not universal, the reported proportions are unlikely to represent the prevalence for the whole ED, but rather the prevalence of infection among patients with clinical suspicion for STI. While HIV and HCV screening was universally ordered for most patients undergoing bloodwork, patients could still opt out, which may have biased the prevalence estimates for these infections.

CONCLUSION

Prevalence of co-testing for sexually transmitted infection was low among patients with clinical suspicion for STI; however, co-infection prevalence was high in several co-infection pairings. Encounters with single STI testing represent a missed opportunity to screen for co-infections. Future efforts are needed to improve STI co-testing rates among high-risk individuals. With the incidence of many STIs increasing, the ED can serve as an important screening setting for STIs, especially in patients without access to traditional outpatient services.

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Public Beliefs About Accessibility and Quality of Emergency Departments in Germany

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Background: It is well established that emergency department (ED) crowding leads to worse health outcomes. Although various patient surveys provide information about reasons to visit EDs, less is known in terms of beliefs about EDs among the general population. This study examines public beliefs regarding accessibility and quality of EDs and their associations with social characteristics (gender, age, education, immigration background) as well as knowledge about emergency care services and health literacy.

Methods: We conducted a cross-sectional study based on a random sample of 2,404 adults living in Hamburg, Germany, in winter 2021/2022. We developed eight statements regarding accessibility and quality of EDs leading to two scales (Cronbach's α accessibility = 0.76 and quality of care = 0.75). Descriptive statistics of the eight items are shown and linear regression were conducted to determine associations of the two scales with social characteristics as well as knowledge about emergency care services and health literacy (HLS-EU-Q6).

Results: Nearly 44% of the respondents agreed that "you can always go to an ED, if you do not get a short-term appointment with a general practitioner or specialist." And 38% agreed with the statement, "If you do not have the time during normal practice hours due to your work, you can always go to an ED." In terms of quality, 38% believed that doctors in EDs are more competent than doctors in general practice, and 25% believed that doctors in EDs are more competent than doctors in specialized practices. In the fully adjusted model, public beliefs about emergency care accessibility and quality of EDs were significantly associated with all social characteristics and knowledge of emergency care options with the strongest associations between knowledge and accessibility ($\beta = -0.17$; $P < 0.001$) and between education and quality ($\beta = -0.23$; $P < 0.001$).

Conclusion: We found endorsement of public beliefs about accessibility and quality of EDs that can lead to inappropriate utilization. Our results also suggest that knowledge of different emergency services plays an important role. Therefore, after system-related reorganizations of emergency care, information campaigns about such services tailored to socially deprived populations may help alleviate the issue of crowding. [West J Emerg Med. 2024;25(3)389–398.]

INTRODUCTION

Crowding of emergency departments (EDs) has become an important issue in many countries.[1–3] Two contributing causes of crowding are boarding of admitted patients (primary) and inappropriate utilization of the ED for non-urgent conditions (secondary).[3–5] In terms of the first cause, access block (ie, access to hospital beds is blocked and no admission to an inpatient ward is possible) and hospital admissions for ambulatory care-sensitive conditions (ACSC) have been extensively discussed.[6,7] In this study we aimed to address the second cause. Among Organization for Economic Cooperation and Development countries, the increase of ED use in Germany is comparatively high.[8]

Emergency department crowding has been shown to negatively affect patient safety.[3–5] Various studies have examined associations between crowded EDs and worse healthcare outcomes (eg, delays in critical treatments, medication errors, return visits, complication rates, and mortality).[9–11] For instance, recent research in the United Kingdom found that ED crowding is associated with treatment delay and an increase in all-cause, 30-day mortality.[12] To reduce patient numbers in EDs, research is focused on avoidable ED visits of patients with non-urgent conditions. Studies have shown that the percentage of all ED visits judged to be non-urgent is about 30–40%, even though study designs were very heterogeneous.[13] Moreover, a study from Germany found that more than half of the patients visiting an ED did not think that their condition required urgent treatment and thus did not meet the definition of a medical emergency.[14]

In numerous patient surveys, different reasons for visiting EDs with non-urgent conditions were reported. Access barriers to outpatient care, assumptions of higher quality of care and more healthcare options at EDs (as well as negative perceptions about primary care physicians), perceived need and anxiety, convenience (eg, 24/7 availability, no appointments, transport), and referral from healthcare professionals were most frequently mentioned in various international surveys.[13,15–17] Patient surveys conducted in Germany found four main motivations for patients who self-referred to the ED: distress/perceived urgency; access; quality of care; and convenience.[14,18,19]

A lower socioeconomic status (SES)—mostly assessed by educational level, income, occupation on individual or regional level, and immigration status—predict more frequent ED utilization and a higher use for low-acuity presentations,[20–23] even though some current findings did not completely confirm these inequalities for Germany.[19] In this context, the concept of health literacy plays an important role.[24] Low health literacy was shown to be associated with preventable ED visits due to minor or non-urgent problems and with more frequent utilization of EDs and emergency services,[25–27] although some other studies did not show this association.[28]

Population Health Research Capsule

What do we already know about this issue?
Crowded EDs are associated with poor health outcomes. Patient surveys have shown problematic assumptions about ED accessibility and quality.

What was the research question?
We sought to examine beliefs about the ED and their associations with various characteristics in a population survey.

What was the major finding of the study?
44% of respondents agreed, "you can always go to an ED, if you can't get an appointment with an office doctor or specialist," and 38% said you could use the ED for care during non-business hours.

How does this improve population health?
By understanding inappropriate ED use, we can develop education programs for vulnerable groups to inform them about alternative venues to obtain care.

While current evidence provides information about reasons and predictors of frequent or inappropriate ED use, nearly all findings are derived from patient surveys that were conducted at EDs or were based on ED records. These surveys examine the recorded healthcare utilization of actual patients rather than the beliefs about EDs among the general population. This research gap concerning public beliefs about EDs and their accessibility and quality was our rationale for conducting this study. Public beliefs about emergency care are highly relevant as they may contribute to a better understanding of inappropriate ED use and to the development of campaigns to improve health literacy.[29] Against this background, we explored two research questions: 1) What are the public's beliefs about EDs in terms of accessibility or convenience and quality of care; and 2) Are there variations in these beliefs about EDs according to social characteristics (age, gender, education level, and immigration status) and health literacy (general health literacy and knowledge of emergency care options)?

METHODS

Study Design and Population

A cross-sectional telephone survey was conducted in Hamburg, Germany in winter 2021/2022 via computer-assisted telephone interviews. We obtained a random sample

of German-speaking people aged ≥18 years using all possible telephone numbers in Hamburg, including non-registered numbers, via random digital dialing. Only landline numbers could be included as mobile telephone numbers are not provided on a regional level. About 83% of all households in Germany have a landline telephone.[30] Thus, a large majority of the population can be reached via landline numbers. Repeated calls were made by trained interviewers of a professional survey research institute (USUMA, Berlin, Germany) on different weekdays. We applied the Kish selection grid to randomly select the target person in the contacted households.[31] Prior to this, the same survey research institute conducted a pilot study among 30 individuals in the general population.

We chose a telephone survey as the method for data collection due to the vignette design of the study. At the beginning of the survey, recorded audio files describing different symptoms were directly played to the respondents. To guarantee a standardized stimulus and immediate response, telephone surveys are usually favored and an established method.[32] Subsequently, a standardized questionnaire was applied. Sample size was calculated based on a vignette design (48 vignettes in total) applied in the study. According to power calculations, a sample size of 50 respondents per vignette was calculated to identify medium size differences resulting in about 2,400 required participants (statistical power 0.8, and type-I error 0.05). These vignettes were not used in the present analyses. The sample consisted of 2,404 respondents.

Due to different approaches for the definition of eligibility in telephone surveys, different response rates (RR) can be calculated.[33] Thus, a RR in this survey varied between 10.9–46.0% (American Association of Public Opinion Research RR3[34] 17.3%). To gain a representative sample, we weighted data for household size, gender, age, educational level, and place of residence (district in Hamburg) using the official statistics regarding the adult population living in Hamburg.[35–37] In accordance with Halbesleben and Whitman,[38] we conducted a sample/population comparison to assess nonresponse bias. Table 1 shows that the weighted sample adequately represents the general adult population of Hamburg regarding the distribution of gender, age, and educational level.[35,36] The survey was approved by the Local Psychological Ethics Committee at the Center for Psychosocial Medicine, University Medical Center Hamburg (No. LPEK-0200). Respondents gave their informed consent for the participation and the use of their data. Consents and refusals were documented by the interviewers.

Table 1. Sample characteristics of survey respondents compared with official statistics for the population in Hamburg by percentage.

	Sample[a] (N = 2,404)	Adult population of Hamburg 2020[b]	*P*[c]
Gender *(0)*[d]			
Male	48.5	48.4	0.95
Female	51.5	51.6	
Age (years) *(0)*			
18–24	9.6	9.4	0.83
25–34	19.7	19.6	
35–44	17.2	17.5	
45–54	17.5	16.6	
55–64	14.1	15.1	
65–74	10.1	10.0	
≥75	11.8	11.8	
Education level *(71)*			
low	27.4	27.0[e]	0.32
middle	24.1	24.1	
high	48.5	48.9	
Migration background *(46)*			
No migration background	77.9	66.8	–[f]
2nd generation	11.2	–[g]	
1st generation	10.9	–[g]	

[a]Weighted;
[b]34,35;
[c]Pearson's chi[2];
[d]Number of missing cases in brackets in italics;
[e]Data for education only available for people ≥15 years old.
[f]No exact data available.
[g]As there was no discrete weighting for immigration background, test statistics were not conducted.

Measures

To assess the public's beliefs about EDs, we developed eight items (statements about EDs) based on a review of the literature.[13–16,18,19,39] As described above, the main motivations for preferring EDs in patient surveys were related to barriers to access of outpatient care, convenience, assumptions of higher quality of care, and distress or subjective need. We developed four statements regarding access barriers and convenience, as well as four statements related to the quality of care provided in EDs (Figure 1). As the survey was conducted among the general population and not acute patients in EDs, we did not include statements regarding distress and subjective need. Response categories were "fully agree," "rather agree," "rather disagree," "fully disagree" and, additionally, "don't know," with higher values indicating stronger agreement. Validity was tested in accordance with some aspects of Messick's unified framework.[40]

We collected content validity evidence through an extensive literature screening of patient surveys identifying the main motivations for preferring EDs. Additionally,

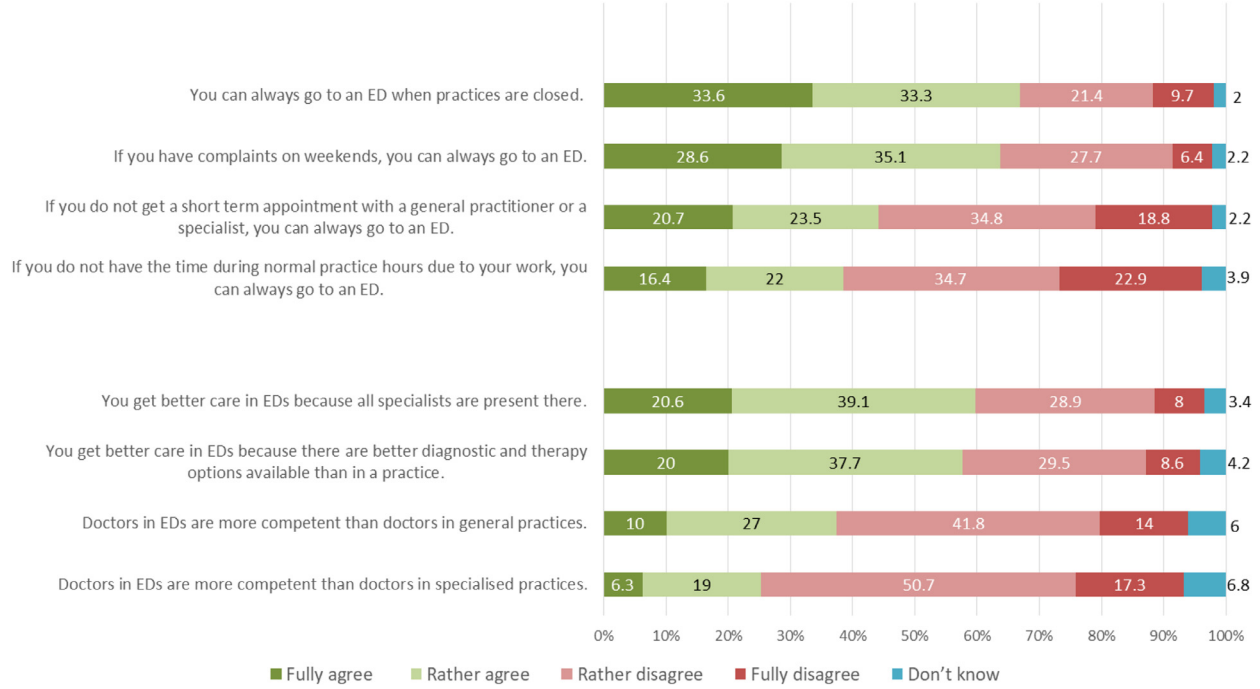

Figure 1. Public beliefs about accessibility and quality of emergency departments (N = 2,404).
ED, emergency department.

experts in emergency care were involved in the item development. Using a pilot study, we pretested items and response consistencies. Furthermore, internal structure validity was tested through Cronbach's α and the factorial structure of the instrument via principal component analysis. The weighting of demographics in our study was aimed to meet external validity.

Gender, age, educational level, and immigration background (no immigration background, first generation, second generation) were introduced as social characteristics of the respondents. Education level was based on years of schooling (9 years = low; 10 years = middle; ≥12 = high). A person was considered to have an immigration background if he or she or at least one parent was born abroad. Respondents with an immigration background who were born in Germany are considered second-generation immigrants, while those with immigration experience are subsequently termed first-generation immigrants. We assessed general health literacy using a European health literacy survey questionnaire, the HLS-EU-Q6, a short form of the established HLS-EU-Q47.[41] On a four-point Likert scale, the answer categories were "very difficult," "fairly difficult," "fairly easy," and "very easy," including "don't know." The Cronbach's α = 0.60 of the scale is acceptable for an instrument that is short and features discrete elements of literacy.[42] We computed a sum scale by averaging the responses to the six items resulting in a range between 1–4, with higher scores indicating an increased health literacy.

To specifically assess knowledge about available emergency care services, we asked the respondents to name all options of emergency care they knew of (open-ended question). In the German healthcare system, patients basically have four options of emergency care.[43] They can 1) call the rescue service (telephone number 112); 2) go to an ED; 3) go to an emergency practice (practices that are usually open from 6 PM to midnight for urgent conditions); or 4) contact the medical on-call service (also known as "116 117," referring to the telephone number) in urgent or emergency cases. In the survey, this question was located before the item about a respondent's beliefs concerning EDs. Based on the responses (respective emergency care service mentioned = 1, not mentioned = 0), we calculated a sum scale with a possible range from 0–4 with higher scores indicating more knowledge.

Analyses

We present percentages of agreement of the eight single items to assess beliefs about EDs as descriptive results. Furthermore, we conducted a principal component analysis including the eight items assessing public beliefs. The analysis revealed two components with eigenvalues ≥1 reflecting accessibility (eigenvalue: 3.22, explained variance: 40.3%) and quality of care (eigenvalue: 1.41, explained variance: 17.6%), which accounted for 57.9% of the total variance (rotated loadings between 0.66–0.78). Eigenvalues are used to determine the relative importance and the explained variance of each principal component. Usually, only factors

with eigenvalues ≥1 are considered.[44] Accordingly, for the multivariate analyses, two scales representing access barriers and convenience (subsequently labelled as "accessibility," four items) and quality of care ("quality," four items) were calculated ranging from 1–4. Higher scores indicate stronger agreement with easy accessibility and superior care quality with regard to EDs. In terms of reliability, internal consistency of the two scales revealed satisfactory results (Cronbach's $\alpha = 0.76$ [accessibility] and 0.75 [quality]).

We calculated linear regression models to analyze associations between social characteristics, health literacy, and public beliefs about accessibility and quality of EDs. Dependent variables were the two scales regarding accessibility and quality of EDs. As predictor variables, gender, age, education level, immigration background, general health literacy, and knowledge of emergency services were introduced. In a first step, we calculated simple unadjusted models showing the single estimates and significances of each predictor variable. Thereafter, in the full model, the predictor variables were entered simultaneously adjusting all variables for each other. We documented regression estimates (B), standardized B (β), significances (P), and explained variance (R^2). Results with $P < 0.05$ were considered statistically significant. As many participants chose the option "don't know" when completing the HLS-EU-Q6, which had to be considered as missing value, the multivariate analyses were conducted with a sample size of 1,751 (quality) or 1,826 (accessibility), respectively. Moreover, various key assumptions for linear regression models (linear relationship, normal distribution of residuals, auto-correlation, homoscedasticity, and multicollinearity) were successfully tested. All analyses were calculated with weighted data and carried out using the Statistical Package for the Social Sciences V 27 (SPSS, Inc, Chicago IL).[45]

RESULTS

Mean age of the respondents was 48.8 years (SD 19.0); 51.5% were female. Almost half of the sample (48.5%) had a high educational level (middle level: 24.1%; low level: 27.4%). About 11% each belonged to the group of first- or second-generation immigrants, while about 78% of the sample had no immigration background (Table 1). The mean (SD) was 2.56 (0.49) for health literacy (HLS-EU-Q6) score (range 1–4). Regarding knowledge of available emergency services, on average the respondents knew two of four options. Figure 1 shows the distribution of the eight items measuring beliefs about accessibility and quality of EDs. Agreement (percentage of respondents who "fully" and "rather" agreed summed up) to the items related to an easy access of EDs ranged between 38.4% ("If you do not have the time during normal practice hours due to your work, you can always go to an ED") and 66.9% ("You can always go to an ED when practices are closed"). In terms of quality of care provided in EDs, 25.3% of the respondents "fully" or "rather" agreed with the item "Doctors in EDs are more competent than doctors in specialized practices," while 68% "rather" or "fully" disagreed. Regarding the item "You get better care in EDs because all specialists are present there," 59.7% expressed agreement.

Table 2 shows the results of linear regression analyses with the sum scale indicating accessibility of EDs as the dependent variable. As can be seen in the unadjusted models, all predictor variables indicated significant associations with beliefs about accessibility. Strongest associations were shown

Table 2. Beliefs about emergency departments: sum scale accessibility[a] (N = 1,826[b]) (linear regressions).

	Unadjusted models			Fully adjusted model		
Predictor variables[c]	**B**	**β**	**p**	**B**	**β**	**P**
Gender	−0.178	−0.12	<0.001	−0.156	−0.10	<0.001
Age	0.006	0.16	<0.001	0.005	0.13	<0.001
Education	−0.197	−0.22	<0.001	−0.116	−0.13	<0.001
Migration background						
1st generation	0.372	0.15	<0.001	0.275	0.11	<0.001
2nd generation	0.135	0.06	0.01	0.179	0.08	0.001
Health literacy (HLS-EU-Q6)	−0.90	−0.06	0.01	−0.049	−0.03	0.15
Knowledge of emergency care services[d]	−0.186	−0.25	<0.001	−0.125	−0.17	<0.001
R^2 (fully adjusted model)					0.122	

B = regression estimate, β = standardized B, P = significance (significant associations [$P < 0.05$] are bold).
[a]Higher values indicate stronger agreement (range 1 to 4).
[b]All analyses based on the sample size of the fully adjusted model.
[c]Gender = reference: male, age = range 18–96 years, education = range 1–3; migration background = reference: no migration background; health literacy = range 1–4; knowledge of emergency care services = range 0–4.
[d]Emergency department/emergency practice/rescue service/medical on-call service.

Table 3. Beliefs about emergency departments: sum scale quality[a] (N = 1,751[b]) (linear regressions)

Predictor variables[c]	Unadjusted models			Fully adjusted model		
	B	β	p	B	β	P
Gender	−0.162	−0.12	<0.001	−0.130	−0.10	<0.001
Age	0.007	**0.19**	<0.001	0.005	**0.13**	<0.001
Education	−0.246	−0.32	<0.001	−0.183	−0.23	<0.001
Migration background						
1st generation	**0.324**	**0.15**	<0.001	0.232	**0.11**	<0.001
2nd generation	0.005	0.05	**0.91**	0.062	0.03	**0.18**
Health literacy (HLS-EU-Q6)	−0.129	−0.10	<0.001	−0.076	−0.06	0.01
Knowledge of emergency care services[d]	−0.144	−0.22	<0.001	−0.073	−0.11	<0.001
R^2 (fully adjusted model)					**0.155**	

B = regression estimate, β = standardized B, p = significance (significant associations [$P < 0.05$] are bold).
[a]Higher values indicate stronger agreement (range 1 to 4).
[b]All analyses based on the sample size of the fully adjusted model.
[c]Gender = reference: male, age = range 18–96 years, education = range 1–3; migration background = reference: no migration background; health literacy = range 1–4; knowledge of emergency care services = range 0–4.
[d]Emergency department/emergency practice/rescue service/medical on-call service.

for education level and knowledge of emergency care service. In the fully adjusted model, female respondents less often agreed that EDs are characterized by easy accessibility. Moreover, agreement increased with age, while it decreased with education level and knowledge of emergency care service options. Compared to respondents without an immigration background, first- and second-generation immigrants more strongly believed in the easy accessibility of EDs. Highest β-values in the fully adjusted model were shown for education ($\beta = -0.13$, $P < 0.001$), knowledge ($\beta = -0.17$, <0.001) and age ($\beta = 0.13$, $P < 0.001$).

In terms of beliefs about superior care quality in EDs, significant associations were shown for all predictors except immigration background (second generation) in the unadjusted models (Table 3). Again, education level and knowledge of emergency care service indicated highest β-values. Regarding the fully adjusted model, significant negative associations with education level, emergency care knowledge, and health literacy emerged. Furthermore, these beliefs increased with age and were more pronounced among first-generation immigrants and males. Education level showed the strongest association ($\beta = -0.23$, $P < 0.001$) in the fully adjusted model.

DISCUSSION

Based on a population survey in a German metropolis, we assessed the public's beliefs about accessibility and quality of care of EDs. Nearly 44% of the respondents agreed that "you can always go to an ED, if you do not get a short-term appointment with a general practitioner or a specialist." Still, 38% agreed to the statement "If you do not have the time during normal practice hours due to your work, you can always go to an ED." In terms of superior quality, 38% believed that doctors in EDs are more competent than doctors in general practice and 25% regarded doctors to be more competent in specialized practices. In addition, nearly 60% agreed that "you get better care in EDs because all specialists are present there." Furthermore, the public's perceptions of emergency care are significantly associated with social characteristics (gender, age, education level, immigration background) and knowledge of emergency care options. Regarding accessibility, knowledge showed the strongest association: The more options of emergency care respondents named, the less respondents agreed that EDs are always accessible. In terms of beliefs about quality of care, education level turned out to be the strongest predictor: The less educated the respondents were the more they agreed that the quality of care is superior in EDs.

As there are many patient surveys but very few population-based studies, comparability of our results with previous research is limited. Some researchers also aimed to assess public perceptions about EDs, but their methods vary considerably.[27,46] Regarding attitudes toward accessibility and quality, males, older people, ethnic minorities, and people with lower SES showed a tendency to use emergency services, even for minor problems, more frequently. An Australian study among the general population showed that perceived urgency, good accessibility, and better healthcare provision were stated as reasons to visit an ED.[46] However, no further analysis about predicting factors was conducted. In a British survey using case vignettes, the tendency to call for an ambulance or to visit an ED in less urgent cases was significantly increased for males, older age, and those who

were of ethnic minorities and had a lower paid occupation and a lower level of health literacy.[27]

When developing the statements concerning accessibility, we deliberately chose strict wording ("always"), so that the items were not too leading. To agree to the four statements was not completely wrong, but it was inappropriate in terms of favored navigation within the German healthcare system. Services in the ED are generally provided for life-threatening conditions or serious acute problems that cannot wait and need to be treated by a doctor immediately. In less urgent cases, other alternatives should be preferred. For these cases, mainly two services are provided when practices are closed: emergency practices and the medical on-call service (also known as "116 117" referring to the telephone number). In fact, these two services were implemented to unburden EDs. This was taken into account when we developed the four statements concerning beliefs about accessibility. It is similar in the case of the statements regarding better quality of care in EDs. There is concentrated expertise in hospitals, but the rating of worse expertise of outpatient doctors and the assumption that all specialists are available in the emergency ward are doubtful and could lead to unrealistic expectations regarding the use of EDs. In this regard, the present study could help us to understand the public's beliefs on which inappropriate utilization of EDs are based. However, it cannot be ruled out that some participants did not correctly understand the items.

The findings provide data about the lack of health education among the general population. Particularly, males, older and less educated people, and those with limited knowledge of emergency care options showed a potentially inappropriate utilization of the ED. In terms of immigration status, especially first-generation, immigrants showed a lack of information that could be due to less experience with the healthcare system, language barriers, different expectations and preferences, as well as formal access barriers (eg, waiting times or travel distances).[47] Regarding gender-specific differences, previous research showed a higher ED attendance for non-urgent problems and a higher use of out-of-hours help-seeking among men.[27,48] Potentially, this preference could be due to longer working hours among men and less willingness to be absent from work because of healthcare. Thus, social inequalities should be considered when implementing interventions (eg, information campaigns). To modify public beliefs about healthcare in general or emergency care in particular, "emergency literacy" campaigns are a way to address the problem of ED crowding. In this regard, knowledge about the availability of different emergency care services, navigation within the healthcare system, and the assessment of symptoms could be addressed.

People should be educated that the ED is for life-threatening and serious conditions such as heavy bleeding, broken bones, chest pain or stroke, and that many symptoms can be treated more appropriately elsewhere. An Australian behavior change campaign that focused on attitudes, awareness, and knowledge was successful in reducing the number of inappropriate or non-urgent calls to ambulance services or medical emergency phone numbers.[29] Currently, a qualitative study from Germany positively evaluated an educational intervention tailored for ED patients with low-acuity conditions.[49] Another study examined physician-directed strategies for improving patient health literacy in EDs.[50] Furthermore, lower health literacy was found among people who were of older age and had lower education levels, less affluence, and with immigration backgrounds,[51,52] which are factors that were also shown to be associated with higher and inappropriate ED use in some studies.[25–27] As our data of public beliefs supports the findings of social inequalities in inappropriate ED use, tailored health education has to take place in more deprived areas where vulnerable groups are living and the availability of healthcare services is potentially limited. Information in different languages and in digital and non-digital versions could help to reach the population in a better way.

In this study, we focused on beliefs that may foster an inappropriate utilization of the ED for non-urgent conditions as one cause of crowding. Another and more important reason is related to boarding of admitted patients.[3] In this context, access block and hospital admissions for ambulatory care-sensitive conditions (ACSC) are discussed.[6,7] Access block is the situation in which access to hospital beds is blocked and no admission to an inpatient ward is possible.[6] Hospital admissions for ACSC are defined as admissions in hospital wards including EDs for medical conditions that are potentially avoidable if they are managed in the outpatient care.[7] Through ACSC, the availability, access and quality of outpatient care can be evaluated, and social inequalities can be revealed.[7] Some reviews summed up possible implications and interventions in terms of reorganization of ED wards and availability of outpatient care.[53–55] Recently, reforms of emergency care have been discussed in Germany in terms of allocating and triaging patients (ie, implementation of a coordination center for first telephone contact and further allocation, and a general counter for initial assessment and triaging at EDs).

LIMITATIONS

This study has some limitations that need to be discussed. Even though the data was weighted for gender, age, and education level, and the comparison of sample and population showed reasonable results, a potential selection bias due to non-response and the exclusive use of landline numbers cannot be ruled out. In this regard, a response rate of between 10.9–46% (depending on definition of eligibility) can be considered acceptable compared to other telephone surveys.[56] Moreover, 83% of households can be reached via landline numbers in Germany.[30] Our data refers to the

situation of healthcare provision in a German metropolis. The conditions in other countries and in more rural regions could be different.

As there was no validated measure for public beliefs about availability of EDs, we developed eight items based on a review of the literature of patient surveys. Although psychometric properties of the two scales seem adequate (Cronbach's $\alpha = 0.76$ [accessibility] and 0.75 [quality]),[42] these scales need to be further developed and tested. In terms of missing values, some items of the accessibility and quality scale ($n = 185$ and $n = 320$), and notably items of the HLS-EU-Q6 scale yielded a high number of missing values due to "don't know" answers (434). Although this procedure was in accordance with the original HLS-EU instrument, the option of "don't know" in questionnaires should not be automatically treated as missing values. Therefore, a missing analysis was conducted. The results revealed only a consistent pattern for age (significantly increased missing values among people with older age). Thus, the relevance of age could be underestimated in the regression analyses, and due to subjective data a common method bias could not be ruled out. Finally, the evaluation of general health literacy was conducted with an established instrument of the HLS-EU consortium, but with the shortest version available (HLS-EU-Q6).[41] So, a more comprehensive instrument would possibly lead to an improved assessment.

CONCLUSION

This study suggests that the public's perceptions about ED quality and accessibility contribute to inappropriate ED utilization and crowding in Germany. Particularly, this holds true for people of older age, male gender, lower education level, and those who are first-generation immigrants and who have less knowledge about available emergency care services. The findings help in understanding inappropriate utilization of emergency care services and developing health education programs tailored to socially deprived populations.

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Support for Thrombolytic Therapy for Acute Stroke Patients on Direct Oral Anticoagulants: Mortality and Bleeding Complications

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Background: Alteplase (tPA) is the initial treatment for acute ischemic stroke. Current tPA guidelines exclude patients who took direct oral anticoagulants (DOAC) within the prior 48 hours. In this propensity-matched retrospective study we compared acute ischemic stroke patients treated with tPA who had received DOACs within 48 hours of thrombolysis to those not previously treated with DOACs, regarding three outcomes: mortality; intracranial hemorrhage (ICH); and need for acute blood transfusions (as a marker of significant blood loss).

Methods: Using the United States cohort of 54 healthcare organizations in the TriNetx database, we identified 8,582 stroke patients treated with tPA on DOACs within 48 hours of thrombolysis and 46,703 stroke patients treated with tPA not on DOACs since January 1, 2012. We performed propensity score matching on demographic information and seven prior clinical diagnostic groups, resulting in a total of 17,164 acute stroke patients evenly matched between groups. We recorded mortality rates, frequency of ICH, and need for blood transfusions for each group over the ensuing 7- and 30-day periods.

Results: Patients treated with tPA on DOACs had reduced mortality (3.3% vs 7.3%; risk ratio [RR] 0.456; $P < 0.001$), fewer ICHs (6.8% vs 10.1%; RR 0.678; $P < 0.001$), and less risk of major bleeding as measured by frequency of blood transfusions (0.5% vs 1.5%; RR 0.317; $p < 0.001$) at 7 days post thrombolytic, than the tPA patients not on DOACS. Findings for 30 days post-thrombolytics were similar/statistically significant with lower mortality rate (7.2% vs 13.1%; RR 0.550; $P < 0.001$), fewer ICHs (7.6% vs 10.8%; RR 0.705; $P < 0.001$), and fewer blood transfusions (0.9% vs 2.0%; RR 0.448; $P < 0.001$).

Conclusion: Acute ischemic stroke patients treated with tPA who received DOACs within 48 hours of thrombolysis had lower mortality rates, reduced incidence of ICH, and less blood loss than those not on DOACs. Our study suggests that prior use of DOACs should not be a contraindication to thrombolysis for ischemic stroke. [West J Emerg Med. 2024;25(3)399–406.]

INTRODUCTION

In the United States, stroke remains common, with the estimated risk of stroke over an individual's lifetime approaching one in four. Ischemic stroke represents 87% of acute insults with intracerebral hemorrhage and subarachnoid hemorrhage making up the remaining

balance.[1,2] For patients who are eligible, the mainstay of treatment of ischemic stroke is restoration of blood flow via thrombolytics and/or thrombectomy. Alteplase (tPA) is currently the only thrombolytic approved for use in acute ischemic stroke by the US Food and Drug Administration.[3]

Thromboembolism from atrial fibrillation is a frequent cause of ischemic stroke and becomes particularly prevalent with aging. In the Framingham study, atrial fibrillation represented a 1.5% risk of stroke in the 50–59 age group and rose to a 23.5% risk in the 80–89 age group.[4] As a preventative measure, most patients with atrial fibrillation are treated with anticoagulation, which can effectively reduce the risk of stroke by approximately two-thirds when compared to placebo.[5–9] Patients with valvular atrial fibrillation should be treated with oral vitamin K antagonists (VKA).[10,11] However, direct oral anticoagulants (DOAC), which include direct thrombin inhibitors and factor Xa inhibitors, have demonstrated non-inferiority to VKAs in the prevention of acute ischemic stroke in patients with non-valvular atrial fibrillation.[12–15]

The most recent 2019 update to the 2018 American Heart Association (AHA) guidelines on tPA excludes patients with concomitant usage of DOACs within 48 hours of the last dose intake, unless coagulation parameters are obtained and normal. Coagulation parameters include tests such as activated partial thromboplastin time (aPTT), prothrombin time (PT), platelet count, thrombin time (TT), or direct factor Xa activity assay.[16] Recent data has suggested that the use of DOACs may not increase the risk of symptomatic intracerebral hemorrhage even in the absence of reversal agents,[17–20] but this has not yet led to a change in guidelines. Prompt administration of thrombolytics to patients with acute ischemic stroke has the potential to lead to clot breakdown and, ideally, restored cerebral perfusion. Patients with acute ischemic stroke who are treated with thrombolytics have improved neurological outcome at three months[21,22] and have a lower risk of long-term mortality[23]; therefore, it is critical to identify the maximum number of patients that can safely receive this intervention. The use of DOACs has rapidly increased in the past decade both for primary stroke prevention in patients with atrial fibrillation, and in the treatment of venous thromboembolism.[24,25] Therefore, this represents a large cohort of patients who may be deprived of the potential benefits of reperfusion therapy.

We sought to assess whether patients receiving DOACs who also received tPA would have an increased risk of adverse events. We evaluated mortality and rate of hemorrhagic conversion across a large, retrospective dataset. Due to the nature of the healthcare dataset, we were not able to assess for severity of all other bleeding directly. Thus, we evaluated for whether patients required blood transfusion as a surrogate marker for clinically significant bleeding. We analyzed these three outcomes at 7 and 30 days post thrombolytic.

Population Health Research Capsule

What do we already know about this issue?
While tPA is the initial treatment for ischemic stroke, guidelines exclude patients taking direct oral anticoagulants (DOAC) due to theoretical risk of bleeding.

What was the research question?
Do patients taking DOACs who receive tPA have worse outcomes than those not taking anticoagulants?

What was the major finding of the study?
With DOAC there was reduced mortality (3.3% vs 7.3%; RR 0.456; $P < 0.001$) and intracerebral hemorrhage (6.8% vs 10.1%; RR 0.678; $P < 0.001$)

How does this improve population health?
Use of DOACs is increasing; this should not prevent patients taking DOACs from receiving the benefits of reperfusion therapy for ischemic stroke.

METHODS

TriNetX is a global federated health research network providing de-identified access to retrospective electronic health records (diagnoses, procedures, medications, lab values, genomic information) from approximately 91 million patients in 54 large healthcare organizations (HCO) within the United States.[26] In this study we used the US Collaborative Network to identify patients who were treated with tPA for acute stroke. Two cohorts were identified for this study within the group of patients treated with tPA on the day of or within one day of the diagnosis of acute stroke: Cohort 1 consisted of acute stroke patients treated with tPA who had received a DOAC on the day of or one day prior to their presentation with acute stroke; and Cohort 2 consisted of actue stroke patients treated with tPA who had not received a DOAC within seven days of the diagnosis of stroke.

We identified stroke patients of all ethnicities, races, and genders using International Classification of Diseases, 10th modification (ICD-10) code I63 (Cerebral Infarction, 1.49 million cases). In the database there were 565,835 patients who were treated with tPA using RxNORM:8410. The dataset was limited to those patients whose index event occurred on or after January 1, 2012, and who had the diagnosis of cerebral infarction so as to exclude patients

treated with tPA for acute coronary syndrome, pulmonary embolism, etc. We then generated two cohorts. In Cohort 1, patients had received a DOAC (edoxaban, dabigatran, apixaban, or rivaroxaban) on the day of or one day prior to their stroke and thrombolytic using RxNORM 1599538, 1037042, 1364430, or 1114195, resulting in 8,582 patients. Cohort 2 was defined as stroke patients treated with tPA who were documented to not be on DOACs in the prior 7 days, resulting in 46,703 patients.

To control for potentially confounding risk factors for the measured outcomes, we performed propensity score matching based on the age at stroke diagnosis, race, ethnicity, gender, presence of hypertensive diseases (ICD-10 codes I10-I16), diabetes mellitus (E08-E13), acute kidney failure and chronic kidney disease (N17-N19), overweight status/obesity (E66), heart failure (I50), cardiac arrest (I46), and ischemic heart diseases (I20-I25). We used the balanced cohort tool in TriNetX for matching.[26]

We performed the outcome analysis between the two cohorts for three events: death (vital status: deceased); nontraumatic intracranial hemorrhage (ICH) and blood transfusions (Current Procedural Terminology code 36430). Nontraumatic ICH was defined as nontraumatic subarachnoid – ICD-10 code I60; nontraumatic intracerebral hemorrhage – ICD-10:I61, or nontraumatic acute subdural hemorrhage – ICD-10:I62.01. Rates of blood transfusion were used as a marker of significant blood loss post thrombolytic administration. All tested outcomes occurred on or after the day of diagnosis of stroke. We measured outcomes over a period of 7 and 30 days post thrombolytics. Patients who had the outcome at the time of or prior to the designated time window were subsequently excluded from the analysis.[26]

We performed univariate analysis using the measure-of-association tool in TriNetX, which compares outcomes within the designated time frames for each cohort reported both as risk ratios (RR), odds ratios, 95% confidence intervals (CI) of these ratios and risk difference as a *P*-value. We obtained de-identified patient data from the TriNetX US Collaborative Network database on November 4, 2022, and we performed the data analyses on the same date. We reported our outcomes as RRs with 95% CIs and risk differences. The TriNetX platform provides access to aggregated counts and statistical summaries of de-identified patient records. No protected health information or personal data is available to the platform users; therefore, this project was exempt from institutional review board review (www.trinetx.com).[26] Our manuscript follows STROBE guidelines for observational cohort studies.[27]

RESULTS

We identified 91,1707,410 patients in the TriNetX United States Collaborative Network from 54 academic medical centers/healthcare organizations. In Cohort 1 of patients treated with tPA on DOACs within 48 hours of thrombolysis for stroke we identified 8,582 patients. In Cohort 2 of patients treated with tPA for stroke documented to not be on DOACs in the prior seven days, there were 46,703 patients. After propensity score matching on basic demographic information and seven prior clinical diagnostic groups associated with mortality there were a total of 17,164 acute stroke patients evenly matched between the DOAC and no-DOAC groups.

Most of the demographic groups except for gender (male/female) were statistically different between the two cohorts before matching. All pre-existing medical conditions associated with mortality were statistically different between cohorts. After propensity matching most of the demographic groups or pre-existing medical conditions were statistically different between the cohorts. Tables 1 and 2 present the demographic characteristics and pre-existing conditions in Cohorts 1 and 2 before and after propensity matching. TriNetX reports infrequent events with outcomes that are ≤10 as 10; so the difference between the two cohorts may have been slightly greater for the Native American and Hawaiian demographic groups where the number in the DOAC group is listed as 10.

We excluded patients if they had an outcome at the time of or prior to the designated index event based on what is recorded in the health records. The risk analysis for the mortality outcome had 193 patients excluded from Cohort 1 (DOAC) and 171 patients from Cohort 2 (no-DOAC). These exclusions are necessary when the timing of an outcome diagnosis is uncertain or occurs before the time window. These exclusions are also in part necessary when the outcome and index event occurs within hours of each other, as the TriNetX database does not always have the degree of granularity to distinguish which event occurred first. The DOACs were much less frequently used more than 10 years ago (introduced approximately 13 years ago); thus, we eliminated this period from the treatment and control groups to avoid confounding.

Patients treated with tPA on DOACs were found to have reduced mortality (3.3% vs 7.3%; RR 0.456; $P < 0.001$), lower incidence of ICH (6.8% vs 10.1%; RR 0.678; $P < 0.001$), and less risk of major bleeding as measured by frequency of blood transfusions (0.5% vs 1.5%; RR 0.317; $P < 0.001$) at seven days post thrombolytic, than the tPA patients who had not been on DOACS. We found similar statistically significant findings with lower mortality rate (7.2% vs 13.1%; RR 0.550; $P < 0.001$), lower incidence of ICH (7.6% vs 10.8%; RR 0.705; $P < 0.001$), and fewer blood transfusions (0.9% vs 2.0%; RR 0.448; $P < 0.001$) at 30 days after the administration of the thrombolytic agent in the 10-year dataset. This information regarding the patient outcomes at seven days (Table 3) and 30 days (Table 4) post thrombolytic is below. The 95% CIs for the RR of death,

Table 1. Cohort 1 (N = 8,582) and Cohort 2 (N = 46,703) characteristics before propensity score matching.

Demographics						
Cohort		**Mean ± SD**	**Patients**	**% of cohort**	***P*-value**	**Std diff.**
1	Age at Index	68.7 +/− 14.4	8,582	100%	<0.001	0.30
2		64.1 +/− 16.7	46,703	100%		
1	Male		4,382	51.1%	0.82	0.003
2			23,910	51.2%		
1	Female		4,199	48.9%	0.82	0.003
2			22,790	48.8%		
1	Not Hispanic or Latino		7,457	86.9%	<0.001	0.35
2			34,166	73.2%		
1	White		6,551	76.3%	<0.001	0.16
2			32,325	69.2%		
1	Unknown Ethnicity		875	10.2%	<0.001	0.34
2			10,576	22.6%		
1	Black or African American		1,32	15.4%	<0.001	0.08
2			38,643	18.5%		
1	Unknown Race		557	6.5%	<0.001	0.13
2			4,731	10.1%		
1	Hispanic or Latino		250	2.9%	<0.001	0.07
2			1,961	4.2%		
1	Asian		117	1.4%	0.42	0.01
2			690	1.5%		
1	American Indian or Alaska Native		25	0.3%	0.01	0.03
2			230	0.5%		
1	Native Hawaiian or Other Pacific Islander		10	0.1%	0.19	0.02
2			84	0.2%		

Diagnosis							
Cohort	**ICD-10**	**Pre-existing condition**	**Mean ± SD**	**Patients**	**% of cohort**	***P*-value**	**Std diff.**
1	I10-I16	Hypertensive diseases		7,001	81.6%	<0.001	0.64
2				24,784	53.1%		
1	I20-I25	Ischemic heart diseases		4,227	49.3%	<0.001	0.49
2				12,330	26.4%		
1	E08-E13	Diabetes mellitus		3,638	42.4%	<0.001	0.32
2				12,864	27.5%		
1	N17-N19	Acute kidney failure and chronic kidney disease		3,422	39.9%	<0.001	0.36
2				10,877	23.3%		
1	E66	Overweight and obesity		2,728	31.8%	<0.001	0.33
2				8,343	17.9%		
1	I50	Heart failure		3,225	37.6%	<0.001	0.48
2				7,805	16.7%		
1	I46	Cardiac arrest		297	3.5%	<0.001	0.09
2				963	2.1%		

ICH, and significant other bleeding are also presented in these tables.

DISCUSSION

In this large, multicenter, propensity-matched, retrospective study, patients with ischemic stroke who received tPA and had received DOACs within two days of thrombolytics were found to have significantly lower risk of death, ICH, and bleeding when compared to patients who received tPA without prior DOACs. These findings were statistically significant at both 7 and 30 days post-thrombolytic. This is significant because current stroke guidelines recommend against administration of thrombolysis in patients who have taken a DOAC within

Table 2. Cohort 1 (N = 8,582) and Cohort 2 (N = 8,582) characteristics after propensity score matching.

Demographics						
Cohort		**Mean ± SD**	**Patients**	**% of cohort**	***P*-value**	**Std diff.**
1	Age at Index	68.7 +/− 14.4	8,582	100%	0.78	0.004
2		68.8 +/− 14.3	8,582	100%		
1	Male		4,382	51.1%	0.64	0.007
2			4,351	50.7%		
1	Female		4,199	48.9%	0.63	0.007
2			4,231	49.3%		
1	Not Hispanic or Latino		7,457	86.9%	0.02	0.04
2			7,557	88.1%		
1	White		6,551	76.3%	0.02	0.04
2			6,677	77.8%		
1	Black or African American		1,323	15.4%	0.64	0.007
2			1,301	15.2%		
1	Unknown Ethnicity		875	10.2%	0.09	0.03
2			808	9.4%		
1	Unknown Race		557	6.5%	0.02	0.04
2			484	5.6%		
1	Hispanic or Latino		250	2.9%	0.12	0.02
2			217	2.5%		
1	Asian		117	1.4%	0.28	0.02
2			101	1.2%		
1	American Indian or Alaska Native		25	0.3%	0.16	0.02
2			16	0.2%		
1	Native Hawaiian or Other Pacific Islander		10	0.1%	>0.99	<0.001
2			10	0.1%		

Diagnosis							
Cohort	**ICD-10**	**Pre-existing condition**	**Mean ± SD**	**Patients**	**% of cohort**	***P*-value**	**Std diff.**
1	I10-I16	Hypertensive diseases		7,001	81.6%	0.35	0.01
2				7,048	82.1%		
1	I20-I25	Ischemic heart diseases		4,227	49.3%	0.75	0.01
2				4,206	49.0%		
1	E08-E13	Diabetes mellitus		3,638	42.4%	0.70	0.006
2				3,663	42.7%		
1	N17-N19	Acute kidney failure and chronic kidney disease		3,422	39.9%	0.45	0.01
2				3,374	39.3%		
1	I50	Heart failure		3,225	37.6%	0.01	0.04
2				3,047	35.5%		
1	E66	Overweight and obesity		2,728	31.8%	0.16	0.02
2				2,642	30.8%		
1	I46	Cardiac arrest		297	3.5%	0.03	0.03
2				248	2.9%		

48 hours of presentation due to a theoretical increased risk of bleeding. Although prior studies have indicated that DOAC use may not increase the risk of intracerebral hemorrhage, to our knowledge our study is the first to suggest a decreased risk of bleeding as well as a decreased risk of death.

Recommendations for withholding thrombolytics from patients using DOACs in the absence of lab testing such as activated partial thromboplastin time (aPTT), prothrombin time (PT), platelet count, thrombin time (TT_, or direct factor Xa activity assay were first instituted in 2013 based on consensus opinion with limited-to-no data (Class IIIC recommendation).[28] These recommendations may have been prudent at the time as DOACs were a relatively novel class of medication, and data surrounding their use was only

Table 3. Outcomes at 7 Days after propensity score matching.

Outcome	tPA + DOAC* (n = 8,582)	tPA - DOAC (n = 8,582)	Risk Ratio (95% CI‡)	Probability (p)
Mortality	3.3%	7.3%	0.456 (0.398, 0.524)	<0.001
ICH†	6.8%	10.1%	0.678 (0.609, 0.756)	<0.001
Blood Transfusion	0.5%	1.5%	0.317 (0.220, 0.456)	<0.001

*Direct Oral Anticoagulant.
‡Confidence Interval.
†Intracranial Hemorrhage.

Table 4. Outcomes at 30 Days after propensity score matching.

Outcome	tPA + DOAC* (n = 8,582)	tPA - DOAC (n = 8,582)	Risk Ratio (95% CI‡)	Probability (p)
Mortality	7.2%	13.1%	0.550 (.500, 0.604)	<0.001
ICH†	7.6%	10.8%	0.705 (0.636, 0.781)	<0.001
Blood Transfusion	0.9%	2.0%	0.448 (0.341, 0.590)	<0.001

beginning to emerge. However, the clinical utility of many common coagulation parameters in patients on DOACs is limited. The APTT, PT, and TT are readily available but poorly sensitive and specific for monitoring of DOACs and should not be used quantitatively to evaluate the degree of anticoagulation effect. By contrast, plasma drug concentration and anti-factor Xa assays may quantify the degree of anticoagulation but are not always available and may require specialized laboratory send-out testing.[29] At our institution, dilute TT is only performed twice weekly, and anti-factor Xa for DOACs is not performed by our hematology lab despite our institution being a comprehensive stroke center. We suspect that this is similar to many comprehensive stroke centers nationwide. Awaiting the above results is problematic since tPA administration is time sensitive; therefore, patients are functionally excluded from receiving tPA due to the time required to obtain these studies.

It has been known for nearly a decade now that DOAC use is non-inferior to warfarin in the prevention of acute ischemic stroke in patients with nonvalvular atrial fibrillation.[12–15] However, while adequate anticoagulation decreases the risk of stroke, it does not completely negate the risk, with the estimated annual risk of ischemic stroke despite oral anticoagulation being approximately 1–2%.[30] We conjecture that perhaps this cohort of patients, while still experiencing ischemic stroke, has relatively milder strokes with smaller thrombus burden, which puts these patients at lower risk of death regardless of tPA administration. Furthermore, these patients may have smaller areas of infarction, which may put them at a diminished risk of hemorrhagic conversion due to less volume of fragile tissue.

Our results favoring DOACs are in line with other data that also suggest that DOACs are associated with lower risk of fatal or disabling stroke when compared to coumadin.[31] Further study in this area could seek to stratify patients by initial National Institutes of Health Stroke Scale score or volume of infarction on imaging to confirm these hypotheses. These hypotheses do not fully explain the third outcome demonstrating a lower rate of blood transfusion as a surrogate for extracranial bleeding. It is possible that less debilitating strokes among patients on DOACs could place less metabolic stress on the body and result in a less globally critical condition of the patient. It is known, for example, that length of intensive care unit stay increases the risk of gastrointestinal bleeding.[32] If patients receiving DOACs have smaller strokes and less severe disease resulting in decreased multisystem organ failure, then this may account for the differences seen in our dataset. It is also possible that the limited half-life of DOAC medications allows for a reduction in their bleeding effect even with a time of abstinence less than 48 hours. The maximal half-life of rivaroxaban is approximately 12 hours, and that of apixaban is similar. Warfarin's mean half-life on the other hand is 40 hours, and this can vary widely.

The rate of ICH seen in this study is slightly higher than was seen in prior studies, for example, in the NINDS trial where the symptomatic ICH rate was found to be 6.4% in patients treated with thrombolytics. This was defined as "any CT [computed tomography]-documented hemorrhage that was temporally related to deterioration in the patient's clinical condition in the judgment of the clinical investigator" within 36 hours of treatment.[21] Our study evaluated for outcomes at 7 and 30 days following treatment, and the more expansive time frame may partially explain the increased hemorrhage rate seen in our study. Additionally, our study included all ICH, not only symptomatic ICH. Institutional stroke protocols may mandate for a routine CT brain for all

patients treated with thrombolytics regardless of whether they were symptomatic, and this may have captured patients included in our study who would have been excluded from others.

LIMITATIONS

The retrospective cohort design of this study makes establishing causality difficult. However, to our knowledge our study is much larger than any other in the literature evaluating outcomes after tPA in patients taking DOACs vs those not taking DOACs. The size of our study, combined with the propensity matching that we performed on our sample, gives it more power to evaluate for differences in outcomes. Furthermore, the generalizability of our study is increased by the number of institutions queried by TriNetX.

We performed 1:1 propensity matching for age, gender, race, hypertensive diseases, ischemic heart disease, diabetes mellitus, acute and chronic kidney failure, heart failure, overweight status/obesity, and prior cardiac arrest, as these are known risk factors for mortality. It is important to note that although we selected multiple potentially confounding variables for matching, a variable that we did not include could have confounded the relationship between drug treatment and mortality. Authors that have been critical of propensity matching techniques acknowledge that most potential deficiencies of this technique are minimized in larger datasets such as this one.

Additionally, we used blood transfusion as a surrogate marker of significant hemorrhage, although this cannot be determined to be secondary to the thrombotic administration. This outcome was investigated over a period of 7 and 30 days post-thrombotic treatment, which should limit confounding due to other causes of bleeding.

We did not exclude warfarin use from our two patient populations. It is possible, but unlikely, that the presence of warfarin use in some non-DOAC patient cohort may have skewed toward higher rates of ICH. However, 2019 AHA guidelines specifically recommend against treatment of ischemic strokes with thrombolytics in patients with an international normalized ratio >1.7, which would exclude most patients therapeutic on warfarin. In addition, patients taking warfarin are unlikely to be concurrently treated with a DOAC.

We are unsure why the patients included in this study were treated with thrombolytics, contrary to current stroke guidelines. It is possible that these were patients who, through coagulation assays such as direct factor Xa, were found not to be anticoagulated. However, due to the time-consuming nature of these studies and the need to administer thrombolytics in a time-sensitive manner and their limited availability even at comprehensive stroke centers such as our own, we believe it is unlikely that these patients were included in a systemic manner or in large numbers. We were unable to evaluate whether there was a clustering of patients on DOACs who received thrombolytics at certain centers, as the TriNetX privacy policy does not allow us to view this information due to the de-identified nature of the dataset. The de-identified nature of the dataset also required us to be dependent on accurate input of the electronic health record to evaluate whether or not the patient was taking a DOAC.

CONCLUSION

In this large, retrospective, multicenter study, patients taking DOACs who received tPA for acute ischemic stroke had a reduced risk of death, lower incidence of ICH, and decreased blood loss in comparison to those who received tPA and were not taking DOACs. Our study adds to the increasing evidence that DOAC use should not be a contraindication to thrombolytics in the initial treatment of acute ischemic stroke. The stroke guidelines should be updated to reflect these findings.

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Patient-related Factors Associated with Potentially Unnecessary Transfers for Pediatric Patients with Asthma: A Retrospective Cohort Study

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Background/Objective: Asthma is a common chronic medical condition among children and the most common diagnosis associated with interfacility transports for pediatric patients. As many as 40% of pediatric transfers may be unnecessary, resulting in potential delays in care and unnecessary costs. Our objective was to identify the patient-related factors associated with potentially unnecessary transfers for pediatric patients with asthma.

Methods: We used patient care data from the California Department of Health Care Access and Information patient discharge and emergency department (ED) datasets to capture ED visits where a pediatric patient (age 2–17 years) presented with asthma and was transferred to another ED or acute care hospital. The outcome of interest was a potentially unnecessary transfer, defined as a visit where length of stay after transfer was <24 hours and no advanced services were used, such as respiratory therapy or critical care. Patient-related characteristics were extracted, including age, gender, race/ethnicity, primary language, insurance status, and clinical characteristics. First, we used descriptive statistics to compare necessary vs unnecessary transfers. Second, we used generalized estimating equations accounting for clustering by ED to estimate odds ratios (OR) and identify factors associated with potentially unnecessary transfers.

Results: A total of 4,233 pediatric ED patients were transferred with a diagnosis of asthma, including 461 (11%) transfers that met criteria as potentially unnecessary. Median age was 12 years (interquartile range 7–15), and 46% were female. Factors associated with increased odds of potentially unnecessary transfer while controlling for key factors included younger age (eg, 2–5 years, OR 2.0, 95% confidence interval [CI] 1.4–2.9), male gender (OR 1.4, 95% CI 1.1–1.7), and Hispanic ethnicity (OR 1.6, 95% CI 1.2–2.1), while multiple hospitalizations for asthma per year was associated with decreased odds (OR 0.2, 95% CI 0.1–0.4).

Conclusion: Several patient-related factors were associated with increased or decreased odds of potentially unnecessary transfers among pediatric patients presenting to the ED with asthma. These factors can be considered in future work to better understand, predict, and reduce unnecessary transfers and their negative consequences. [West J Emerg Med. 2024;25(3)407–414.]

INTRODUCTION

Background

Asthma is a common chronic medical condition among children,[1] affecting 7.5% of the overall pediatric population[2] with peak prevalence in young teenagers (12–14 years) at nearly 11%.[3] Children with asthma exacerbations account for approximately 650,000 emergency department (ED) visits in the US annually, and many of these visits result in hospital admission, including via interfacility transfer by emergency medical services (EMS) to another hospital.[4] Indeed, asthma is the most common primary medical diagnosis associated with interfacility transport for pediatric patients.[5] Interfacility transfers are typically initiated by emergency physicians, citing a need for a higher level of care (ie, critical care), recommendation of specialty services (eg, pediatric pulmonology), or capacity-related limitations (ie, current availability of beds or other resources). Despite the commonplace nature of pediatric transfers for asthma in the ED, there is no prior literature to support policy makers and other stakeholders that include emergency physicians and administrators when navigating this routine decision-making process.

Population Health Research Capsule

What do we already know about this issue?
Asthma is the most common diagnosis associated with interfacility transfer of pediatric patients. Transfers entail costs, delays in care, and resource strain.

What was the research question?
Which patient-related factors are associated with unnecessary transfer for pediatric asthma exacerbations?

What was the major finding of the study?
Younger age (OR 2.0, 95% CI 1.4-2.9) and Hispanic ethnicity (OR 1.6, 95% CI 1.2–2.1) were associated with unnecessary transfer.

How does this improve population health?
Several patient-related factors were associated with increased odds of unnecessary transfer, which can cause preventable strain on families and healthcare systems.

Importance

Prior work has shown that more than 40% of undifferentiated pediatric transfers were either discharged directly from the receiving ED or within 24 hours of direct admission upon transfer,[6] and that only one-quarter of all pediatric transfers are completed to provide a higher or more specialized level of care to the patient.[7] These outcomes are important because interfacility transfers are associated with missed doses of medication, prolonged time to initiation of inpatient care, and a substantial financial burden on families and taxpayers.[7,8] With these risks and costs in mind, a recent study of 1.7 million pediatric transfers in the US reported that only 12.3% of all pediatric transfers met criteria for a medically necessary transfer, demonstrating the limited direct benefit to patient care in many cases retrospectively.[9] Moreover, socioeconomically vulnerable populations are disproportionally affected by asthma,[10–14] and the disproportionate financial burden of interfacility transfers on underserved rural patients has been previously described,[8] indicating the important likely health equity implications of this topic. These considerations underscore the need for improved guidance for policy makers when contemplating the routine practice of interfacility transfer of pediatric patients who present to the ED with asthma.

Goals of this Investigation

We aimed to describe the patient-related factors associated with potentially unnecessary interfacility transfer of pediatric patients presenting to the ED with asthma. Our ultimate goal in this work is to stimulate discussion and future research regarding the characteristics of patients most likely to experience the consequences of unnecessary transfer and to develop interventions to reduce unnecessary strain on patients and their families, EMS, and hospital resources.

METHODS

Study Design and Data Source

We used a retrospective cohort study to analyze patient care and healthcare administrative data from a sample of pediatric patients who presented to the ED with asthma. The primary source of data for this study was the California Department of Health Care Access and Information (HCAI), from which we received a non-public version of the Emergency Department and Ambulatory Surgery (EDAS) Data and Patient Discharge Data (PDD) datasets. The HCAI compiles its data via mandatory standardized collection from all licensed hospitals throughout the state of California. The HCAI organizes data as unique encounters between a patient and healthcare facility, such that each record corresponds to one patient encounter at a given facility (eg, an interfacility transfer would generate two records for that patient). Visits to the ED that result in same-hospital admission are included in the PDD, whereas all other ED visits, including those that result in interfacility transfer, are included in the EDAS. Combining EDAS and PDD for a given year provides a full dataset of all unique, unduplicated ED visits in California within that year. The HCAI datasets are subject to standardized quality assurance

procedures. More detailed information about HCAI can be found on its website.[15]

This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline for cross-sectional studies[16] and was approved by the Mass General Brigham Human Research Committee and the California Committee for the Protection of Human Subjects.

Study Population

We extracted all ED visits from the EDAS and PDD datasets from HCAI during 2016–2019. We included all patients aged 2–17 years to specifically study pediatric patients, and we excluded patients younger than two years of age because wheezing at this young age is more likely attributable to a transient condition such as bronchiolitis rather than a chronic one such as asthma.[17,18] We included pediatric patients who presented to the ED and had a diagnosis of asthma (ie, International Classification of Diseases, Rev 10, codes J45, J98.01, and R06.2) for any documented discharge diagnosis. Finally, we included pediatric asthma ED visits that resulted in an interfacility transfer from the ED, regardless of the initial care setting at the receiving facility (eg, ED to ED, ED to inpatient floor, ED to intensive care unit, etc). In summary, the final study sample included patients aged 2–17 years who presented to an ED in California during 2016–2019, were diagnosed with asthma, and were transferred via EMS to another facility.

Measures

The primary outcome measure used for this study was potentially unnecessary interfacility transfer. This measure was designed to capture patient transfers that—within the limitations of this data source—were not associated with clear retrospective indications that the patient received clinically necessary services that required transfer. We defined potentially unnecessary pediatric transfer based on recent literature (including all chief complaint categories),[9] where the transfer did not result in a disposition of death or admission >24 hours, involve sedation or advanced imaging (defined as any imaging study apart from plain radiographs), or incur operating room or critical care charges. We added respiratory therapy as an additional marker of necessary transfer in the case of asthma, in addition to services captured under critical care such as positive-pressure ventilation. All remaining transfers were considered necessary.

More generally, we identified interfacility transfers by finding two encounters associated with a single unique patient identifier within one day of each other per encounter date, where the encounters occurred at two separate hospitals, and where disposition at the sending facility was designated as a transfer. Additional variables of interest included sociodemographic characteristics and details to describe patients' medical history and healthcare utilization related to asthma. Demographic data included patient age, gender, race, ethnicity, primary language, residence urbanicity, and insurance status. We also included the number of ED visits and hospital admissions each patient had per year where asthma was listed as the discharge diagnosis. Finally, we calculated the number of complex chronic conditions from each patient's past medical history per the Pediatric Complex Chronic Condition version 2 system (including technology dependence and organ transplantation).[19,20]

Statistical Analysis

First, we used descriptive statistics to compare pediatric transfers for asthma that met vs did not meet criteria for potentially unnecessary transfer. Comparisons between groups were made using *t*-tests, Wilcoxon rank-sum tests, or chi-square tests as appropriate. We used generalized estimating equations (GEE) accounting for clustering by facility to calculate adjusted odds of unnecessary transfer, estimated with binominal distribution, logit link function, working independence correlation, and robust standard errors. Covariates included the patient-related factors described above that were included a priori based on prior literature and substantive reasoning. We performed all statistical analyses using Stata version 15.0 (StataCorp, College Station, TX).

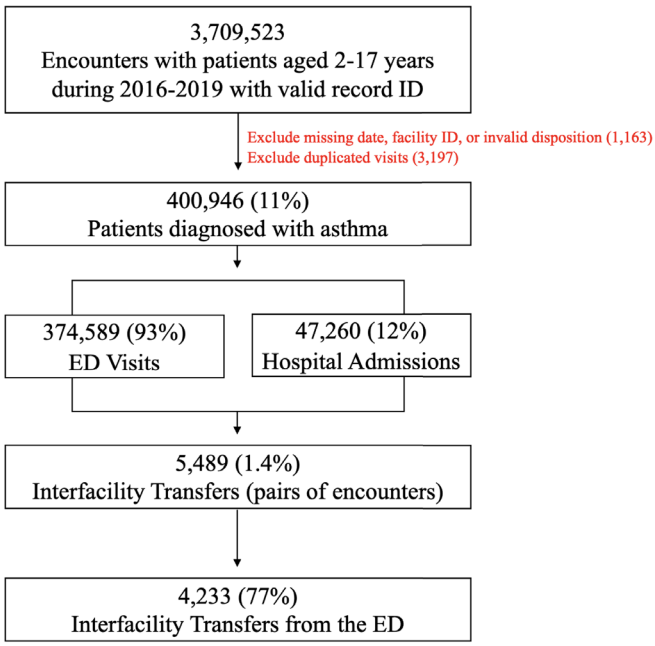

Figure 1. Inclusion and exclusion criteria used to develop the final study sample. Statistics regarding emergency department visits and hospital admissions do not represent patients being included or excluded; instead they provide context to aid in understanding the relative rate of patient transfers within the sample.
ED, emergency department.

RESULTS

From an initial sample of 3,709,523 pediatric encounters, a total of 4,233 patients with asthma were transferred from an ED (each including a pair of two encounters, one at the sending facility and a second at the receiving facility; Figure 1). Among this sample, 461 (11%) met criteria as

Table 1. Descriptive characteristics and comparison of necessary and potentially unnecessary interfacility transfers.

Factor	Overall	Necessary	Unnecessary	*P*-value*
Total n	4,233	3,772 (89)	461 (11)	
Age in years				
Mean (SD)	10.8 (4.8)	11.0 (4.8)	9 (4.6)	<0.001
Age category, n (%)				<0.001
Child (2–5 years)	843 (20)	718 (19)	125 (27)	
School age (6–12 years)	1,451 (34)	1,249 (33)	202 (44)	
Teen (13–17 years)	1,939 (46)	1,805 (48)	134 (29)	
Gender, n (%)				<0.001
Female	1,952 (46)	1,789 (47)	163 (35)	
Male	2,281 (54)	1,983 (53)	298 (65)	
Race/ethnicity, n (%)				<0.001
Non-Hispanic White	1,041 (25)	961 (26)	80 (17)	
Non-Hispanic Black	918 (22)	835 (22)	83 (18)	
Hispanic	1,724 (41)	1,491 (40)	233 (51)	
Non-Hispanic other	518 (12)	455 (12)	63 (14)	
Missing	*32*	*30*	*NR*	
Primary language, n (%)				0.02
English	3,874 (92)	3,467 (92)	407 (88)	
Spanish	322 (8)	275 (7)	47 (10)	
Other or missing	37 (1)	30 (1)	NR	
ED visits without transfer for asthma per year				
Mean (SD)	2.1 (1.9)	2.1 (2.0)	1.6 (1.6)	<0.001
>2 ED visit per year, n (%)	1,068 (25)	983 (26)	85 (18)	<0.001
Admissions for asthma per year				
Mean (SD)	1.2 (0.8)	1.2 (0.8)	0.6 (0.7)	<0.001
>1 admission per year, n (%)	688 (16)	669 (18)	19 (4)	<0.001
Any complex chronic condition†, n (%)	463 (11)	425 (11)	38 (8)	0.050
Patient residence urbanicity, n (%)				0.15
Rural	83 (2)	78 (2)	NR	
Urban	4,131 (98)	3,679 (98)	452 (99)	
Missing	*19*	*15*	*NR*	
Insurance status, n (%)				0.85
Public	2,514 (59)	2,235 (59)	279 (61)	
Private	1,548 (37)	1,385 (37)	163 (35)	
Self-pay/other/missing	171 (4)	152 (4)	19 (4)	

Column percentages shown. Percentages may not sum to 100 due to rounding.
**T*-test or chi-square test as appropriate.
†Complex chronic conditions defined using version 2 definition from Feudtner et al, 2014, (https://bmcpediatr.biomedcentral.com/articles/10.1186/1471-2431-14-199), adapted from Kurowski et al, 2014. (https://pubmed.ncbi.nlm.nih.gov/25039935/). Notably, the version 2 definition includes technology dependence and transplant but does not add these to the total. In this analysis, technology dependence and transplant are included in total complex chronic condition.
ED, emergency department; *NR*, not reported (due to data reporting restrictions).

potentially unnecessary. The mean age of all pediatric patients with a transfer for asthma was 10.8 years (SD 4.8), 47% were female, and 41% were Hispanic (Table 1). Patients with a potentially unnecessary transfer were younger (9 vs 11 years, $P < 0.001$), more often male (65% vs 53%, $P < 0.001$), and more often had Hispanic ethnicity (51% vs 40%, $P < 0.001$). In terms of clinical characteristics, patients who met criteria for potentially unnecessary transfer less often had a complex chronic condition (8% vs 11%, $P = 0.05$) and over the prior year experienced fewer ED visits (1.6 vs 2.1, $P < 0.001$) and hospital admissions (0.6 vs 1.2, $P < 0.001$) for asthma.

Table 2. Odds of unnecessary transfer using generalized estimating equations to account for clustering by hospital.

Factor	AOR	95% CI
Age category		
Child (2–5 years)	2.01	1.39, 2.91
School age (6–12 years)	2.03	1.50, 2.73
Teen (13–17 years)	1.00 (referent)	
Gender		
Female	1.00 (referent)	
Male	1.39	1.15, 1.70
Race/ethnicity		
Hispanic	1.00 (referent)	
Non-Hispanic Black	0.63	0.45, 0.86
Non-Hispanic White	0.63	0.48, 0.83
Non-Hispanic other	0.88	0.65, 1.20
Primary language		
English	1.00 (referent)	
Spanish	1.18	0.82, 1.70
Other or missing	1.69	0.74, 3.87
ED visits for asthma per year		
0–2	1.00 (referent)	
≥3	0.94	0.68, 1.28
Admissions for asthma per year		
0–1	1.00 (referent)	
≥2	0.22	0.13, 0.36
Complex chronic condition*		
None	1.00 (referent)	
≥1	0.79	0.55, 1.15
Patient residence urbanicity		
Rural	0.72	0.35, 1.58
Urban	1.00 (referent)	
Insurance status		
Public	0.98	0.75, 1.28
Private	1.00 (referent)	
Self-pay/other/missing	1.02	0.55, 1.89

*Complex chronic conditions defined using version 2 definition. In this analysis, technology dependence and transplant are included in total complex chronic condition.
AOR, adjusted odds ratio; *CI*, confidence interval; *ED*, emergency department.

Using the GEE model to account for clustering by hospital (Table 2), we found that younger age groups were associated with increased adjusted odds of potentially unnecessary transfer (ie, age 2–5 years, odds ratio [OR] 2.01, 95% confidence interval [CI] 1.39–2.91, compared to age 13–17 years). Male gender (OR 1.39, 95% CI 1.15–1.70) was also associated with increased odds of potentially unnecessary transfer. No associations were found with insurance status, residence urbanicity, or primary language. Patients of Hispanic ethnicity, compared to non-Hispanic White patients, had increased odds of potentially unnecessary transfer (OR 1.59, 95% CI 1.21–2.10). (Note that Hispanic ethnicity was used as the referent in Table 2 given that this was the largest racial/ethnic group in this sample.) Two or more hospital admissions for asthma per year was associated with decreased odds of potentially unnecessary transfer (OR 0.22, 95% CI 0.13–0.36), whereas no associations were found with ED visits for asthma or absence of any complex chronic conditions.

DISCUSSION

Using a comprehensive, statewide dataset of ED visits and admissions, we found several patient characteristics associated with potentially unnecessary transfer of pediatric patients who present to the ED with asthma. These findings describe the patient-level characteristics associated with elevated (or reduced) odds of potentially unnecessary transfer, which can inform policy makers and ED administrators to consider subpopulations with elevated risk of unnecessary transfer when developing future studies and policies related to the transfer of pediatric patients with asthma. Potentially unnecessary transfers mark cases where patients do not show evidence of the benefits of transfer, such as a higher level of care or access to a specialist but do experience the risks and costs associated with transfer.

The rate of potential unnecessary transfer among this cohort was 11%, which is much lower than reported previously in studies of undifferentiated pediatric patients, including rates of one-in-two to nearly nine-tenths.[9,21,22] However, in prior literature the diagnostic category of respiratory emergencies had the greatest number of transferred pediatric patients and was the only diagnostic category associated with decreased odds of direct discharge home from the ED, which may at least partially explain why we observed a lower rate of potentially unnecessary transfer.[21] Perhaps respiratory emergencies are relatively less likely to be quickly discharged from the receiving facility compared to other diagnoses because they are more likely to involve an observation period (eg, continuous oxygen

saturation monitoring, gradual reduction in frequency of respiratory treatments), or perhaps because emergency physicians have more comfort with decision-making for these transfers due to their more commonplace nature. Similarly, the increased prevalence of observation units may have contributed to this finding compared to earlier studies when this option was less available.

Demographic factors associated with increased odds of unnecessary transfers included younger age, male gender, and Hispanic ethnicity. Younger patients were associated with increased odds of potentially unnecessary transfer, which was consistent with prior reports that found particularly high risk among preschool-age patients.[9,22] One possible explanation for this finding could simply be relatively inferior comfort among clinicians caring for younger patients. Increased odds of potentially unnecessary transfer among male patients was not expected a priori and was not found in the literature among undifferentiated pediatric patients, where female patients are more often found to be at higher risk when gender-based differences are found.[9] Prior research has suggested that male pediatric patients tend to have greater prevalence and illness severity of asthma before puberty, in contrast to greater prevalence and severity among females after puberty, with some indication that sex hormones may play a role.[23,24] Further research focused on the transfer of pediatric patients with asthma will be needed to determine whether gender-related differences are widespread, and if so, what may account for this disparity.

Hispanic ethnicity was also found to be associated with increased odds of potentially unnecessary transfer. One possible contributing factor to this finding might have been language barriers; however, even after controlling for primary language spoken, we found an independent association with Hispanic ethnicity. Hispanic ethnicity has previously been reported to be associated with increased odds of unnecessary transfer, but the reasons for this remain unclear.[9,25] Given the known financial costs and medical risks that can be associated with interfacility transfer[7,8] and prior findings that Hispanic patients incur greater costs associated with their asthma-related care in general,[26] we encourage further work to evaluate this trend to gain a better understanding of how to minimize disparities in the burden of undue risk associated with potentially unnecessary interfacility transfer.

We found no association with patient residence urbanicity or with insurance status, in contrast to prior research that found increased risk of potentially unnecessary transfer among urban patients and those with public health insurance.[9] In contrast to our findings, important prior work has highlighted that rural patients are more likely to experience potentially unnecessary transfer because their nearest hospitals tend to be less resourced, especially for pediatric care, compared to urban patients who are more likely to reside in geographic proximity to more resourced centers that are less likely to transfer pediatric patients.[8] Characteristics specific to the state of California may account for these differences, although rates of public insurance and urban residence were quite similar in this cohort compared to prior work. Alternatively, our focus on asthma could be the explanatory factor, given that asthma is more common in urban settings (particularly in the presence of other factors that tend to affect such areas, such as environmental and housing-related insults) and is considered an ambulatory care-sensitive condition shown to be modulated by changes in insurance status among populations.[14,27] Taken together, a solid, generalizable conclusion regarding the potential association between potentially unnecessary transfer and urbanicity or insurance status remains difficult to reach.

Finally, regarding clinical patient-level factors, we found that multiple hospital admissions for asthma per year were associated with decreased odds of potentially unnecessary transfer, whereas no association was found with ≥3 ED visits or the presence of a complex chronic condition. The finding that multiple hospital admissions for asthma was associated with decreased risk is not unexpected. The increased risk of mortality associated with recent hospitalization for asthma not only suggests greater likelihood of increased clinical severity among this cohort but is also a well documented and widely taught piece of evidence that directly factors into clinical decision-making, which makes it less likely for such patients to meet criteria for potentially unnecessary transfer.[28,29] However, the same line of work that tends to indicate the association between hospitalizations and mortality often highlights similar associations with ED use, albeit an intuitively weaker association given that children who visit the ED and are admitted presumably have more severe asthma than those who are instead discharged.

Prior research has shown that complex chronic conditions tend to be associated with longer length of stay and greater resource utilization when transferred compared to not transferred for admission, suggesting that complex pediatric patients tend to be appropriately transferred. However, we did not find decreased risk among this cohort, perhaps due to over-triage in some cases where an asthma exacerbation was relatively mild, but transfer was nevertheless pursued out of concern for poor reserve and likely clinical deterioration or to provide a higher level of specialized care, perhaps in some cases with teams to whom the patient is known.

LIMITATIONS

There are limitations associated with this study. First, the HCAI data includes a mix of administrative and clinical data sourced from patient health records. Thus, definitions of key variables, such as race/ethnicity and even including the diagnosis of asthma, are subject to information bias and misclassification. Most notably, the primary outcome measure uses a composite definition previously established in

the literature but slightly adapted for the purposes of a study focused on asthma. This definition of potentially unnecessary transfer is a useful tool for retrospective research but is far from perfect and likely includes some degree of error associated with misjudgment in the absence of more detailed case-by-case information. Moreover, appropriateness of discharge within 24 hours was not assessed, such as thorough documentation of return visits. Similarly, defining the inclusion criteria for this study relied upon assumptions and trade-offs, such as including patients with any active diagnosis of asthma exacerbation, rather than primary diagnosis, to overcome the limitations of this dataset despite the risk of including patients with other primary diagnoses.

Second, the HCAI dataset is restricted to the state of California. California is a large, heavily populated, and diverse state, which makes findings from samples of its residents more nationally relevant than those from most states. However, the generalizability of these findings to other states and nationally is unclear. Third, the models used in this analysis focus on patient-level characteristics, therefore neglecting the many other factors that have been reported to play into the decision for interfacility transfer, including patient volumes and hospital capacities, hospital-related factors such as resources available, and community-related factors such as the availability of outpatient physicians. Fourth, we used a retrospective cohort design, which limits the interpretation of these findings.

Fifth, data was from 2016–2019, prior to the COVID-19 pandemic. The COVID-19 pandemic had widespread and complex effects on the US healthcare system, including the management of respiratory conditions and the reallocation of pediatric and critical care resources throughout systems; thus, use of data prior to the pandemic might more closely relate to current conditions as the US healthcare system continues to adapt and further normalize. Ongoing research into the effects of the COVID-19 pandemic on the interfacility transfer of pediatric patients with respiratory complaints will provide additional information to better evaluate this assessment.

CONCLUSION

Using a statewide dataset of ED visits and admission, we found that younger, Hispanic, and male children who presented to the ED with asthma had higher odds of experiencing potentially unnecessary interfacility transfer. Patients with multiple hospital admissions for asthma within the prior year were found to have decreased odds of potentially unnecessary transfer. Important next steps in this line of investigation include studies targeted at discrepancies between these findings and prior research, investigation of the financial costs associated with unnecessary transfer of pediatric patients with asthma, and analysis of the healthcare systems-related factors associated with potentially unnecessary interfacility transfers. These insights can be considered by policy makers and ED administrators to identify subpopulations of patients that are more likely to be impacted by new interventions or to inform future studies concerned with disparities in delays in care or financial costs associated with unnecessary transfer. Findings from this study will need validation through a more rigorous prospective study to confirm the patient characteristics that might be associated with increased risk of possibly avoidable transfers and the potential consequences associated with them.

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Public Health Interventions in the Emergency Department: A Framework for Evaluation

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Emergency departments (ED) in the United States serve a dual role in public health: a portal of entry to the health system and a safety net for the community at large. Public health officials often target the ED for public health interventions due to the perception that it is uniquely able to reach underserved populations. However, under time and resource constraints, emergency physicians and public health officials must make calculated decisions in choosing which interventions in their local context could provide maximal impact to achieve public health benefit. We identify how decisions regarding public health interventions are affected by considerations of cost, time, and available personnel, and further consider the role of local community needs, health department goals, and political environment. We describe a sample of ED-based public health interventions and demonstrate how to use a proposed framework to assess interventions. We posit a series of questions and variables to consider: local disease prevalence; ability of the ED to perform the intervention; relative efficacy of the ED vs community partnerships as the primary intervention location; and expected outcomes. In using this framework, clinicians should be empowered to improve the public health in their communities. [West J Emerg Med. 2024;25(3)415–422.]

INTRODUCTION

Emergency departments (EDs) in the United States serve a dual role in public health: a portal of entry to the health system, and a safety net for the community at large. Clinically, its position is clear; the ED provides unscheduled acute care, regardless of a patient's ability to pay. Given its function as a safety net for people lacking consistent access to care, however, the ED is often identified for potential public health interventions due to a perception that it has a unique ability to reach underserved populations. Unsurprisingly, the field of emergency medicine (EM) has taken on this challenge and pioneered a number of effective public health interventions, ranging from community violence prevention[1] to treatment of opioid use disorder.[2]

One study[3] identified 43 conditions proposed in the peer-reviewed literature for ED-based public health screening and/or intervention. Given the logistical improbability of any department employing all proposed interventions, clinicians must make calculated decisions about *which* interventions to deploy and *how* to implement them successfully. Unfortunately, there is a lack of evidence-based guidance in the EM literature on how EDs should prioritize and implement such interventions so as to maximally benefit the public health of their local community. These decisions are increasingly important given the growing stress and demands already placed on EDs around the country. Annual patient volumes have increased substantially. Patient acuity is getting more complex. Emergency department boarding has become a national crisis.[4] Given the significant resource limitations of the ED from these types of factors, any public health intervention beyond core clinical care must have a clear role in the ED setting.

In this paper, we propose a framework grounded in implementation science principles for EDs to prioritize interventions that maximize public health benefits and review the key elements of successful implementation. We present

this from the perspective of our own expertise: ED medical directors who have implemented numerous ED-based public health interventions; an emergency medical services medical director working on population health projects; public health researchers and advocates; public policy experts; and emergency physicians. We recognize that the conversation regarding ED-based public health interventions is challenging and affected by many considerations both internal and external to the ED, but we believe success is possible with the right approach.

PROPOSAL

The volume of potential public health proposals necessitates a framework for determining which are most meaningfully deployed as interventions in a specific ED. As each additional public health screening or intervention takes time within the context of an ED visit, there is a tangible cost to the individual patient associated with participation in public health-focused interventions. Prioritization is challenging for ED administrators, as proposed initiatives rarely arise by a fixed process but rather from a constellation of factors: acute public health emergencies; issues of long-standing concern with individual interest or expertise from a frequently changing physician and nursing staff; strategic initiatives from hospital systems; and often changing priorities from local public health departments or political leaders. Considerations of funding, time, and capacity to provide the intervention with fidelity are often incomplete. Moreover, interventions may be implemented without a plan for rigorous evaluation to justify their continued presence. Given these challenges, a systematic approach to decision-making may maximize health outcomes.

In this context, we provide a framework for considering the merits of conducting a particular intervention within an ED visit. As no ideal framework yet exists, we have adapted constructs from the Consolidated Framework for Implementation Research (CFIR). This implementation framework was originally published in 2009,[7] representing the cumulative knowledge of implementation science at the time. It is a "pragmatic structure" for effective implementation of programs and systems change—precisely what is needed for enacting effective public health programs in the ED. We did not find all constructs of CFIR pertinent to determining the appropriateness of a new, ED-based public health intervention. Those constructs deemed most relevant, by author consensus, are outlined in Table 1 as a modified framework for considering the merits of a potential intervention. The framework we present is thus a commentary, based on our experience in EM and public health administration.

The CFIR groups implementation science constructs across five domains (intervention, process, individuals, inner

Table 1. Recommended considerations for implementing new emergency department-based public health interventions (Consolidated Framework for Implementation Research model).

CFIR major domains	Relevant CFIR constructs	Questions to consider
Intervention characteristics	1. Evidence strength and quality	• Has the proposed intervention shown effectiveness in patient-centered outcomes in the ED setting? • If not, has the intervention shown benefit that is likely to translate to the ED setting? • How strong is the evidence base?
	2. Relative advantage	• Are there locations other than an ED, either in the hospital or in the community that may be a more patient-centric intervention site? • Can any of these locations perform this intervention more easily, efficiently, cheaply, or effectively?
	3. Adaptability	• Will the local context require any deviations from the established program model? If so, how could these differences impact efficacy? • Does the proposed intervention have the flexibility to evolve, as necessary, after initial implementation?
	4. Trialability	• What is the timeline of the intervention? Is there a clear endpoint? • Will it be possible to end the intervention if not effective?
	5. Complexity	• What challenges might arise to maintaining fidelity to the established program model? • What are possible unintended adverse effects of the intervention for non-participants? Are costs shared, or are specific populations disproportionately harmed? • Are there health equity considerations?

(*Continued on next page*)

Table 1. Continued.

CFIR major domains	Relevant CFIR constructs	Questions to consider
External context*	1. Patient needs and resources	• What is the local prevalence of the targeted condition in the general population? The ED population? • Is the targeted population most readily accessible within the ED? Are there alternative and potentially more patient-centered locations? • How does the condition affect local ED utilization, including return visits and hospitalization?
	2. External networking	• Are there effective systems in place to continue care after ED discharge? • How might the absence, change, or loss of external partners affect the intervention?
	3. Peer pressure	• How does the engagement of others in the area affect the need for the intervention and the potential for efficacy?
	4. External policy and incentives	• What stakeholders or policy makers are encouraging implementation? • For programs relying on external funding, what is the long-term stability of this funding?
Organizational characteristics**	1. Culture	• Does the intervention fit within the organizational mission of the ED? • Does the intervention fit within the organizational mission of the hospital?
	2. Compatibility	• How does this intervention fit within the existing workflow of the ED? • How would the intervention alter ED performance metrics?
	3. Relative priority	• What essential ED processes might be impacted by the intervention? For example, will throughput be reduced, wait times increased, or triage burdened? • What other programs may need to be sacrificed for implementation? • Do expected benefits outweigh potential disruption?
	4. Leadership engagement	• Is there buy-in from both ED and hospital leadership? • Is there bandwidth within the ED leadership for the intervention?
	5. Available resources	• Will additional resources be required to accomplish the intervention in the ED? How might those resources be made available? • Are there additional outside resources that that could be brought to bear?
	6. Access to knowledge and information	• Is this a condition in which emergency clinicians have specific expertise? • What sources of public health expertise can be tapped within the department? • What additional training or technical expertise might be accessed?
Characteristics of individuals involved	1. Knowledge & beliefs about the intervention	• Are the assumptions supporting implementation in the ED valid?
	2. Individual stage of change	• Are front-line staff motivated to participate in the intervention?
	3. Other personal attributes	• What cultural, religious, or political concerns may staff have about the intervention?
Process of Implementation	1. Planning	• How will the plan be developed and disseminated? • How much time is needed to develop an implementation plan and formulate alliances?
	2. Opinion leaders	• What support or opposition will implementation have from opinion leaders?
	3. Champions	• How is a project champion going to be identified? • Would that champion have the bandwidth, expertise, and influence to overcome obstacles to the intervention?
	4. Executing	• What is the process for continued monitoring and improvement?
	5. Reflecting and evaluating	• What will be the process for evaluation of intervention effectiveness?

*The original CFIR model wording called external setting "outer setting." The language was changed for clarity when we adapted the framework.
**The original CFIR model called organizational characteristics "inner setting." The language was changed for clarity when we adapted the framework.
CFIR, Consolidated Framework for Implementation Research; *ED*, emergency department.

setting, outer setting) that can assist systematic assessment of opportunities and barriers to successful implementation. Many of these are well suited to be considered even earlier in the implementation process, as an initial assessment of value and appropriateness. These are posed as priority questions in Table 1. We further explore this proposed framework by discussing its application to several established and experimental, ED-based interventions. These examples are meant to be representative of benefits and challenges that may accompany the implementation of certain interventions. They are not meant to be comprehensive.

CASE EXAMPLES

Table 2 lists many (but not all) proposed public health interventions in the ED according to level of acceptance and penetrance. Some interventions have become so engrained in the ED workflow that they no longer are perceived as "public health" interventions. Tetanus vaccines, as well as screening for sexually transmitted infections, fall under this category. Below, we explore the proposed framework using individual interventions as case studies as a guide from which to explore the proposed questions. Each example was selected to highlight major considerations required to deploy and maximize public health benefits, and each varies in the extent to which the intervention is accepted and implemented in EDs throughout the country. We consider the overall disease prevalence and impact of the interventions as it relates to future ED utilization. We explore whether the intervention is typically integrated with, runs parallel to, or is separate from the workflow of an ED visit. Similarly, we examine the ability and appropriateness of performing the interventions by considering both financial costs and requisite resources.

HIV Screening

The US Centers for Disease Control and Prevention endorsed ED-based screening for undiagnosed HIV in 2001,[8] but these recommendations have not risen to the level of official guidelines or quality metrics. Such programs have the potential to test large populations and may find individuals who do not have access to traditional testing programs.

Multiple studies have examined how to best fit HIV screening into existing ED workflow or develop parallel workflows.[9] Frequent questions include which patients to test (universal vs symptoms vs risk-based screening); who

Table 2. Selective overview of the current state of emergency department–based public health interventions.

Level of acceptance	Concept	Select examples	Notes
Established	Accepted interventions that are well-integrated in the ED setting	• Sexually transmitted disease testing • Tetanus vaccination • Blood pressure screening • Smoking and tobacco screening • Intimate partner violence screening	Typically codified by current federal guidelines or recommendations, such as The Joint Commission, The Centers for Medicare and Medicaid Services requirements or reimbursement, US Preventive Services Taskforce recommendations.
Supported	Interventions for which implementation is context dependent based on, for example, local epidemiology, local resources, and community priorities.	• Substance use screening, intervention, and referral to treatment • HIV screening and referral for treatment • Hepatitis A and C screening and referral for treatment • Naloxone provision for substance use and overdose • Buprenorphine initiation in the ED for opioid use disorder • Community violence intervention programs • Depression screening and referral	Potentially widely discussed in the emergency medicine literature, these are typically non-regulated interventions that may be the topics of grants or regional implementation. National guidelines may be supportive but not necessarily within the ED setting.
Experimental	Interventions are discussed or implemented at a small number of select departments, often experimental or otherwise research oriented.	• Hepatitis A vaccination • Early pregnancy linkage to care • Dementia screening • Naloxone provision for all opioid prescriptions • COVID-19 vaccination • Screening for housing insecurity and other health-related social needs	Potentially grant funded, these may also be individual departmental projects or the subjects of trials. Well established guidance within or outside the ED is rare.

ED, emergency department; *COVID-19*, coronavirus disease 2019.

should initiate screening (counselor or clinician); and the operational needs of such programs.[9] A recent large, randomized trial comparing universal screening against two types of targeted screening showed similar effectiveness in identifying new cases, but with lower resource expenditure of targeted screening programs.[9] Research demonstrating that clinician-based testing results in lower screening rates suggests the potential benefit of dedicating additional staffing and funds to such initiatives to maximize effectiveness. Operational challenges may further complicate efforts to establish ED-based HIV screenings, including poor linkage to care,[10,11] low willingness to test among marginalized populations,[12,13] and lack of cultural competency surrounding testing initiatives.[14,15] Factors such as lower HIV incidence, improved community awareness and risk-mitigation, increased testing during routine medical care, fewer regulatory barriers to HIV screening in other locations, more effective anti-retroviral medication, and decreased stigma of the disease may also have changed the benefit of ED-based programs since they were first developed more than 20 years ago.

Intimate Partner Violence Screening

Intimate partner violence (IPV) refers to "physical violence, sexual violence, stalking and psychological aggression by a current or former partner" and affects an estimated one in four women and one in 10 men nationwide.[16] Screening for IPV in women of reproductive age may help ameliorate physical and psychologic sequelae.[17,18] The US Preventive Services Task Force (USPSTF) provides a Grade B recommendation that "clinicians screen for IPV in women of reproductive age and provide or refer women who screen positive to ongoing support services."

Screening for physical injury could be readily integrated into an ED's existing assessment of acute injuries. However, for complaints with less obvious connections to IPV, such as mental health conditions exacerbated by IPV exposure, integration of screening may be harder to define or standardize in the absence of universal screening protocols. In practice, universal screening is often deployed while collecting patient information on a myriad of other variables (eg, past medical history, medication history, suicide screening), and may be prone to "click fatigue," wherein the screener, tasked with compiling a large amount of data in a short amount of time, is unable to perform the screening questions with the intended fidelity.[19] Patients also can be fatigued by time spent screening for conditions not related to their chief complaint and may be reluctant to divulge sensitive information in this setting. However, focused screening of high-risk populations may miss patients and is prone to bias.

The existing evidence base cited by the USPSTF includes 30 studies, including three random controlled trials (RCT), which yielded nuanced results highlighting the necessity of both components of screening and robust intervention. As Feltner et al report in their conclusion: "Although available screening tools may reasonably identify women experiencing IPV, trials of IPV screening in adult women did not show a reduction in IPV or improvement in quality of life over 3 to 18 months."[20] This highlights the challenge of translating positive screens into positive health outcomes. Practicing clinicians will recognize that intervening to protect victims of IPV is challenging when patients present explicitly with this complaint, let alone when patients may be unwilling or unable to divulge symptoms of abuse. Close relationships with community resources equipped to assist victims of IPV are necessary to ensure effectiveness, which requires substantial and sustained administrative support.

Community Violence Intervention Programs

Gun violence in the United States remains an intractable public health problem, with 2020 recording 19,384 homicides.[21] In response, hospitals have implemented hospital violence intervention programs (HVIP) in EDs and wards.[22] These programs use what is described as a "golden moment" of opportunity when patients are in the hospital to foster close, long-term care relationships between culturally competent violence prevention professionals and patients. This includes the creation of comprehensive needs assessments, delivery of case management services, long-term peer support, mental health services, and addressing social determinants of health as root causes of violence.

Initial studies of HVIPs have demonstrated promising results with decreased injury recidivism and improved intermediate outcomes such as delivery of mental health services.[23] However, to achieve these outcomes, significant commitment is required by EDs, including buy-in from multiple hospital departments, community partners, and internal program champions. The costs of hiring specially trained staff are significant, as time and expertise to perform this intervention is often outside the typical workload of emergency clinicians. Many programs require an annual budget of greater than $300,000. This funding has historically been challenging, although recent developments allow for reimbursement through the Medicaid program in a minority of states.[24]

Hepatitis A Vaccination

Hepatitis A virus (HAV) is a vaccine-preventable transmissible infection with the potential for long-term, fatal liver disease. A single vaccine dosage is up to 98% effective at preventing transmission.[25] Consequently, ED-based HAV vaccination has the potential to limit long-term sequelae in those at highest risk of contracting the illness. Still, the process of identifying these at-risk individuals relies on simple screening questions that are often incorporated into standard history-taking instruments and practices in the

emergency context. Storage and provision of vaccines can leverage existing hospital pharmacy and nursing protocols. While at-risk groups, including individuals experiencing homelessness or using intravenous drugs, men who have sex with men, and those who have been incarcerated[26] frequently receive healthcare in the emergency setting, there are also outpatient clinics and other, non-healthcare entities (eg, homeless shelters, nightclubs, jails, substance use treatment facilities) tailored to serve this population. Targeting these community sites may achieve better penetrance of the intervention for underserved population more quickly at lower cost, given modest enrollment of ED-based programs.[27]

COVID-19 Vaccine Administration

Vaccination efforts based in the ED were also bolstered by the presumptive view that the ED patient population might not have ready access to vaccination outside the ED,[28] as well as by a desire on the part of many staff members to take part in a national effort of clear import.[29] An ED-based vaccination seemed to be an obvious extension of hospital-based vaccination programs. The ED vaccination could leverage resources such as ready access to pharmacy and freezers, a relatively small pool of staff who could be trained to administer vaccines, and cultural competency in offering vaccinations. Absent these considerations was an assessment of resource and vaccine availability in the setting of COVID-19-related staffing shortages. The multiple dosing regimen for COVID-19 added complexity and required a separate workflow within the ED context and required follow-up that was sometimes not possible within the ED setting. Additionally, much was unknown about whether the ED offered vaccination to a new or different population or was redundant to other hospital, state, or local community efforts. With varying disease incidence and increasing vaccination rates, there was likely a short window to realize a modest benefit for the intervention.

DISCUSSION

Emergency physicians are committed to improving public health outcomes, as evidenced by the 2009 and 2021 Society for Academic Emergency Medicine consensus conferences[30,31] and the development of several post-EM fellowships in recent years committed to public health and public policy.[32] Emergency departments have embraced many public health tasks such as screening, surveillance, and interventions outside the traditional scope of emergency care. With limited time and resources, not all public health projects can be undertaken. To maximize public benefit, care must be taken to select interventions that have the largest impact while maintaining integrity to the ED's core clinical mission. While emergency physicians take pride in the mantra, "anyone, anything, anytime," we must recognize that some resources may be better spent outside the walls of the ED. This does not mean abandoning certain patient populations, but rather bringing the skills of emergency physicians beyond the walls of the ED through a variety of creative ways, such as collaborations with public health or nonprofit organizations, leveraging emergency medical services experience and connections to develop mobile integrated health programs,[33] or deploying the tactics of "street medicine."

Additionally, emergency physicians should consider not just how the program design affects that single condition but how adaptable the intervention is for a specific department and available resources. Consider a hypothetical intervention that may have 90% sensitivity for universal screening, but only 70% for targeted screening. Depending on the difference in staff time between the two, implementing the lower sensitivity targeted approach may in fact allow the same ED to deploy an intervention for an additional public health concern with the marginal resources needed for universal screening, thus maximizing overall benefit.

Screening programs that collect data but do not provide an intervention in response to positive screens are unlikely to be impactful. We posit that the highest value screening programs have appropriate sensitivity and specificity for their target condition, are cost effective, and are actionable. The value of a screening program should be assessed based on the patient population most in need of this screening, the effectiveness of a possible intervention, and the proposed rationale or relative advantage for doing it in the ED. Additionally, buy-in for an intervention is necessary from stakeholders across multiple levels of the organization: hospital and ED leadership, physicians, nursing, and staff. Failure to obtain support from leadership allocating resources or staff carrying out the intervention can damage morale and limit program efficacy.

Interventions for positive screening results, whether for chronic infectious disease or health-related social needs, may need to be provided outside the ED. Therefore, robust external networks between the ED and outpatient clinics and social services are the most important part of a screening and referral program. Most EDs enthusiastically embrace additional resources to coordinate care for their most vulnerable patients, with or without formalized screening programs. Thus, in the planning process EDs should ensure there is significant buy-in from potential external partners, so that any screening implemented has tangible downstream effects. Many may be public clinics or nonprofit organizations that may themselves be underfunded and understaffed, necessitating external funding that should be equitably distributed between stakeholders. External partners often benefit from a champion point of contact in the ED to advertise, monitor, and coordinate referral pathways.

Patient openness to accepting an intervention in the ED is also an important factor in an ED-based intervention. What

expectations do patients bring into the ED? For example, a patient suffering an ankle injury may not want to answer questions about their marital sexual practices or smoking habits while awaiting the results of a radiograph. Such questions may be perceived as irrelevant to the stated reason for the visit, and the patient may find them invasive or alienating.

Identifying a literature base for proposed interventions that shows benefit to patient-centered outcomes (eg, improved blood pressure, reduced mortality), or population-based outcomes (e.g., fewer community overdoses or shootings), is an optimal standard for considering implementation of public health intervention in the ED. Observational studies without well-matched controls are often subject to selection bias and regression to the mean. Rigorous evaluation methodology that isolates the effect of the intervention on meaningful outcomes, such as RCTs, is preferred to identify the most impactful interventions. Ideally, implemented interventions will continue monitoring and evaluation of key metrics to ensure local efficacy. When that evidence is absent, we hope that this framework can inform the decision-making process analogous to the way we make clinical decisions in the absence of robust evidence.

Emergency departments are intimately familiar with the ways in which social needs drive healthcare utilization and outcomes. However, disparities in population-based health outcomes are not driven primarily by lack of quality emergency care, but by disparities in broader social determinants of health. These disparities are unlikely to be ameliorated by a one-time intervention within the ED context. Thus, emergency physicians must consider implementing public health programs not as a one-time isolated intervention but rather as the beginning process of long-term, transformative, structural change of the healthcare and social services systems as a whole.[34]

CONCLUSION

Emergency clinicians and staff care deeply about the public health of the communities they serve. To maximize public health benefit, emergency physicians face challenging decisions regarding which public health interventions hold the most potential for impact, as well as the way they are deployed. Local dynamics will inform decision-making—the balance of benefits and harms may differ on account of context-specific circumstances. Many proposed interventions could also be implemented effectively in some settings but not in others. Given that there is no "one size fits all" approach, we have proposed a framework grounded in implementation science to assess potential interventions in a systematic manner to maximize public health intervention without detracting from the ED's core function. It is critical to use a guiding framework to properly evaluate efficiency, feasibility, local context, and cost before deployment of any ED-based public health intervention.

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Trauma-informed Care Training in Trauma and Emergency Medicine: A Review of the Existing Curricula

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Background and Objectives: Greater lifetime exposure to psychological trauma correlates with a higher number of health comorbidities and negative health outcomes. However, physicians often are not specifically trained in how to care for patients with trauma, especially in acute care settings. Our objective was to identify implemented trauma-informed care (TIC) training protocols for emergency and/or trauma service physicians that have both sufficient detail that they can be adapted and outcome data indicating positive impact.

Methods: We conducted a comprehensive literature search in MEDLINE (Ovid), Scopus, PsycInfo, Web of Science, Cochrane Library, Ebsco's Academic Search Premier, and MedEdPORTAL. Inclusion criteria were EM and trauma service clinicians (medical doctors, physician assistants and nurse practitioners, residents), adult and/or pediatric patients, and training evaluation. Evaluation was based on the Kirkpatrick Model.

Results: We screened 2,280 unique articles and identified two different training protocols. Results demonstrated the training included patient-centered communication and interprofessional collaboration. One curriculum demonstrated that targeted outcomes were due to the training (Level 4). Both curricula received overall positive reactions (Level 1) and illustrated behavioral change (Level 3). Neither were found to specifically illustrate learning due to the training (Level 2).

Conclusion: Study findings from our review show a paucity of published TIC training protocols that demonstrate positive impact and are described sufficiently to be adopted broadly. Current training protocols demonstrated an increasing comfort level with the TIC approach, integration into current practices, and referrals to trauma intervention specialists. [West J Emerg Med. 2024;25(3)423–430.]

INTRODUCTION

Greater psychological trauma exposure within one's lifetime correlates with an increased number of health comorbidities and negative health outcomes.[1] Childhood exposures to trauma are linked to increased health risks in adulthood for substance use disorder, depression, obesity, heart disease, cancer, and more. Experiencing trauma is often thought of as a rare occurrence, but the foundational adverse childhood experiences (ACE) study has shown how common and pervasive traumatic events are within the US. The study investigated different categories of childhood trauma that included physical/sexual/emotional abuse, parental incarceration, and parental drug use. More than half of the participants reported at least one ACE, and 25% reported more than two categories of ACEs. From 2011–2015, the state of Wisconsin ran the Behavioral Risk Factor Survey, which found that 57% of the 25,518 adult participants reported one or more ACEs.[2]

Many studies recommend screening for ACEs in the emergency department (ED), but this has not become common practice.[3] The ACE questionnaire remains the most common tool used for such screening[1]; however, more recent research has suggested that trauma-informed care (TIC) should be applied in all patient interactions because patients with a history of trauma infrequently classify themselves as such.[4] Practicing with the assumption that each patient has experienced some form of trauma allows the healthcare team to avoid re-traumatization, or the re-experiencing of a prior trauma when exposed to a new traumatic event, and to deliver compassionate and patient-centered care, which is a critical piece in TIC.[5–7]

Because a patient's first contact with the healthcare system is often in the acute care setting, it is crucial that these clinicians are equipped with the appropriate resources and knowledge to provide TIC.[5,8,9] This encourages them to use a more mindful approach to assessing patients. Studies have indicated that 11–61% of ED patients present with a trauma history and 20% of patients at admission report suffering from acute emotional distress.[10,11] In these acute care settings, there are multiple scenarios in which re-traumatization can occur. For example, although it is not surprising to find that restraint use on a patient can be harmful, studies suggest that even a routine physical exam without verbal cues can unintentionally re-traumatize a patient.[12,13] Such events can cause patients to withdraw from the healthcare interaction and decision-making, which leads to a portrayal of patient non-adherence. Furthermore, patients with trauma history are less likely to seek out a primary care physician, instead relying on the ED for treatment.[14,15] Thus, if TIC is not practiced in these settings, long-term health outcomes are impaired and morbidity is increased. It is essential that medical staff be trained in trauma-informed practices to provide high-quality care and promote healing.

The TIC pyramid outlines five overarching principles: 1) patient-centered communication and care; 2) understanding the health effects of trauma; 3) interprofessional collaboration; 4) understanding your own history and reactions; and 5) screening, including universal trauma precautions and trauma-specific strategies (Figure 1).[16] The first two principles are universal precautions that foster trust and rapport and can be used without establishing a patient's trauma history. The remaining three principles are specific for when the clinician knows the patient has experienced trauma.

The positive impact of TIC in both acute care and primary care settings has been well documented in the literature.[9,17–23] The use of TIC has been associated with improved childhood and family adjustment during periods of increased adversity, enhanced health outcomes, increased satisfaction with care, and better mental health outcomes, with decreased substance abuse rates and reduced post-traumatic stress disorder symptoms.[22]

Population Health Research Capsule

What do we already know about this issue?
Many patients who access emergency care have a history of psychological trauma. Best practices recommend a trauma-informed care (TIC) approach.

What was the research question?
What TIC training protocols have shown a positive impact for emergency and trauma clinicians?

What was the major quantitative finding of the study? Major comparison with p-value and confidence interval.
Only two TIC curricula in the literature show positive impact and are reproducible.

How does this improve population health?
The limited existing curricula show that targeted TIC training increases clinician use of TIC practices and improves patient outcomes and satisfaction.

Practicing TIC can also decrease the psychological and emotional burden on the healthcare team.[10,23] Frequent occupational exposure to the trauma experiences of others is considered secondary trauma and is thought to have a cumulative effect on clinician well-being, resulting in greater distress over time.[24] The impact of these experiences has been described as clinician burnout, compassion fatigue, and

Figure 1. Trauma-informed care pyramid adapted from Raja et al (2015).
Universal trauma precautions*; trauma-specific care.**[16]

secondary traumatic stress. Clinician burnout has been shown to lead to poor sleep, distraction, and defensiveness, among other physical and psychological ramifications.[23] These reactions impair a clinician's ability to deliver care, increasing the likelihood of medical errors and making patients feel less safe.[23] Practicing TIC allows the healthcare team to not only identify and attend to a patient's prior trauma, mitigate new trauma due to current medical care, and better understand the reactions and behaviors of patients and their families, but also encourages the medical team to recognize their own history with trauma.

Our aim in this scoping review was to identify TIC training protocols designed for US EDs and trauma services that have demonstrated positive impact in order to develop a new training protocol to be used in these settings. Identifying implemented training will assist clinicians, healthcare practices, and teaching programs interested in improving knowledge and clinical practice to address trauma. Reviewing existing training protocols will facilitate adaptation and development of future training to further improve patient care.

METHODS

Literature Search

We used the PRISMA Extension for Scoping Reviews (PRISMA-ScR) checklist as a reporting guide for this review.[25] Furthermore, we modeled this paper from a previous published paper on a scoping review on TIC within the primary care setting.[21] A comprehensive literature search was developed by a medical librarian and peer reviewed using the PRESS guideline.[26] Searches were conducted in MEDLINE (Ovid), Scopus, PsycInfo, Web of Science, Cochrane Library, Ebsco's Academic Search Premier, and MedEdPORTAL, and the searches were conducted twice. Searches were limited to English language articles. There was no restriction on year or status of publication; we included articles through November 24, 2021, in the search. Search strategies were created using medical subject headings (MeSH) and keywords combined with database-specific advanced search techniques. MeSH terms and keywords were identified to represent trauma-informed approach training for emergency and trauma care clinicians. The full search strategy from Ovid Medline is further detailed in Table 1. We downloaded a total of 6,786 results from the literature searches into EndNote, and duplicate articles were removed; 2,280 unique publications were uploaded into Rayyan (Rayyan Systems Inc, Boston, MA; https://www.rayyan.ai/) for screening (Figure 2).

Study Selection

All the results were screened by three independent reviewers to determine eligibility for this review. The first phase of screening was a blinded title/abstract review conducted in Rayyan, and potentially relevant articles were moved to the second phase of screening for the full text of the publications. Conflicts were resolved with group discussion and consensus. Final analysis included identification of specific training protocols from each of the articles.

Evaluation Criteria

Although many papers reference TIC training, we specifically sought training protocols that were described to the level that they could be duplicated and that had been evaluated with a minimal degree of rigor. Studies were selected if they met the following criteria: the population included emergency or trauma service clinicians (medical doctors, nurses, residents, nurse practitioners and physician assistants); study design involved TIC training for emergency or trauma clinicians and included evaluation of the training, and the setting was a US ED or trauma hospital environment. Only articles written in English were included.

We evaluated training protocols based on who participated, mode and length of training, evaluation methods, results, and Kirkpatrick levels (Table 2). The Kirkpatrick Model, developed in 1959, remains the most common method for evaluating the impact of training programs and is primarily used to assess medical training. As a well-established tool for evaluation, the Kirkpatrick Model is widely considered to be a valid and reliable tool that can be implemented with ease to measure the effectiveness of training on a particular target goal. The model uses four levels of training evaluation: Level 1: Reaction—how favorable, engaging, and relevant training is to the participants' jobs; Level 2: Learning—did participants acquire the intended knowledge, skills, attitude, confidence, and commitment through participation; Level 3: Behavior—will participants apply what they learned in practice; and Level 4: Results—are targeted outcomes (changes in clinician behaviors and improved patient outcomes) due to training.[27]

RESULTS

After reviewing 2,280 unique articles, we included 16 articles for full-text review. Of the 16 articles, only two were included in the final analysis. Fourteen articles were excluded for targeting the incorrect population,[23,28] having a training center location outside the US,[29,30] not describing the TIC training curriculum,[31–39] or lacking evaluation of the curriculum.[40] The included articles highlight different training protocols, one addressing the treatment of agitation and one encouraging clinician referrals.[6,7] Both articles cover subject matter related to patient-centered communication, use in-person learning methodologies, including didactic sessions or roleplays, and address interprofessional collaboration as part of the training.[6,7] These two articles detail the development of TIC curricula for emergency and trauma clinicians from their design to their impact, providing comprehensive insight that will be able to inform the development of future training protocols.

Table 1. Ovid MEDLINE search strategy (through November 24, 2021).

1 (trauma informed or (aces or adverse child* event* or adverse child* experience*)).mp.
2 trauma.ti. or trauma.ab. or traumatiz*.mp. or traumatis*.mp. or retraumatis*.mp. or retraumatiz*.mp.
3 exp stress, psychological/ or psychological stress*.mp. or stressful event*.mp. or stressful experience*.mp. or exp life change events/ or life chang* event*.mp.
4 exp RESILIENCE, PSYCHOLOGICAL/ or resilien*.mp. or coping.mp. or cope.mp. or coped.mp.
5 exp Adaptation, Psychological/ or (psychological* adj5 adapt*).mp. or (emotional* adj5 adjust*).mp. or exp emotional adjustment/
6 exp Stress Disorders, Post-Traumatic/ or post traumatic stress disorder*.mp. or posttraumatic stress disorder*.mp. or ptsd.mp. or posttraumatic neuros*.mp. or post traumatic neuros*.mp. or (moral* adj5 injur*).mp.
7 exp social support/ or social support*.mp. or social network*.mp.
8 exp self care/ or self care.mp.
9 well being.mp. or exp "Quality of Life"/ or qol.mp. or quality of life.mp. or life quality.mp.
10 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11 patient centered*.mp. or exp Patient-Centered Care/ or patient focused*.mp. or medical home*.mp. or client centered*.mp.
12 exp "Delivery of Health Care, Integrated"/ or (behavioral adj5 health adj5 integrat*).mp. or (behavioural adj5 health adj5 integrat*).mp. or (integrated adj5 care).mp.
13 11 or 12
14 10 and 13
15 1 or 14
16 exp education/ or exp curriculum/ or exp education, professional/ or exp education, medical/ or curricul*.mp. or ed.fs.
17 (educat* or train* or orientat* or lectur* or teach* or workshop* or pre-post or implement* or assessment*).mp.
18 exp simulation/ or simulat*.mp. or screen*.mp.
19 exp TEACHING/ or exp TEACHING MATERIALS/ or exp lectures/
20 exp Education, Medical, Continuing/ or continuing medical educat*.mp. or cme.mp.
21 exp Health Personnel/ed or interprofessional educat*.mp.
22 exp program development/ or (program* adj5 develop*).mp.
23 exp quality improvement/ or (quality adj5 improv*).mp.
24 exp Evaluation Studies as Topic/ or (research adj5 evaluat*).mp. or (program* adj5 evaluat*).mp.
25 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24
26 Advanced Trauma Life Support Care/ or exp emergency medicine/ or emergency nursing/ or exp Emergency Service, Hospital/
27 (emergency or emergicenter* or emergency center* or trauma service* or trauma unit* or trauma center* or advance* trauma*).mp.
28 (emergency department* or emergency hospital service* or emergency outpatient unit* or emergency room* or emergency unit* or emergency ward* or hospital emergency service* or emergency service* or emergency nurs* or emergency physician* or emergency medicine).mp.
29 26 or 27 or 28
30 15 and 25 and 29
31 limit 30 to English language
****

Five Points of Trauma-Informed Care

One of the TIC training protocols, entitled the Five Points of TIC, was implemented for Level I trauma center clinicians.[7] Clinicians and staff from the departments of EM, pediatrics, surgery, and social work, as well as medical students and nurses, among others, participated in training that consisted of a 90-minute workshop, facilitated by a pediatrician and former patients. This model outlined five pillars to guide clinicians and aid families affected by trauma or violent injury: safety; screening; understanding context; avoiding re-traumatization; and discharge planning. Additionally, the training focused on promoting a patient's sense of safety, which can help improve their healing and establish trust between clinician and patient.[7] This includes factors such as privacy, a consistent and dependable clinician, and a soothing environment.

Within this workshop, participants discussed correlating clinical cases, complex trauma, and a hospital-based violence

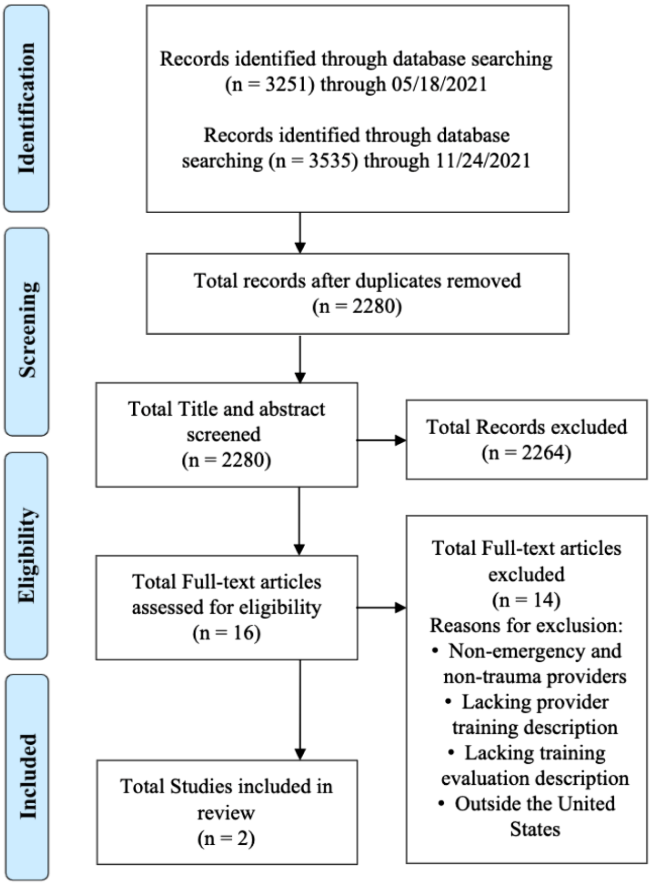

Figure 2. Source selection process.

intervention program (VIP). The VIP included trauma intervention specialists who could provide crisis intervention, support, and psychoeducation on trauma. Next, participants reviewed the Five Points of TIC and discussed patient cases. Following the cases, they held a patient panel and VIP panel, where patients were able to share their experiences with trauma-sensitive communication skills and healing.

The Kirkpatrick levels highlighted for this protocol include Levels 1 and 3. Participants completed pre- and post-workshop surveys assessing comfort with the Five Points of TIC. Results demonstrated an increase in comfort levels with TIC ($P < .001$) for attendings, residents, fellows, and medical students, with medical students having the highest increase in comfort levels (Level 1). Additionally, behavioral change was directly assessed, with VIP referrals from physicians significantly increasing from 7.3% in 2014 to 47.8% of patients referred in 2018 following the course ($P < .001$) (Level 3). These results demonstrate that as a result of training, there can be an improvement in TIC comfort and familiarity with TIC approaches, leading to substantive change in practice.

BETA Project

Another TIC training protocol was completed by nurses, and later all staff, in the ED.[6] Participants completed Management of the Agitated Patient in the Emergency Department training, part of the Best Practices in Evaluation and Treatment of Agitation (BETA) project, which focuses on evidence-based guidelines and non-pharmacological interventions to minimize use of restraints and seclusion when caring for agitated patients. De-escalation techniques, environmental modifications, and sensory approaches are the foundation of this approach.

The four-hour training consisted of didactic simulations and role play. Beyond staff education, the protocol also called for the development of new clinical processes and ongoing monitoring and feedback. Based on the Kirkpatrick Model of training evaluation, learning associated with this protocol included Levels 1, 3, and 4. Following completion of the training, results indicated that the nurses found it valuable and able to be easily integrated into their practice (Level 1). Participants reported improved confidence and satisfaction with managing aggressive patients (Level 1). There was also a significant reduction in restraint use in the ED, demonstrating that a behavioral change and improved outcomes can occur through providing staff with TIC knowledge and the skills to address underlying causes of patient behaviors (Level 3 and 4).

DISCUSSION

This review highlights the need for continued development and evaluation of outcomes of TIC trainings for emergency and trauma service physicians. Although only two curricula were identified that met the inclusion and exclusion criteria established for this review, several studies highlighted the importance of TIC training (Hawkins, Fisher).[9,34] These studies do not, however, include specific curricula that were used to train emergency and trauma service physicians. To promote the literature on this topic and aid institutions striving to bring TIC to their EM or trauma services, it is important to not only identify the training curricula available for emergency and trauma service clinicians, but to evaluate the *effectiveness* of the TIC training.

Prior to designing and implementing a training protocol, a needs assessment can be conducted to determine the specific deficits within an institution or practice.[21,41] This is a step that was not indicated in the current included results and may be an important piece prior to creating a curriculum.[6,7] To create the most impactful curriculum, the needs of the clinicians, patients, and communities must be understood. First, this involves surveying clinician attitudes and beliefs about TIC, as well as specific knowledge of what TIC encompasses and its role in building trust within the medical system.[8] Second, this involves asking clinicians what they feel they may need in TIC training and the outcomes they are hoping for.

The needs as perceived by physicians on a trauma service may differ dramatically from those as perceived by outpatient primary care physicians.[21] Furthermore, a needs

Table 2. Summary of two approaches to trauma-informed care training for emergency and trauma physicians.

Source	Population	Training methodology	Evaluation	Results	Kirkpatrick Model level of learning
Cole R (2014)	Two new nurses and four recent graduate nurses (pilot group) at an acute-care, Level II trauma center. Expanded to include all ED staff	Four-hour pilot training course: read 2 BETA Project articles and complete homework before workshop; didactic sessions and roleplay	• Post-test • Class evaluation by pilot group	1. Most participants found the training valuable and integrable into their existing practice. 2. Initially, 15–20 episodes of restraint or seclusion per month decreased to 0 episodes. 3. Overall behavioral health seclusion/restraint hours reduced from 38.5 h/mo. (August 2011) to 0 h/mo. (September 2013) with overall shorter episode duration and improved documentation compliance.	• Reaction – Level 1 • Behavior – Level 3 • Results – Level 4
McNamara M, et al (2020)	318 clinicians and hospital staff members at two Level I pediatric trauma centers	90-minute workshops from 2015–2018 plus patient expert advice and a panel discussion, followed by implementation of "Five Points of TIC" curriculum	• Pre-/post-workshop surveys • Tracked referrals to the Violence Intervention Program (VIP) from 2014–2018	1. Increased referrals to VIP from physicians ($P < 0.001$; 7.3% to 47.8%). 2. Decreased probability of patients being identified only by VIP staff ($P < 0.001$; 62.1% to 23.4%). 3. Self-reported comfort with TIC after workshops improved by 21% ($P < 0.001$).	• Reaction – Level 1 • Behavior – Level 3

ED, emergency department; *BETA*, Best Practices in Evaluation and Treatment of Agitation; *h/mo*, hours/months; *TIC*, trauma-informed care.

assessment would promote understanding of any TIC approaches that are already being implemented (whether or not they are explicitly recognized as TIC) within the ED or trauma service setting. Finally, this needs assessment would focus on addressing concerns of the unique patient populations that the clinicians care for. Even across EDs and trauma services, there may be marked differences in patient populations and community resources already available, which may impact what is emphasized in a hospital-based TIC training.

When developing a training protocol, outcomes have indicated that even moderate training improves the ability of the healthcare team to provide TIC; however, more intensive protocols are correlated with improved results.[35] Protocols such as the Five Pillars of TIC and the BETA Project, which use in-person workshops with case-based discussions, role-play, and simulations versus didactics alone, show greater clinician proficiency associated with improved patient-reported outcomes and physician comfort levels.[6,7,35]

Although the literature regarding the outcomes of implementing TIC training for emergency and trauma service physicians is limited, research on the development of such training programs suggests that training and simulations should encourage a multidisciplinary approach, mirroring the reality of the environment.[41] This method helps both to identify system-level conditions that might impact the delivery of TIC, such as organizational issues, and to highlight any social dynamics or authority hierarchies that could discourage team members from voicing concerns.

As noted in the included articles by Cole (2014) and McNamara et al (2020), the success of a TIC protocol can be evaluated through pre- and post-training surveys or evaluations to gauge the impact of the course on healthcare clinicians and their practice.[6,7,35] Metrics that include referral to outside resources, involvement of social workers, and patient satisfaction can be used to track successful implementation of TIC methods as illustrated through the BETA Project.[7] These can be monitored by monthly or quarterly chart audits and patient surveys.[6] Additionally, long-term evaluation of behavioral changes, knowledge and beliefs, and comfort with providing TIC should be tracked to monitor the impact of the training program.

Finally, future research should emphasize the ways in which TIC can improve healthcare costs, clinician satisfaction and well-being, and long-term health outcomes for patients affected by traumatic experiences, including reduced re-traumatization, decreased healthcare utilization, improved mental and physical health outcomes, and decreased substance use.[19] Existing evidence suggests that recognizing trauma's impact on patient behavior and health allows clinicians to avoid unnecessary interventions, decrease readmissions, and improve health outcomes.[5]

Additionally, evaluating TIC practices to reduce clinician burnout could limit staff turnover and associated recruitment and training costs.[10,23,24] This data, along with more robust data from emergency and trauma services that have implemented TIC protocols, is critical in ultimately providing the most considerate and appropriate care for patients.

LIMITATIONS

This review is limited in that only two articles were found to meet inclusion criteria. While there was more available research on TIC training evaluations within mental health and primary care settings, the unique nature of EDs and trauma services warranted strict inclusion criteria, which resulted in a narrow selection of literature. In these settings, patients are faced with unfamiliar physicians and fast-paced interactions, and there is evidence indicating that a large proportion of patients in these settings report a history of trauma and often rely on acute care for all healthcare needs.[11,12,15,16] An environment emphasizing empathy and safety is paramount in TIC, especially in these departments.[7,10] The primary intention of including evaluations of TIC training only in US healthcare facilities was to account for differences in healthcare system resources and investment in training compared to other countries. Excluded were articles discussing the potential of certain TIC training and practices without evaluation of effectiveness that would inform future curricula development. With the necessary criteria that were established for a robust review, the final results yielded limited data for determining the most optimal features of a TIC training protocol.

CONCLUSION

Our review demonstrates a considerable paucity in the literature regarding implemented and evaluated trauma-informed care curricula for emergency and trauma service clinicians. However, the existing training protocols demonstrate that, with targeted training, clinicians become more comfortable with TIC and can integrate aspects of TIC into current practices.

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Relationship of Beta-Human Chorionic Gonadotropin to Ectopic Pregnancy Detection and Size

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Introduction: Ectopic pregnancies are a significant cause of morbidity and mortality in the first trimester of pregnancy. Hospital protocols requiring a specific beta-human chorionic gonadotropin (β-hCG) level to qualify for diagnostic testing (pelvic ultrasound) can delay diagnosis and treatment. In this study we sought to determine the relationship between β-hCG level and the size of ectopic pregnancy with associated outcomes.

Methods: We performed a retrospective case review of patients diagnosed with ectopic pregnancy in an urban, academic emergency department specializing in obstetrical care, from January 1, 2015–December 31, 2017. Variables extracted included presentation, treatment, adverse outcomes, and rates of rupture.

Results: We identified 519 unique ectopic pregnancies. Of those ectopic pregnancies, 22.9% presented with evidence of rupture on ultrasound, and 14.4% showed evidence of hemodynamic instability (pulse >100 beats per minute; systolic blood pressure <90 millimeters of mercury; or evidence of significant blood loss) on presentation. Medical management outcomes were as follows: of 177 patients who received single-dose methotrexate, 14.7% failed medical management and required surgical intervention; of 46 who received multi-dose methotrexate, 36.9% failed medical management and required surgical intervention. Ultimately, 55.7% of patients required operative management of their ectopic pregnancy. Mean β-hCG level at initial presentation was 7,096 milli-international units per milliliter (mIU/mL) (SD 88,872 mIU/mL) with a median of 1,289 mIU/mL; 50.4% of ectopic pregnancies presented with β-hCG levels less than the standard discriminatory zone of 1,500 mIU/mL. Additionally, 44% of the patients who presented with evidence of rupture had β-hCG levels less than 1,500 mIU/mL. Comparison of size of ectopic pregnancy (based on maximum dimension in millimeters) to β-hCG levels revealed a very weak correlation ($r = 0.144$, $\boldsymbol{P < .001}$), and detection of ectopic pregnancies by ultrasound was independent of β-hCG levels.

Conclusion: Levels of β-hCG do not correlate with the presence or size of an ectopic pregnancy, indicating need for diagnostic imaging regardless of β-hCG level in patients with clinical suspicion for ectopic pregnancy. Almost one-sixth of patients presented with evidence of hemodynamic instability, and approximately one quarter of patients presented with evidence of rupture requiring emergent operative management. Ultimately, more than half of patients required an operative procedure to definitively manage their ectopic pregnancy. [West J Emerg Med. 2024;25(3)431–435.]

INTRODUCTION

Ectopic pregnancies are not a rare occurrence, affecting approximately 2% of all pregnancies.[1–3] There is no centralized system to monitor rates of ectopic pregnancy; thus, the true incidence is likely higher than this estimate.[2] Ectopic pregnancy is a leading cause of morbidity and mortality in the first trimester of pregnancy. Medical management requires more from a patient in terms of follow-up (multiple blood draws, ultrasounds, and appointments) when compared to surgical management; between 12–24% of patients will fail medical management and ultimately require surgical management.[4]

The classic presentation of an ectopic pregnancy is unilateral pelvic pain with vaginal bleeding in the presence of a positive pregnancy test. Risk factors (present in 50% of those with ectopic pregnancy) include prior ectopic pregnancy; history of pelvic inflammatory disease or pelvic surgery; assisted reproductive technology for conception; age >35 years; tobacco use; intrauterine diethylstilbestrol exposure; and presence of an intrauterine device at the time of conception.[1,2] About 96% of ectopic pregnancies will occur within the adnexa; rarer locations include the cervix, cesarean section scars, ovaries, and abdominal cavity.[1,3,5]

Diagnostic workup for suspected ectopic pregnancy includes bloodwork to check for beta-human chorionic gonadotropin (β-hCG) levels, Rh type, hemoglobin level, and transvaginal ultrasound to visualize location of the pregnancy (intra- vs extrauterine). The published discriminatory zone for β-hCG levels (1,500–4,000 milli-international units per milliliter [mIU/mL]) can be used to aid for correlation to expected ultrasound findings. Patients with a β-hCG >3,500 mIU/mL should have findings on ultrasound that demonstrate the location of the pregnancy (intrauterine [gestational sac plus yolk sac within the endometrial cavity] vs ectopic [lack of intrauterine pregnancy with an extrauterine mass with sonographic characteristics consistent with ectopic pregnancy]).[1] While the discriminatory zone is helpful to determine when an intrauterine gestation should be seen on ultrasound, signs of an ectopic pregnancy may be visible at significantly lower β-hCG levels.[6] In this study we sought to determine whether β-hCG levels correlate with the size of an ectopic pregnancy as well as the rate of treatment failure of ectopic pregnancy.

Population Health Research Capsule

What do we already know about this issue?
Beta-human chorionic gonadotropin (β-hCG) levels and the discriminatory zone cutoffs are used to determine ultrasound-ordering algorithms at many hospitals.

What was the research question?
Do β-hCG levels correlate with size of an ectopic pregnancy and/or rate of treatment failure?

What was the major finding of the study?
50.4% of ectopic pregnancies, and 44% who had rupture, had β-hCG levels less than 1,500 mIU/mL. The ectopic pregnancy β-hCG levels only very weakly correlated ($r = 0.144$, $P < .001$) with ectopic size.

How does this improve population health?
β-hCG levels should not be a factor in ordering transvaginal ultrasound in a patient with suspected ectopic pregnancy.

METHODS

We performed a retrospective case review of patients seen in an urban, academic ED housed in a tertiary- care facility specializing in obstetrical care. Cases occurred between January 1, 2015–December 31, 2017, for patients who were diagnosed with an ectopic pregnancy. This study was approved by the institutional review board; participant consent was not required. The criterion for inclusion was a diagnosed ectopic pregnancy in the chart and/or on ultrasound, identified by searching billing codes for "Ectopic Pregnancy," "Ectopic Pregnancy, Other," "Abdominal Pregnancy," "Tubal Pregnancy," "Ectopic Pregnancy, Nonspecific," and "Ovarian Pregnancy." This search yielded 1,265 visits during the research period with 519 unique cases of ectopic pregnancy (where each case could have multiple associated visits). Patients of all ages were included in the study if they met the inclusion criterion. Exclusion criteria was loss of patient to follow-up after initial presentation (thus making it impossible to confirm final diagnosis of ectopic pregnancy and/or outcomes related to treatment) or if the patient was ultimately found to have a diagnosis other than ectopic pregnancy (ie, intrauterine pregnancy). For the 519 cases of ectopic pregnancy, data extracted from each chart included the following variables: presentation (including initial β-hCG levels and ultrasound findings [size of ectopic pregnancy, evidence of rupture, and/or fetal heartbeat]); treatment (expectant, medical, and/or surgical); and treatment outcomes (successful, failure, or rupture). Data was extracted by two individuals; the principal investigator (**xx**) reviewed the extracted data every five cases to ensure consistency of data extraction. We compared data using standard means, the Pearson correlation coefficient, and Student *t*-testing using Excel (Microsoft Corp, Redmond, WA). For charts where data was incomplete (for example, missing ultrasound evidence of ectopic pregnancy), we

included the chart in the analyses where data could be extracted and we excluded data from the analyses where it was missing.

RESULTS

The dataset contained 519 unique ectopic pregnancies presenting to the ED during a three-year period (Table). The average age of the subjects at presentation was 29.39 years with near equal racial distribution between self-reported Black and White. Evidence of ectopic rupture was present in 22.9% of cases on presentation, and 14.4% had evidence of hemodynamic instability. A heartbeat was detected 9.1% of the time, which per current American College of Obstetricians and Gynecologists (ACOG) recommendation is a relative contraindication for treatment with methotrexate.[1] Subjects receiving single-dose methotrexate treatment had a failure rate of 14.7%. Subjects who received multi-dose methotrexate (generally because they did not meet ACOG requirements for single-dose methotrexate treatment) had a failure rate of 36.9%. The β-hCG levels for both ruptured and non-ruptured ectopic pregnancies were similar.

Table. Age of patient in years, reported race, rate of ectopic rupture at presentation, unstable at presentation (heart rate >100 bpm, systolic blood pressure <90 mmHg, or documentation of instability), rate of methotrexate failure after treatment, rate of live ectopic at presentation, β-hCG levels for visualized ectopic, β-hCG levels for ruptured vs non-ruptured ectopic, and greatest diameter of visualized ectopic.

Variable assessed	Findings
Age (Years)	29.39 (SD 4.42)
Race (May include more than one)	
White	51.8%
Black	40.8%
Asian	3.6%
American Indian/Native American	0.6%
No response	2.7%
Ruptured at presentation	22.9%
Unstable at presentation	14.4%
Methotrexate failure rate	
Single dose	14.7%
Multi dose	36.9%
Live ectopic at presentation	9.1%
β-hCG levels (mIU/mL)	
Ruptured	7,005 (SD 8,949)
Non-ruptured	7,609 (SD 8,773)
T-test	$P = 0.51$
β-hCG for visualized ectopic pregnancy (mIU/mL; n = 456)	
Mean	4,964 (SD 12,217)
Median	1,209
Greatest diameter of visualized ectopic pregnancy (mm; n = 456)	
Mean	24 (SD 14.3)
Median	21

β-hCG, beta-human chorionic gonadotropin; *mIU/ML*, milli-international units per milliliter; *mm*, millimeter.

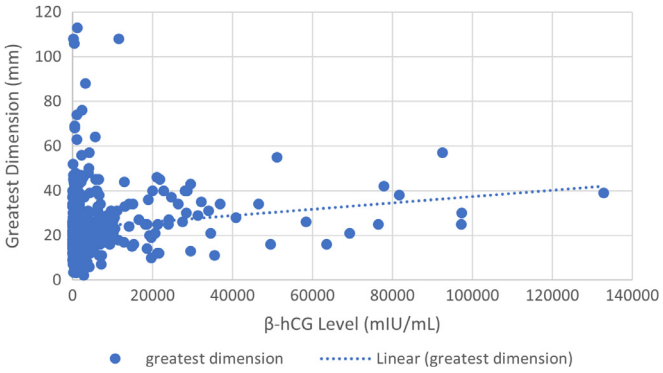

Figure. β-hCG level in relation to the greatest dimension of ectopic pregnancy (n = 456). Pearson correlation between β-hCG level and greatest dimension was r = 0.144 ($P < .001$), demonstrating a very weak correlation.
β-hCG, beta-human chorionic gonadotropin; *mm, millimeters; mIU/mL,* milli-international units per milliliter.

Greatest dimension of ectopic pregnancy (diameter in millimeters [mm]) was correlated with β-hCG level (milli-international units per milliliter [mIU/mL]) for each patient (Figure). We excluded from this analysis patients who did not have an extrauterine mass visualized on ultrasound as dimensions of ectopic size were unknown. Mean β-hCG for this group of 456 subjects was 4,964 mIU/mL (SD 12,217; 95% confidence interval [CI] 3,793–6.135), and median β-hCG was 1,209 mIU/mL; mean greatest diameter was 24 mm (SD 14.3; 95% CI 22.69–25.31) and median was 21 mm. The Pearson correlation coefficient (r-value) of this group was r = 0.144 ($P < .001$), indicating a very weak correlation between β-hCG level and greatest dimension of ectopic pregnancy. We also calculated the Pearson correlation for β-hCG compared to ectopic volume (in mm^3); the results were not statistically significant.

DISCUSSION

Nearly 25% of patients with an ectopic pregnancy in this study presented with evidence of rupture, and about 15% of patients presented with evidence of hemodynamic instability, both scenarios requiring emergent surgical treatment. The ectopic rupture rate seen in this study was greater than prior reported rates of 15%, although, interestingly, less than 10% of ruptured ectopic pregnancies in the study required a blood transfusion (data not shown), which is similar to previous published data of 8.7%.[7,8]

The majority of visualized ectopic pregnancies in the current study had β-hCG levels below the traditional 1,500 mIU/mL discriminatory zone, with the lowest β-hCG level in the study being 9 mIU/mL (which had sonographic evidence of an ectopic pregnancy). The β-hCG levels were similar between ruptured and non-ruptured ectopic pregnancies. Prior studies have also demonstrated low β-hCG levels in ectopic pregnancies, with levels as low as <10 mIU/mL documented.[9] While ectopic pregnancies typically have lower β-hCG levels compared to intrauterine pregnancies, the presence of very low β-hCG levels in documented ectopic pregnancy cases is striking.[9] One study found that 41% of ectopic pregnancies had a β-hCG level <2,000 mIU/mL at the time of diagnosis, and approximately 9% (18 of 204 cases) had a β-hCG level under 100 mIU/mL.[9] These findings combined with our results (50.4% of cases had a β-hCG <1,500 mIU/mL, and 8.5% had a level <100 mIU/mL) emphasize the need to consider and work up suspected ectopic pregnancies fully at the time of presentation, regardless of serum β-hCG level, to avoid missing the diagnosis of ectopic pregnancy. Thus, discriminatory cutoffs of β-hCG levels should not be a determining factor when ordering transvaginal ultrasonography to evaluate for ectopic pregnancy.[10]

We found a very weak correlation between β-hCG and size of ectopic pregnancy, when looking at greatest dimension, and no correlation of β-hCG to volume of ectopic pregnancy. These findings are in stark contrast to prior studies, where β-hCG levels and ectopic pregnancy volume were found to be strongly correlated.[9] Therefore, this study indicates that β-hCG levels may have less predictive value for estimating the size or volume of an ectopic pregnancy than previously thought, further strengthening the need for transvaginal ultrasound attainment regardless of β-hCG level.

Post-methotrexate failure or rupture is not uncommon; about 20% of patients in the current study ultimately required surgical management (higher than the 10.2% reported in previous studies).[11] This increased rate of post-methotrexate failure might be related to study location (tertiary-care center for obstetrical care), patient delay in seeking care, or higher rate of cases necessitating multiple-dose methotrexate treatment (due to treatment at a tertiary-care center), although any conclusion regarding these variables is difficult. Patients receiving methotrexate for ectopic pregnancy with complaints of new or worsening abdominal pain or increased vaginal bleeding should be evaluated for potential ectopic pregnancy rupture.

LIMITATIONS

The study took place at a single-site academic center, where the population of the ED could have been skewed due to location (urban), referral center status (tertiary care for obstetrical care), and higher acuity level of care compared to many hospitals. In addition, patient encounters took place between 2015–2017 using ACOG guidelines published in 2008; however, current ACOG guidelines (released in 2018) are similar to those used during the timeframe of patient care; thus, any potential effect on the data was negligible.[1,12]

CONCLUSION

In the setting of a positive pregnancy test, pelvic pain and/or vaginal bleeding should prompt a complete workup for ectopic pregnancy to include Rh status, hemoglobin, β-hCG level, and transvaginal pelvic ultrasound (regardless of β-hCG level). Clinicians must consider the ongoing risk of ectopic pregnancy rupture after methotrexate treatment. Finally, patients may be lost to follow-up and have an untreated ectopic pregnancy, which can lead to significant morbidity and/or mortality.

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Prevalence and Characteristics of Emergency Department Visits by Pregnant People: An Analysis of a National Emergency Department Sample (2010–2020)

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Introduction: The number and characteristics of pregnant patients presenting to the emergency department (ED) has not been well described. Our objective in this study was to determine the prevalence and characteristics of pregnant patients presenting to EDs in the US between 2010–2020.

Methods: We completed a retrospective, cross-sectional study of patient encounters at hospital-based EDs in the US from 2010–2020. Using the ED subsample of the National Hospital Ambulatory Medical Care Survey (NHAMCS) we identified ED visits for female patients aged 15–44 years. We defined a subsample of these as visits for pregnant patients using discharge diagnosis codes specific to pregnancy. We compared this population of pregnant patient visits to those for non-pregnant patients and computed point estimates for nationally weighted values. Multivariable linear regression was used to determine factors independently associated with pregnant patient visits.

Results: The 2010–2020 NHAMCS dataset included 255,963 ED visits. Of these visits 59,080 were for female patients 15–44 years old, and 6,068 of those visits were for pregnant patients. Pregnant patients accounted for 3% (95% confidence interval [CI] 2.7–3.2) of all ED visits and 8.6% (95% CI 8–9.3) of all visits among female patients 15–44 years. Weighting to a national sample, this equates to 2.77 million pregnant patients presenting for ED visits annually. Pregnant patients were more likely to be Black, Hispanic, or to use public insurance.

Conclusion: Pregnant patients make up a significant number of ED visits annually and are more likely to be people of color or publicly insured. Interventions to address the effects of changing abortion legislation on emergency medicine practice may benefit from consideration that certain populations of pregnant people are more likely to present to the ED for care. [West J Emerg Med. 2024;25(3)436–443.]

INTRODUCTION

Background

In June 2022, the US Supreme Court ruled on *Dobbs v Jackson Women's Health Organization* and determined that there is no constitutional right to abortion, allowing individual states to legislate abortion restrictions.[1] This decision has multiple anticipated implications for emergency clinicians, including an increase in pregnant patients presenting to the emergency department (ED) as a result of barriers to care, complications of self-managed abortions, or delayed presentation of emergent diagnosis due to fear of legal repercussions.[2]

Importance

Use of the ED is high among pregnant patients, with studies showing that approximately 35% of these patients

will visit the ED at least once during their pregnancy.[3,4] These patients are more likely to be of racial and ethnic minorities, publicly insured, and have barriers to prenatal care access.[3,5,6] Less is known, however, about the total population of pregnant patients who present to the ED. A secondary analysis of the 2006–2016 National Hospital Ambulatory Medical Care Survey (NHAMCS) identified that there were approximately 900,000 visits to the ED for early pregnancy loss, but the total population of pregnant patients was not described.[5]

Older cohort studies disagree on the pregnancy rate among reproductive-capable female patients, reporting values ranging from 2.3–33%.[7–9] These studies report that many pregnancies are first identified in the ED, but the rate of incidental pregnancy in more recent years and how often these patients are provided with counseling has not been described.[10] In fact, before the repeal of *Roe v Wade* there was an identified need for further emergency physician training in patient-centered reproductive healthcare.[5,10] With increased legal restrictions, the need for emergency medicine policy and physician education has never been greater.[2,11] To do this successfully, we must have a better understanding of the population that will be affected by these changes: pregnant people. This has not been recently reported in the literature, which led us to undertake this study.

Goals of this Investigation

The primary objective of our study was to identify the prevalence of and characterize pregnant patients presenting to US EDs between 2010–2020.

METHODS

Study Design and Data Source

We completed a retrospective, cross-sectional study of patient encounters at hospital-based EDs in the US from 2010–2020. This period was selected as 2010 saw the passage of the Affordable Care Act, which had many effects for expanding healthcare and contraceptive coverage for women.[12] Data was from the publicly available ED subsample of the NHAMCS.[13] The NHAMCS is a survey conducted annually by the National Center for Health Statistics (NCHS), a part of the US Centers for Disease Control and Prevention (CDC).[14]

The NHAMCS uses a three-stage probability sampling design in an effort to provide a representative sample of all EDs in the country.[14] First, 112 geographic probability sampling units, determined by various counties, towns, and cities are chosen. These are selected to be representative of different geographical regions and urban and rural areas. Within these sampling units, 450–500 short-stay hospitals (average length of stay fewer than 30 days) are sampled to ensure a diversity of hospital size and type. Finally, EDs that provide unscheduled care 24 hours a day/7 days a week at these sampled hospitals are selected for inclusion. Each included ED has visit data recorded over a randomly assigned 4-week period. During this period, data from selected visits is abstracted from the chart and entered into an electronic form by trained census takers.

Further description of the NHAMCS survey is available on the NCHS website.[14] The NHAMCS produces a dataset that reflects a broad spectrum of ED visits. Using the survey's sampling design, each data entry is assigned a weight to account for the relative contribution of that entry to the larger sample. As a result, each data point in the dataset represents a varying number of actual visits, depending on its assigned weight.

Study Population

To determine our study population, we identified the total ED visits for NHAMCS between 2010–2020 for all patients. Visits were selected for women of reproductive age, defined by the CDC as being between ages 15–44 years.[15] We acknowledge that research surrounding pregnancy often assumes cisgender identities, which may not describe people who are transgender or non-binary. We attempted to use language that is as inclusive; however, the data analyzed in this study uses gender labels that cannot be changed while remaining accurate to the source material.

Definition of Pregnancy

We defined visits for pregnant patients within our cohort as those visits that had an International Classification of Diseases Revisions 9 or 10 (ICD-9 and -10) diagnosis code specific to pregnancy as one of the discharge diagnoses (eg, ectopic pregnancy; excessive vomiting in pregnancy; pregnant state, incidental). Specific diagnosis codes used for patient identification are listed in Appendix 1. These were initially filtered by SPSS Statistics v27 (IBM Corporation, Armonk, NY) and were then hand-verified by one study author (CP). We excluded encounters without ICD diagnosis codes or coded only as "elopement" or "left without being seen."

Pregnancy Identified in the Emergency Department

As this has important implications for emergency clinicians, a secondary goal of our analysis was to identify an estimate of the incidence of new pregnancy diagnosis in the ED—that is, visits where patients were first identified as pregnant during their ED visit. We defined a subset of pregnant patient visits as "incidental pregnancy" through ED reason-for-visit (RFV) codes and whether pregnancy was tested for in the ED. The RFV codes include the chief complaint, as well as other symptoms or medical problems related to the ED visit.[16] We examined RFV codes and excluded patient visits with codes that suggested a previous diagnosis of pregnancy (eg, 1790.0 Problems and other conditions related to pregnancy; 2735.0 Diagnosed

complications of pregnancy and puerperium). With the goal of obtaining a conservative estimate, we also excluded patient visits with RFV codes for vaginal bleeding. Patient visits from this group that had a pregnancy test sent in the ED made up our "incidental pregnancy" population. To obtain evidence of construct validity, we examined the ICD-9 and ICD-10 discharge codes for the "incidental pregnancy" population to ensure they were consistent with a new pregnancy diagnosis.

Characteristics of ED Visits

Available demographics included patient age; race/ethnicity (non-Hispanic Black, non-Hispanic White, Hispanic, and other); payment/insurance status (private insurance, public insurance [Medicare, Medicaid or other state-based program], self-pay, and other or unknown insurance); and residence (private, unhoused, or other).

Visit characteristics included day of the week the visit took place (weekend or weekday), season (Fall, Winter, Spring, or Summer), and year of visit. Visit characteristics also included hospital admission, whether a pregnancy test was sent, use of ultrasound, consultation, length of visit, wait time to see a clinician, and return visit within 72 hours. Pregnancy test, ultrasound use, hospital admission, consultation, and return visit within 72 hours were dichotomous variables, and return visit referred to whether the patient was seen in the same ED in the prior 72 hours for any reason. We defined wait time as the time from arrival to first clinician contact, and length of visit was defined as the time from arrival to discharge. We analyzed both values as continuous variables.

Hospital-level characteristics included geographic region (Midwest, Northeast, South, and West) and metropolitan statistical area, reflecting an urban vs rural location as defined by the US Office of Management and Budget.

Data Analysis

We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.[17] We descriptively analyzed ED visits for pregnant patients and determined the proportion of ED visits for pregnant patients among all ED visits (for women and men) as well as among women 15–44 years old. Demographic, visit, and hospital characteristics of presentations of pregnant patients among women of reproductive age were similarly analyzed. We compared the characteristics of visits for pregnant reproductive-aged women to those for non-pregnant reproductive-aged women using chi-squared tests for categorical factors and two-sample *t*-test for continuous variables. Statistical significance was set at $P < 0.01$ as recommended by NHAMCS documentation.[13]

We compared characteristics of visits for pregnant patients to non-pregnant patients using multivariable logistic regression. We examined unadjusted associations and then used multivariable logistic regression models to determine factors independently associated with visits for pregnant patients. Models generated odds ratios (OR) and 95% confidence intervals (CI). Statistical calculations were completed with SAS OnDemand for Academics (SAS, Inc, Cary, NC).

Weighted results representative of all ED visits rounded to the nearest thousand in the US were presented for analysis unless otherwise stated, as recommended by NHAMCS.[13,18] Based on best practices for the use of NHAMCS data in research, we ensured that all reported estimates were based on >30 unweighted records, had a relative standard error of <30%, and did not include any items with a non-response rate >30% in our analysis.[14,18] The NHAMCS imputes data for missing values in age, gender, race, and ethnicity using a model-based single, sequential regression method.[13] Race and ethnicity had the highest average proportion of missing values in our dataset (17% and 21%, respectively); therefore, we performed a sensitivity analysis to ensure result durability.

Ethics

Data from the NHAMCS are de-identified and publicly available. Use of this data for research purposes has been reviewed and approved by the National Center for Health Statistics Ethics Review Board (Protocol #2021-03).

RESULTS

The 2010–2020 NHAMCS dataset included 255,963 visits (weighted n = 1,502,215,000, 95% CI 1,342,435,000–1,661,995,000), including 59,080 visits among women ages 15–44 (weighted n = 353,012,000, 95% CI 310,947,000–395,078,000). A total of 6,068 of these visits were for pregnant patients (weighted n = 30,489,000, 95% CI 26,117,000–34,861,000). Pregnant patient visits accounted for 3.0% (95% CI 2.7–3.2) of all ED visits. This equates to 2.77 million pregnant patients presenting for ED visits annually. Limiting the population to women ages 15–44 years, pregnant patient visits accounted for 8.6% (95% CI 8–9.3) of all ED visits.

Incidental pregnancy was identified in 672 patient visits (weighted n = 4,056,000, 95% CI 3,323,000–4,789,000). Incidental pregnancy visits accounted for 13.3% (95% CI 12.7–13.7) of all pregnant ED visits. Annually, this equates to 368,000 (95% CI 352,000–379,000) visits where pregnancy is diagnosed in the ED. The majority (52%) of the ICD-9 and −10 codes for these visits were for pregnancy-related complaints (eg, hyperemesis gravidarum, infection of the genital tract in pregnancy), and the remainder were diagnoses of pregnancy (eg, encounter for supervision of normal first pregnancy, pregnant state, incidental), aligning with our assumption that these visits represented new pregnancy diagnoses.

Study Population Characteristics

The median age of women presenting with pregnancy was 25 years (interquartile range 21–30 years), with over half (57.9%) between the ages of 20–29 years (Table 1). Visits for pregnant patients were more likely to be for Black (31.6% vs 26.3% for non-pregnant women) and Hispanic (22.0% vs 15.5%) women. Pregnant patient visits were more likely to use public insurance than non-pregnant visits.

Emergency Department Visit Characteristics

There were no significant differences in presentation of pregnant patients between weekdays and weekends or across seasons. The number of pregnant patients presenting to the ED did not significantly vary across years, even when normalized to total patients in our population. Regional distribution of pregnant patient visits did not differ. Pregnant patients were more likely to present to a hospital in an urban area (89% vs 84.7%, $P < 0.001$). Only 44.8% of patient visits included a pregnancy test, and 44% included an ultrasound; 17.5% of pregnant patient visits included a pelvic exam. Seven percent of pregnant patient visits resulted in hospitalization vs 4.7% of non-pregnant patient visits ($P < 0.001$); and 11.5% of pregnant patient visits included evaluation by a consulting physician.

There was no significant difference in wait time between pregnant vs non-pregnant patient visits. The ED visits generally lasted longer for pregnant patients (33.6% over four hours vs 24.5%, $P < 0.001$). Most (84.4%) patients were seen by an attending physician, without meaningful differences between groups that were seen by other clinicians.

Table 1. Characteristics of female patients aged 15–44 years old presenting to the emergency department for care, 2010–2020, weighted and stratified by pregnancy status.

	Pregnant (n = 30,489,000)	Non-pregnant (n = 322,524,000)	*P*-value
Patient characteristics			
Age	25 (21–30)	28 (22–36)	<0.001
Age			<0.001
15–19 years	4,185,000 (13.7)	47,282,000 (14.7)	
20–29 years	17,640,000 (57.9)	124,098,000 (38.5)	
30–39 years	7,802,000 (25.6)	103,558,000 (32.1)	
40–44 years	862,000 (2.8)	47,586,000 (14.8)	
Race/ethnicity			<0.001
Non-Hispanic White	13,199,000 (43.3)	178,581,000 (55.4)	
Non-Hispanic Black	9,642,000 (31.6)	84,808,000 (26.3)	
Hispanic	6,695,000 (22.0)	49,863,000 (15.5)	
Non-Hispanic Other	952,000 (3.1)	9,271,000 (2.9)	
Payment source			<0.001
Private insurance	8,039,000 (26.4)	96,150,000 (29.8)	
Public insurance	15,197,000 (49.8)	133,820,000 (41.5)	
Self-pay	3,289,000 (10.8)	46,446,000 (14.4)	
Other	1,164,000 (3.8)	13,203,000 (4.1)	
Unknown	2,800,000 (9.2)	32,905,000 (10.2)	
Residence			0.21
Private residence	29,464,000 (96.6)	309,823,000 (96.1)	
Homeless	76,000 (0.2)	1,556,000 (0.5)	
Other	226,000 (0.7)	3,517,000 (1.1)	
Unknown	723,000 (2.4)	7,628,000 (2.4)	
Visit characteristics			
ED visit day			0.86
Weekend	8,087,000 (26.5)	86,105,000 (26.7)	
Weekday	22,403,000 (73.5)	236,419,000 (73.3)	

(*Continued on next page*)

Table 1. Continued.

	Pregnant (n = 30,489,000)	Non-pregnant (n = 322,524,000)	*P*-value
ED visit season			0.44
Fall	7,503,000 (24.6)	85,173,000 (26.4)	
Winter	7,735,000 (25.4)	77,058,000 (23.9)	
Spring	7,536,000 (24.7)	81,156,000 (25.2)	
Summer	7,715,000 (25.3)	79,136,000 (24.5)	
Year			<0.001
2010	2,453,000 (8.0)	17,134,000 (5.3)	
2011	2,716,000 (8.9)	32,089,000 (9.9)	
2012	2,363,000 (7.8)	30,316,000 (9.4)	
2013	2,362,000 (7.7)	30,350,000 (9.4)	
2014	2,570,000 (8.4)	32,656,000 (10.1)	
2015	3,028,000 (9.9)	31,333,000 (9.7)	
2016	3,073,000 (10.1)	31,538,000 (9.8)	
2017	2,902,000 (9.5)	30,809,000 (9.6)	
2018	2,710,000 (8.9)	27,058,000 (8.4)	
2019	3,558,000 (11.7)	31,182,000 (9.7)	
2020	2,743,000 (9.0)	28,059,000 (8.7)	
Hospital admittance	2,147,000 (7.0)	15,048,000 (4.7)	<0.001
Pregnancy test	13,665,000 (44.8)	87,455,000 (27.1)	<0.001
Ultrasound	13,423,000 (44.0)	18,889,000 (5.9)	<0.001
72-hour revisit	1,293,000 (4.2)	12,776,000 (4.0)	0.03
Seen by consultant	3,498,000 (11.5)	19,499,000 (6.0)	<0.001
Length of visit			<0.001
<1 hr	1,769,000 (7.6)	29,062,000 (11.8)	
1–2 hr	3,221,000 (13.9)	64,011,000 (26)	
2–4 hr	10,413,000 (44.9)	93,180,000 (37.8)	
>4 hr	7,789,000 (33.6)	60,415,0000 (24.5)	
Wait time			0.20
<30 min	15,538,000 (59.5)	172,983,000 (61.6)	
30 min-1 hr	4,830,000 (18.5)	50,720,000 (18.1)	
1–2 hr	3,475,000 (13.3)	35,543,000 (12.7)	
>2 hr	2,280,000 (8.7)	21,565,000 (7.7)	
Hospital characteristics			
Geographic region			0.38
Northeast	4,241,000 (13.9)	51,007,000 (15.8)	
Midwest	7,302,000 (23.9)	73,129,000 (22.7)	
South	12,631,000 (41.4)	130,591,000 (40.5)	
West	6,315,000 (20.7)	67,797,000 (21.0)	
Metropolitan statistical area (MSA)			<0.001
MSA	25,040,000 (89.0)	247,480,000 (84.7)	
Non-MSA	3,085,000 (11.0)	44,727,000 (15.3)	

Data are n (%), median (interquartile range).
ED, emergency department.

Multivariable Analysis

Unadjusted and adjusted ORs for associations of patient demographics and hospital characteristics with presentation of pregnant patients compared to non-pregnant patients to the ED are presented in Table 2. In the generated model, age 20–29 years, Hispanic ethnicity, public insurance status, and metropolitan location were significantly associated with visits for pregnant patients. These results held through sensitivity analyses to ensure that imputation in the dataset did not affect our findings.

Table 2. Bivariable and multivariable logistic regression models.

	Unadjusted OR	*P*-value	Adjusted OR	*P*-value
Age				
15–19 years	Reference		Reference	
20–29 years	1.61 (1.41–1.83)	<0.001	1.71 (1.48–1.97)	<0.001
30–39 years	0.85 (0.73–0.99)	<0.001	0.91 (0.77–1.07)	<0.001
40–44 years	0.21 (0.16–0.26)	<0.001	0.22 (0.17–0.29)	<0.001
Race/ethnicity				
Non-Hispanic White	Reference		Reference	
Non-Hispanic Black	1.54 (1.35–1.75)	0.07	1.32 (1.15–1.51)	0.74
Hispanic	1.82 (1.60–2.06)	<0.001	1.72 (1.50–1.98)	<0.001
Non-Hispanic Other	1.39 (1.11–1.74)	0.90	1.43 (1.13–1.81)	0.45
Payment source				
Private insurance	Reference		Reference	
Public insurance	1.36 (1.21–1.52)	<0.001	1.24 (1.10–1.39)	<0.001
Self-pay	0.85 (0.73–0.99)	<0.001	0.74 (0.63–0.87)	<0.001
Other	1.05 (0.86–1.29)	0.89	0.90 (0.74–1.08)	0.53
Unknown	1.02 (0.85–1.23)	0.73	0.91 (0.75–1.10)	0.64
Residence				
Private residence	Reference		Reference	
Homeless	0.51 (0.27–0.99)	0.13	0.60 (0.31–1.18)	0.21
Other	0.68 (0.39–1.17)	0.60	0.77 (0.44–1.35)	0.71
Unknown	1.00 (0.71–1.39)	0.12	1.10 (0.74–1.65)	0.17
ED visit day				
Weekend	0.99 (0.90–1.09)	0.86	0.97 (0.88–1.08)	0.60
Weekday	Reference		Reference	
ED visit season				
Fall	Reference		Reference	
Winter	1.14 (0.96–1.36)	0.29	1.14 (0.95–1.38)	0.33
Spring	1.05 (0.88–1.26)	0.72	1.04 (0.87–1.25)	0.52
Summer	1.11 (0.94–1.31)	0.50	1.14 (0.95–1.38)	0.25
Geographic region				
Northeast	Reference		Reference	
Midwest	1.20 (1.01–1.43)	0.21	1.28 (1.09–1.52)	0.02
South	1.16 (0.95–1.42)	0.55	1.26 (1.04–1.52)	0.09
West	1.12 (0.95–1.32)	0.98	1.03 (0.86–1.22)	0.09
Metropolitan statistical area (MSA)				
MSA	1.47 (1.22–1.76)	<0.001	1.41 (1.18–1.67)	<0.001
Non-MSA	Reference		Reference	

OR, odds ratio; *ED*, emergency department.

DISCUSSION

In this study, using data available from NHAMCS, we estimated that there are 2.77 million ED visits for pregnant patients annually in the United States. Most commonly, women presenting to the ED with pregnancy are between the ages of 20–29 years, publicly insured, and identify as Black or Hispanic. Of these pregnant patient visits, we estimate that 13.3% of these resulted in a new diagnosis of pregnancy in the ED, equivalent to approximately 370,000 pregnancies first identified in the ED annually.

We found that 8.6% of visits among women between ages 15–44 years were for pregnant patients, which generally aligns with previously reported values; however, there was a large amount of variability in reported figures.[7–9] Benson et al performing a similar evaluation for patients presenting for early pregnancy loss reported approximately 900,000 visits annually, which would represent 32% of the 2.77 million pregnant patient visits we describe.[5] This is higher than the often reported rate of 20% early pregnancy loss, which we suspect is due to early pregnancy loss being a common reason for ED presentation.[19]

Our data shows that pregnant patients seeking care in the ED are more likely to be Black, Hispanic. or publicly insured. These populations are less likely to receive routine prenatal care and have a higher rates of pregnancy-related morbidity and mortality when compared to White patients.[20] Furthermore, unintended pregnancy rates are higher and the rate of referral for desired family planning services is lower in these patient groups.[21–23] Currently more than one half of abortions are among women of color despite these patients experiencing greater barriers to accessing family planning services.[24] Patients on Medicaid similarly have challenges accessing abortion care due to limited coverage for these services.[24] The *Dobbs* decision is likely to exacerbate these disparities and may disproportionately affect pregnant patients presenting to the ED.[24] Future studies should investigate these impacts as legislation changes and examine how ED presentations and care differ between states that enact restrictive abortion legislation compare to states without restriction.

Our results suggest that a large proportion (13.3%) of pregnant patients who seek care in the ED are first diagnosed during their ED encounter. Based on historical data, half of these pregnancies are unplanned, and half would end in abortion in the pre-*Dobbs* era.[21] Discovery of these pregnancies in the ED offers an opportunity for counseling and referral to available abortion services if desired. This is especially important in states where strict restrictions on gestational age for legal abortion exist. These patients may face barriers to care and delays in care following ED discharge, suggesting a critical need for counseling and linkage to care during the ED encounter.

Nationwide access to these reproductive healthcare services is supported by the American College of Emergency Physicians. Although the ED is taking a larger role in offering this care, further research is required to identify the needs of this population.[25,26] Specifically, future studies could directly measure the rate of new pregnancy diagnosis in the ED, determine counseling practices among emergency clinicians, and examine how these patients are linked to care if a pregnancy is undesired. This data, along with comparisons between states with varying degrees of legislation change, could help inform policy changes.

LIMITATIONS

Results are based on data from the NHAMCS, which has several, well-reported limitations.[18] Although the NHAMCS makes great efforts to include a representative sample, it is possible that the included visits are not completely representative of ED visits nationwide. Nevertheless, the NHAMCS is the largest dataset to date with population-based estimates of ED visits in the US. Non-response rate for items in the NHAMCS may also bias results; however, all our variables of interest had non-response rates that fell within acceptable margins, and those with higher non-response rates (race and ethnicity) were evaluated with sensitivity testing to ensure imputed values did not compromise results.

We defined visits with pregnant patients in our population by pregnancy-related ICD-9 and -10 diagnoses, which may have been entered in error for non-pregnant patients. Visits with an incidental pregnancy diagnosis were based on triage data and pregnancy testing, which may have misclassified pregnancies as incidental or failed to identify other incidental pregnancies not captured. To obtain a conservative estimate, we excluded patient presentations for vaginal bleeding, which may have raised clinician or patient suspicion of pregnancy. Due to the nature of the dataset we analyzed, we were not able to provide definitive information about completion of a previous pregnancy test or ultrasound, nor about the patient's suspicion for pregnancy, which would be preferred markers for identifying new pregnancy diagnoses.

Finally, we were unable to provide information about whether these pregnancies were desired, whether patients had established care with an obstetrician, or the outcomes of these pregnancies.

CONCLUSION

Our study reveals that pregnant patients make up 3% of ED visits annually. Given recent legislative changes concerning reproductive healthcare, these patients could be significantly impacted. The ED, often seen as the healthcare system's safety net, provides crucial care that might not be available elsewhere. With the possibility of pregnant patients turning more often to the ED for care, there is an urgent need to develop and implement educational and policy strategies that support these patients in navigating the increasingly complex realm of family planning services.

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