WestJEM

Volume 25, Number 2, March 2024 Open Access at WestJEM.com ISSN 1936-900X

Western Journal of Emergency Medicine:

Integrating Emergency Care with Population Health

Indexed in MEDLINE

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CALIFORNIA CHAPTER DIVISION OF THE AMERICAN ACADEMY OF EMERGENCY MEDICINE

A Peer-Reviewed, International Professional Journal

VOLUME 25, NUMBER 2, March 2024

PAGES 144-302

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Western Journal of *Emergency Medicine*:

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

Available in MEDLINE, PubMed, PubMed Central, CINAHL, SCOPUS, Google Scholar, eScholarship, Melvyl, DOAJ, EBSCO, EMBASE, Medscape, HINARI, and MDLinx Emergency Med. Members of OASPA.

Editorial and Publishing Office: *West*JEM/Depatment of Emergency Medicine, UC Irvine Health, 3800 W. Chapman Ave. Suite 3200, Orange, CA 92868, USA
Office: 1-714-456-6389; Email: Editor@westjem.org

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Editorial and Publishing Office: *West*JEM/Depatment of Emergency Medicine, UC Irvine Health, 3800 W. Chapman Ave. Suite 3200, Orange, CA 92868, USA
Office: 1-714-456-6389; Email: Editor@westjem.org

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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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Characteristics for Low, High and Very High Emergency Department Use for Mental Health Diagnoses from Health Records and Structured Interviews

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Section Editors: Brad Bobrin, MD, and Yanina Purim-Shem-Tov, MD, MS
Submission history: Submitted May 24, 2023; Revision received November 17, 2023; Accepted November 22, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18327

Introduction: Patients with mental health diagnoses (MHD) are among the most frequent emergency department (ED) users, suggesting the importance of identifying additional factors associated with their ED use frequency. In this study we assessed various patient sociodemographic and clinical characteristics, and service use associated with low ED users (1–3 visits/year), compared to high (4–7) and very high (8+) ED users with MHD.

Methods: Our study was conducted in four large Quebec (Canada) ED networks. A total of 299 patients with MHD were randomly recruited from these ED in 2021–2022. Structured interviews complemented data from network health records, providing extensive data on participant profiles and their quality of care. We used multivariable multinomial logistic regression to compare low ED use to high and very high ED use.

Results: Over a 12-month period, 39% of patients were low ED users, 37% high, and 24% very high ED users. Compared with low ED users, those at greater probability for high or very high ED use exhibited more violent/disturbed behaviors or social problems, chronic physical illnesses, and barriers to unmet needs. Patients previously hospitalized 1–2 times had lower risk of high or very high ED use than those not previously hospitalized. Compared with low ED users, high and very high ED users showed higher prevalence of personality disorders and suicidal behaviors, respectively. Women had greater probability of high ED use than men. Patients living in rental housing had greater probability of being very high ED users than those living in private housing. Using at least 5+ primary care services and being recurrent ED users two years prior to the last year of ED use had increased probability of very high ED use.

Conclusion: Frequency of ED use was associated with complex issues and higher perceived barriers to unmet needs among patients. Very high ED users had more severe recurrent conditions, such as isolation and suicidal behaviors, despite using more primary care services. Results suggested substantial reduction of barriers to care and improvement on both access and continuity of care for these vulnerable patients, integrating crisis resolution and supported housing services. Limited hospitalizations may sometimes be indicated, protecting against ED use. [West J Emerg Med. 2024;25(2)144–154.]

Keywords: *emergency department; frequency of emergency department visits; low service users; high service users; very high service users; mental health diagnoses; probability factors; associated variables.*

INTRODUCTION

Emergency department (ED) crowding is a major impediment to the efficacy of healthcare systems,[1] caused in part by a minority of patients who use the ED frequently.[2] According to a 2019 systematic review, the estimated prevalence of high ED users was 4-16%, yet these patients accounted for 14–47% of all ED visits, averaging 6.9 ED visits per year.[3] High ED users, commonly defined as having 4+ ED visits in a 12-month period,[4,5] are more likely than other patients to be hospitalized frequently[6] and have 2.2 times greater probability of death than other ED users according to a 2015 systematic review.[7] Mental health diagnoses (MHD), including substance-related disorders (SRD), are very prevalent among high ED users.[1,4,8] Another 2013 review reported that between 0.3–18% of patients with MHD were frequent ED users.[8] A 2019 Canadian study showed that Quebec patients with MHD had used the ED roughly twice as often as patients without MHD, and 17% of these patients were high ED users in 2015-16.[9] As the ED is not an appropriate setting for treating recurrent patients with MHD, the identification of high ED users and their characteristics is key to improving care among these vulnerable patients and for reducing crowding and healthcare costs in the ED, given that ED use is one of the costliest components of healthcare.[10]

Several studies have assessed patient characteristics associated with high ED use among patients with MHD, most comparing high ED users vs other ED users.[11–17] The sociodemographic characteristics distinguishing high ED users from other ED users included being male,[15] younger,[14] single,[16] having public health insurance,[11,12] and living in more socially or materially deprived[15,18] or metropolitan[15] areas. Personality disorders,[11,13,15,16] serious MHD[15,17] or SRD,[5,17] and having chronic physical illnesses[12] were the main clinical characteristics associated with high ED use. High ED users also differed from other ED users in terms of higher overall use of mental health services.[15,19,20] To our knowledge, few studies have compared subgroups of low, high, and very high ED users among patients.[1,21] Those studies have focused on MHD to explain the frequency of ED use, including patients with multiple conditions and with SRD, as the main factor leading to increased use. Very high ED users also reported more recurrent ED use in previous years.[22] Yet, how the frequency of ED use was categorized differed greatly among these studies: "very high ED use" could be anywhere between 8+[1] and 18+ visits/year.[21]

A better understanding of patient characteristics associated with low, high, and very high ED users may help tailor interventions and programs to ED profiles and reduce ED use, particularly for high and very high users. We found no previous research comparing low ED users to high and very high users among patients with MHD or SRD. Also, most studies were based solely on single-site hospital health records. Our study is original in that it integrates patient structured interviews with health records from four large mental health networks that include hospitals and community-based services. Very few studies on ED use integrate overall outpatient service use, from primary to specialized care, and assess how these services relate to patient ED use frequency.[22] Moreover, few studies have tested associations between ED use frequency and quality of outpatient care or motivational behaviors, such as satisfaction with care, unmet needs or perceived stigma that may trigger ED use.

Based on the literature, we hypothesized that very high ED users, followed by high ED users, would be more likely than low ED users to have complex health and social issues and unmet needs, and to use outpatient care more frequently. We assessed various patient sociodemographic and clinical characteristics, and service use patterns associated with low ED users with MHD (1–3 visits/year), compared with high ED users (4–7 visits) and very high ED users (8+ visits) in four large ED networks in Quebec (Canada).

Population Health Research Capsule

What do we already know about this issue?
Emergency department (ED) crowding is a major impediment to the efficacy of healthcare systems, caused in part by a minority of patients who use the ED frequently.

What was the research question?
We sought to assess patients' characteristics and service use patterns associated with low, high and very high ED users.

What was the major finding of the study?
Violent/disturbed behaviors or social problems increased 5.55 times the probability of very high ED use.

How does this improve population health?
A reduction of barriers to care and better access and continuity of outpatient care should be provided for the most vulnerable patients.

METHODS

Description of the Quebec Mental Health System

In Canada, all residents are covered by a universal health insurance managed at the provincial level.[23] Mental health

services, including medication, are mainly public, except services such as psychological services, which are usually paid by the user or covered by some employers. Quebec public healthcare services are mainly managed through 22 large networks, integrating hospitals, long-term and addiction facilities, and community healthcare centers.[24] In these networks, specialized mental healthcare is provided in psychiatric departments of general hospitals or in psychiatric hospitals, or in specialized addiction treatment centers.[25] Hospital ED staff include specialized or general emergency physicians, psychiatrists, and psychosocial clinicians—mostly nurses and some social workers and addiction specialists. Primary mental healthcare is offered in medical clinics staffed by general practitioners, in community healthcare centers mainly providing psychosocial services, and by psychologists mostly working in private practice. Community-based organizations, the voluntary sector, integrate crisis and suicide prevention centers, detox centers, and peer support groups.

Study Settings and Data Collection

The study was conducted in four ED networks serving about two million people—roughly one-fourth of Quebec's population. Study participants had to be ED users, 18+ years old, able to complete a structured interview, know French or English, and had to grant the research team access to their health records. Study participants were recruited randomly by ED staff based on a health record list of 1,751 ED users who had MHD, including SRD, and had used the ED at least once within the four ED networks in the 12 months preceding recruitment. Of the first 563 eligible patients reached, 450 (80%) agreed to be referred to the research team for consideration as study participants. They were then contacted by the research coordinator and asked to take part in a structured telephone interview, done by trained interviewers closely monitored by the research team.

These interviews were administered between March 1, 2021–May 13, 2022. Average completion time was 45 minutes. Health records for the 12 months prior to interviews were collected to complement interview data, except for previous ED use, which was measured within the two years prior to the last year of ED use. Health records data concerned ED use (Banque de données communes des urgences [BDCU] database), psychiatric outpatient services used, hospitalization (MED-ÉCHO database), and psychosocial services from community healthcare centers (I-CLSC database). Patient diagnoses were included in BDCU and MED-ÉCHO, and framed by the International Classification of Diseases, Canada, 10th Rev (Appendix). All health records included information on patient service use (eg, type, frequency) but exclusively within the ED network. Validated by a steering committee integrating clinicians, structured interview data considered service use outside ED networks and services not included in health records (eg, medical clinics, psychologists). These merged data allowed for a broad dataset on patient service use and other patient characteristics prior to recruitment. Participation in the study was voluntary. Patients who provided consent received a modest financial compensation. The multisite protocol was approved by the ethics review board of the Douglas Mental Health University Institute.

Study Variables

The dependent variable was ED use frequency for mental health reasons among patients with MHD, measured 12 months prior to interviews. Patients were categorized as low ED users (1–3 visits/year), high ED users (4–7 visits/year) or very high ED users (8+ visits/year). The standard definition of high ED use is 4+ times/year,[11,12,26] while very high use was defined as 8+ times/year based on previous[1,27] studies and on a minimal distribution of very high ED visits in the study sample. Independent variables were sociodemographic characteristics, clinical characteristics, and service use patterns, again based on previous research.[21,28]

Sociodemographic characteristics included the following: sex; age group; education level; civil status; employment status (eg, worker, unemployed); household income ($Can); type of housing (eg, supervised); number of significant social support network; and stigma. All except "age group" were determined by interview data. Based on the Canadian Community Health Survey (CCHS), social support was measured with the following question: "Do you have one or more people around you on whom you can rely for help with problems? If yes, how many people?" Also based on the CCHS, on a 5-point scale, with responses ranging from "totally disagree" to "totally agree" (greatest stigmatization), stigma was measured with the following affirmation: "Most people in my community treat a person with a MHD or SRD in the same manner as they would treat any other person."

Clinical characteristics included the following: MHD; SRD; suicidal behaviors (suicide ideation or attempt); violent/disturbed behaviors or social problems; chronic physical illnesses (eg, heart diseases, diabetes); co-occurring MHD-SRD; and high triage priority among ED users. All these variables were based on health records, except SRD, which was based on both health records and the structured interviews. The MHD included serious MHD (schizophrenia spectrum and other psychotic disorders, and bipolar disorders), personality disorders, and common MHD (anxiety, depressive and adjustment disorders; attention deficit/hyperactivity disorder). The SRD integrated alcohol- and drug-related disorders (use, induced, intoxication and withdrawal), measured using health records along with the Alcohol Use Disorders Identification Test[29] and the Drug Abuse Screening Test-20.[30] These were included in the structured interviews, as SRD are often underdiagnosed in health records.[31] We identified chronic physical illnesses and

their severity (0 to 2+) based on an adapted version integrating both the Charlson and Elixhauser comorbidity indexes.[32] The ED triage priority was based on the Canadian Triage Acuity Scale,[33] consisting of five priority levels or illness severity, with levels 4–5 considered treatable in outpatient care.[33] In this study, high triage priority ED use (1–3) was considered a proxy for functional disability, based on mean of number of ED visits per patient, with 1–3 triage priority divided by total of ED visits per patient (1–5).

Patient service use included the following: knowledge of mental health or addiction services; having a family doctor or other regular care clinician; frequency of primary care, community-based, and specialized outpatient services used; overall satisfaction with outpatient services used; number of barriers related to unmet needs; frequency of hospitalization, and frequency of previous ED use. Patient service use in the ED networks, mostly mental health specialized care and some primary care services (community healthcare centers), was based on health records, and services outside the ED networks were reported in the structured interviews—mostly primary care, community-based, or specialized addiction services. Service use measured with both types of data integrated only the highest frequency of service use patients reported. As a proxy of continuity of care, patients were asked if they were followed regularly by a family doctor or other clinicians. Based on a previous study,[34] the benchmark for frequent service use, or minimal intensity of optimal care, was 5+ follow-up appointments/year. Primary care included services received from family doctors, general practitioners in walk-in clinics, psychologists in private practice, and psychosocial clinicians in community healthcare centers.

Community-based organizations integrated crisis and suicide prevention centers, etc. Specialized outpatient care included psychiatric services (eg, treatment from psychiatrist teams, assertive community treatment, and intensive case management programs), and services from addiction treatment centers. Patients were asked to indicate on a 5-point scale their yearly satisfaction with each outpatient service received. We calculated the mean satisfaction score, with higher scores indicating greater satisfaction. Unmet needs were measured through the following CCHS question: "Could you explain the reasons why services outside of the ED did not respond to your needs?" including multiple choice of barriers to care (eg, "I prefer to manage by myself;" "The help is not readily available"). The number of barriers was counted as 0, 1–2, or 3+. Frequency of previous ED use included 4–7 (high ED users) and 8+ ED visits (very high ED users), measured for the two-year period preceding the 12-month interview period.

Analyses

Missing values (<1%) were imputed by mean for continuous variables and mode for categorical variables.[35] Descriptive analyses included percentages for categorical variables and mean values for continuous variables. We used bivariate multinomial logistic regression to examine the associations between each independent variable and the dependent variable, frequency of ED use. The intraclass correlation coefficient (ICC) for the study was small (<0.01), indicating low shared variance among patients from the ED networks; multilevel analysis was not required. Based on criterion procedures for forward model selection, independent variables identified as significant in the bivariate analyses (Alpha: 0.20)[36] were entered sequentially into the multivariable multinomial logistic regression model for frequency of ED use, with low ED use (1–3 visits/year) as the reference group. We used the Akaike Information Criterion (AIC)[37] to compare the relative goodness of fit among different models before selecting the final multivariate model with the smallest AIC that best fit the data. We also used variance inflation factor (VIF) to measure the amount of multicollinearity in regression analysis and found smaller than 4, indicating that multicollinearity was not a concern.[38] Relative risk ratios (RRR) and 95% confidence intervals (CI) were calculated in the final model. We performed statistical analyses using Stata 17 (StataCorp LLC, College Station, TX).

RESULTS

Of the 450 ED users referred, 50 could not be reached and 300 agreed to participate in the study (75% response rate). One patient was withdrawn. Of the 299 patients in the final sample, a majority (55%) were women; 39% were 30–49 years old, 82% single, and 57% unemployed or retired; 47% had a household income of less than CAN$20,000; 57% had post-secondary education, 58% lived in rental housing, and 50% perceived high stigma (Table 1). Over half (57%) had common MHD, 44% serious MHD, 42% personality disorders, 59% SRD, and 45% chronic physical illnesses; 38% had co-occurring MHD-SRD, 54% suicidal behaviors, and 17% violent/disturbed behaviors or social problems. In terms of ED use, 39% were low ED users (1–3 visits/year), 37% high ED users (4–7 visits/year), and 24% very high ED users (8+ visits/year) (Table 2). Nearly half (46%) had poor to fair knowledge of mental health or addiction services; 88% had a family doctor (74%) or other regular care clinician (58%). In the previous year, 58% had used 5+ primary care services, 26% 5+ services from community-based organizations, and 65% 5+ specialized outpatient care. Overall satisfaction with outpatient services averaged 4.02/5; 37% of participants had unmet needs, with 15% identifying 3+ barriers. A majority (56%) were hospitalized, 35% of those 1–2 times, and 39% had been very high ED users over the previous two-year period.

We compared variables associated with high or very high ED users with variables among low ED users (Table 3). Women had 1.30 times more probability of being high ED

Table 1. Sociodemographic and clinical characteristics of patients using the emergency department (N = 299).

Group		Low ED users (1–3 visits/year)		High ED users (4–7 visits/year)		Very high ED users (8+ visits/year)		Total		Bivariate analysis
Size (N)		117 n mean	39.13 % SD	109 n mean	36.45 % SD	73 n mean	24.41 % SD	299 n mean	100 % SD	*P*-value
Sociodemographic characteristics (measured in the previous 12 months)										
Women[1]		53	45.3	69	63.3	43	58.9	165	55.18	<0.20
Age[2]	18–29 years	30	25.64	36	33.03	26	35.62	92	30.77	<0.20
	30–49 years	48	41.03	41	37.61	28	38.36	117	39.13	
	50+ years	39	33.33	32	29.36	19	26.03	90	30.1	
Education level[1]	High school or less	48	41.03	50	45.87	32	43.84	130	43.48	≥0.2
	Post-secondary education	69	58.97	59	54.13	41	56.16	169	56.52	
Civil status[1]	Single (including separated, divorced, or widowed)	92	78.63	89	81.65	65	89.04	246	82.27	<0.20
	In couple	25	21.37	20	18.35	8	10.96	53	17.73	
Employment status[1]	Worker or student	58	49.57	41	37.61	31	42.47	130	43.48	≥0.20
	Unemployed or retired[3]	59	50.43	68	62.38	42	57.53	169	56.52	
Household income (Can$/year)[1]	0–$19,999	54	46.15	52	47.71	35	47.95	141	47.16	<0.20
	$20,000–$39,999	30	25.64	38	34.86	21	28.76	89	29.77	
	$40,000+	33	28.21	19	17.43	17	23.29	69	23.07	
Type of housing[1]	Private	28	23.93	25	22.94	7	9.59	60	20.07	<0.20
	Rental	63	53.85	63	57.8	47	64.38	173	57.86	
	Supervised[4]	26	22.22	21	19.27	19	26.03	66	22.07	
Number of significant social support network (mean/SD)[1]		3.52	3.19	3.61	5.08	3.63	5.40	3.58	4.51	≥0.20
Stigma[1]	High	56	47.86	56	51.38	37	50.68	149	49.83	≥0.20
	Medium	23	19.66	19	17.43	12	16.44	54	18.06	
	Low	38	32.48	34	31.19	24	32.88	96	32.11	
Clinical characteristics (measured in the previous 12 months)										
Serious mental health diagnoses (MHD)[2,5,6]		55	47.01	41	37.61	37	50.68	133	44.48	<0.20
Personality disorders[2,5,6]		31	26.50	52	47.71	44	60.27	127	42.47	<0.20
Common MHD[2,5,6]		61	52.14	64	58.72	44	60.27	169	56.52	≥0.20
Substance-related disorders[1,2,5,7,8]		62	52.99	65	59.63	48	65.75	175	58.53	<0.20
Suicidal behaviors (suicide ideation or attempt)[2,5]		44	37.61	63	57.80	54	73.97	161	53.85	<0.20
Violent/disturbed behaviors or social problems[2]		9	7.69	21	19.27	20	27.40	50	16.72	<0.20
Chronic physical illnesses[2,5]		38	32.48	48	44.04	50	68.49	136	45.48	<0.20
Severity of chronic physical illnesses[2,5]	0	93	79.49	72	66.06	30	41.1	195	65.22	<0.20
	1	15	12.82	18	16.51	27	36.99	60	20.07	
	2+	9	7.69	19	17.43	16	21.92	44	14.72	
Co-occurring MHD-SRD[1,2,5,7,8]		35	29.91	43	39.45	35	47.95	113	37.79	<0.20
Percentage of high priority in ED triage[2]	0–33%	19	16.24	20	18.35	9	12.33	48	16.05	≥0.20
	34%–66%	24	20.51	29	26.61	22	30.14	75	25.08	
	67%–100%	74	63.25	60	55.05	42	57.53	176	58.86	

[1]Patient structured interviews. [2]*Banque de données communes des urgences* (BDCU, ED database). [3]The sample was too small to separate unemployed from retired. [4]Supervised housing included group homes, residential care, supported apartments, etc. [5]*Maintenance et exploitation des données pour l'étude de la clientèle hospitalière* (MED-ÉCHO, hospitalization database). [6]Patients may have more than one MHD. [7]Alcohol Use Disorders Identification Test (AUDIT). [8]Drug Abuse Screening Test-20 (DAST-20). Details of diagnostic codes are presented in the Appendix.
ED, emergency department.

Table 2. Service use of patients using the emergency department (N=299).

Service use (measured in the previous 12 months, or other as specified)										
Group		Low ED users (1–3 visits/year)		High ED users (4–7 visits/year)		Very high ED users (8+ visits/year)		Total		Bivariate analysis
		117	39.13	109	36.45	73	24.41	299	100	
Size (N)		n mean	% SD	n mean	% SD	n mean	% SD	n mean	% SD	*P*-value
Very good to excellent knowledge of mental health or addiction services[1]		59	50.43	63	57.80	39	53.42	161	53.85	≥0.2
Having a family doctor or other regular care clinician[1–3]		102	87.18	96	88.07	66	90.41	264	88.29	<0.20
Frequency of primary care service use[1]	0	25	21.37	22	20.18	5	6.85	52	17.39	<0.20
	1–4	29	24.79	32	29.36	14	19.18	75	25.08	
	5+	63	53.85	55	50.46	54	73.97	172	57.53	
Frequency of service use of community-based organizations[1,3]	0	68	58.12	51	46.79	29	39.73	148	49.50	<0.20
	1–4	24	20.51	33	30.28	16	21.92	73	24.41	
	5+	25	21.37	25	22.94	28	38.36	78	26.09	
Frequency of specialized outpatient care use[1,4]	0	19	16.24	20	18.35	12	16.44	51	17.06	<0.20
	1–4	28	23.93	18	16.51	9	12.33	55	18.39	
	5+	70	59.83	71	65.14	52	71.23	193	64.55	
Overall satisfaction with outpatient services used (mean/SD)[1]		4.18	0.70	3.98	0.77	3.83	0.81	4.02	0.76	<0.20
Number of barriers related to unmet needs[1,5]	0	81	69.23	66	60.55	41	56.16	188	62.88	<0.20
	1–2	24	20.51	24	22.02	17	23.29	65	21.74	
	3+	12	10.26	19	17.43	15	20.55	46	15.38	
Frequency of hospitalizations[1,6]	0	54	46.15	47	43.12	30	41.1	131	43.81	<0.20
	1–2	50	42.74	37	33.94	18	24.66	105	35.12	
	3+	13	11.11	25	22.94	25	34.25	63	21.07	
Frequency of previous ED use (measured within the 2 years prior to the 12-month period in which interviews were conducted)[1,2]	0–3	45	38.46	37	33.94	14	19.18	96	32.11	<0.20
	4–7 (high ED users)	44	37.61	31	28.44	11	15.07	86	28.76	
	8+ (very high ED users)	28	23.93	41	37.61	48	65.75	117	39.13	

[1]See note [1]below Table 1. [2]See note [2]below Table 1. [3]*Système d'information permettant la gestion de l'information clinique et administrative dans le domaine de la santé et des services sociaux* (I-CLSC, community healthcare center database). [4]Psychiatric outpatient services used database. [5]Based on the CCHS, barriers to care explaining unmet needs were a) I preferred to manage by myself; b) I haven't gotten around to it yet (eg, too busy); c) I didn't have enough confidence in the healthcare system or social services; d) I was afraid about what others would think of me; e) I preferred to ask my family or friends for help; f) I am dissatisfied with the quality of services; g) I don't know how or where to get this kind of help; h) My job interfered with possible treatment (eg, hours of work); i) The help is not readily available; j) I could not afford to pay; my insurance didn't cover the cost; and k) Services are not offered in my language. [6]See note [5]below Table 1.
ED, emergency department.

users than men. Patients living in rental housing had 2.09 times more probability of being very high ED users than those living in private housing. Patients exhibiting violent/disturbed behaviors or social problems, or chronic physical illnesses, respectively, showed 2.87 and 1.02 times increase in probability of high ED use, and a 5.55 and 4.95 times greater probability of very high ED use. Patients with personality disorders had 1.06 times greater probability of high ED use, and those with suicidal behaviors, a 1.29 increased probability of very high ED use. Patients with 3+ barriers related to unmet needs had 1.64 and 2.27 times greater probability of being high or very high ED users, respectively. Patients with 5+ primary care services and high recurrent ED use had 2.5 and 1.53 times greater probability of being very high ED users. Patients hospitalized 1–2 times had a reduced probability of 54% for high and 79% for very high ED use, compared with those not hospitalized.

Table 3. Estimations of multivariable multinomial logistic regression model on emergency department (ED) visits (reference group: low ED users, 1–3 visits/year).

	High ED users (4–7 visits/year)				Very high ED users (8+ visits/year)			
	RRR*	*P*-value	95% CI*		RRR*	*P*-value	95% CI*	
Sociodemographic characteristics (measured in the previous 12 months)								
Women vs men	2.30	0.007	1.25	4.23	1.48	0.307	0.70	3.16
Type of housing[1]								
Rental vs private	1.43	0.326	0.70	2.94	3.09	0.036	1.08	8.85
Supervised vs private	0.81	0.631	0.34	1.94	2.18	0.200	0.66	7.18
Clinical characteristics (measured in the previous 12 months)								
Personality disorders	2.04	0.039	1.04	4.01	2.26	0.055	0.98	5.18
Suicidal behaviors (suicide ideation or attempt)	1.81	0.063	0.97	3.38	2.29	0.046	1.01	5.16
Violent/disturbed behaviors or social problems	3.87	0.005	1.52	9.85	6.55	0.001	2.26	19.00
Chronic physical illnesses	2.02	0.043	1.02	4.00	5.95	0.000	2.50	14.13
Service use (measured in the previous 12 months, or other as specified)								
Frequency of primary care service use								
1–4 vs. 0	0.97	0.941	0.41	2.31	1.26	0.737	0.33	4.75
5+ vs. 0	0.83	0.641	0.38	1.80	3.51	0.036	1.09	11.35
Number of barriers related to unmet needs[2]								
1–2 vs. 0	1.05	0.892	0.51	2.15	1.13	0.788	0.46	2.76
3+ vs. 0	2.64	0.032	1.09	6.42	3.27	0.028	1.14	9.44
Frequency of hospitalizations								
1–2 vs. 0	0.46	0.037	0.22	0.96	0.21	0.002	0.08	0.56
3+ vs. 0	1.47	0.410	0.59	3.69	1.15	0.797	0.39	3.45
Frequency of previous ED use (measured within the 2 years prior to the 12-month period in which interviews were conducted)								
4–7 (high ED users) vs. 0–3	0.70	0.308	0.35	1.40	0.56	0.788	0.46	2.76
8+ (very high ED users) vs. 0–3	0.93	0.855	0.44	1.97	2.53	0.028	1.14	9.44

ED, emergency department; **RRR*, relative risk ratio; *CI*, confidence interval. [1]See note [4]below Table 1. [2]See note [5]below Table 2.

DISCUSSION

In this study we aimed to identify sociodemographic and clinical characteristics, as well as service use, among patients with MHD, comparing low (1–3 visits/year) to high (4–7 visits) and very high ED use (8+ visits) for mental health reasons. Most patients had high (37%) or very high (24%) ED use, which may be explained by the substantial social and health issues they faced. Their levels of social and material deprivation were high, as was their perceived stigma. Nearly half had serious MHD, personality disorders or chronic physical illnesses, while most experienced SRD and suicidal behaviors. About 40% reported unmet needs or poor to fair knowledge of services, which may explain their high overall ED use. As found in other studies,[13,28] most high ED users were also high users of outpatient care and were frequently hospitalized.

Findings partly confirmed the hypotheses that very high ED users, followed by high ED users, were more likely than low ED users to have complex health and social issues, unmet needs, and to make more frequent use of outpatient care. The result—showing that disturbed/violent behaviors or social problems were the patient characteristics most strongly associated with both very high and high ED use—underlined the special needs of these patients, who for some were likely involuntary ED users. Police are frequently called in to deal with people presenting violent or erratic behaviors and to transport them to ED.[39]

Intervention plans[40] integrating behavioral treatment[41] and help in crisis resolution[42,43] may be better deployed for these high and very high ED users. Studies have shown that few overall interventions are being deployed in the ED for high users.[44,45] Previous studies have also shown that patients with chronic physical illnesses made more ED visits.[21,26] Those with co-occurring issues had poorer health overall, higher risk of medication interactions[46] and more distress,[47] explaining their frequent ED use. Improving

collaborative care[48] between psychiatrists and primary care services for better treatment of patients with co-occurring issues may also reduce their ED use.

Higher perceived barriers for unmet needs were also strongly associated with more ED use. Barriers may be structural (eg, lack of access to services) or motivational (eg, due to distrust or dissatisfaction with services).[49] A US study on barriers to care among frequent ED users found that most of them perceived the ED as the only place where their health problems would be treated.[50] These results highlight the importance of acknowledging barriers to outpatient care and developing more personalized patient care based on recovery-orientated services with patient-centred interventions,[51,52] or alternative "rapid" specialized responses for patients with MHD in crisis.[53,54] Even if very high ED users received primary care more frequently, it doesn't mean those services were adequate or sufficient to reduce or prevent unmet needs.

Our finding that being hospitalized 1-2 times, but not 3+ times/year, was protective against high or very high ED use compared with not being hospitalized, was an original result. Most hospitalized patients are referred by emergency physicians,[55] which might suggest that these repeated hospitalized patients have very serious health conditions and that their inpatient care episodes may be unavoidable. Lack of ability to refer (eg, time of day) or possibility to refer (eg, long waiting lists) to outpatient care, lack of mental health support in the ED (eg, brief intervention teams)[56,57] or of comfort in treating patients with more complex MHD profiles in outpatient care might also explain frequent patient hospitalizations. Hospitalization may sometimes be the most appropriate solution for maximizing patient recovery.[58] For patients with 1–2 hospitalizations/year, close follow-up care,[59,60] which is increasingly recommended following discharge, may have contributed to reducing their ED use. Diversified strategies such as assertive community treatment programs,[61] home treatment teams,[62] short-stay crisis units,[63] and crisis intervention teams[64] are also increasingly being promoted to help reduce acute care use. Although such interventions remain insufficiently deployed in Quebec, the province's new Mental Health Action Plan (2022–2026) promises to increase their use.[25]

Compared to low ED users, very high ED users had a higher probability of having suicidal behaviors, while high users showed higher probability of having personality disorders. Previous studies have found associations for both these issues with greater ED use.[13,16,28] Considering that healthcare systems tend to respond poorly to crisis situations,[55] especially those that occur outside regular business hours, the fact that these study participants were very high ED users was not surprising. Greater availability of sustained psychosocial programs in primary care and more specialized crisis and suicidal prevention services[65] may help prevent ED visits for suicidal behaviors.[66] Dialectical behavior therapy may also be promoted more extensively to reduce symptoms of personality disorders, borderline personality disorder in particular, as reported in a systematic review.[67] In general, the ED should not replace outpatient care for vulnerable patients, as their capacity to treat such patients was identified as limited.[68,69]

Women had a greater probability of high ED use than men, and patients living in rental housing showed a greater probability of very high ED use than those in private housing. Women reportedly use more health services than men,[70] which for high ED use contradicted previous studies that found more men were high ED users.[15,26] Because high and very high ED users were differentiated in our study, it may account for this divergent result, with no difference found between women and men in very high ED users. The composition of our study sample could also explain this finding, as a majority of participants recruited randomly by ED staff were women. Concerning patients residing in rental housing, they may experience greater deprivation, including inadequate housing support, compared with those living in private or supervised housing, which may account for their very high ED use. Some type of supportive housing with case management[71] may help these patients avoid frequent ED use. Difficulty to access outpatient care because of long waiting lists or transportation issues might also explain very high ED use among these patients.

Using 5+ primary care services/year and recurrent high ED use were only associated with very high ED users compared to low ED users, but not high ED users. As for high ED users, studies have identified them as high service users in general,[72] and as being "recurrent" ED users over several consecutive years.[6,28] Our study added to this literature by specifying that only patients who made at least five primary care appointments in the previous year and eight ED visits in the previous two years had a greater probability of being very high ED users (8+ ED visits/year). The greater use of primary care services among very high ED users may be explained by their higher rates of chronic physical illnesses and the greater severity of these conditions, compared with rates for low and high ED users. Perhaps primary care was not adequate or continuous enough to prevent ED use [22,73] or to prevent or reduce unmet needs. General practitioners have been shown to lack training or sufficient team capacity to adequately follow up on vulnerable patients with MHD.[74,75] Collaborative care may be more promoted between primary and psychiatric care and team work to reduce ED use and better treat these patients.[76,77]

LIMITATIONS

This study had certain limitations that should be noted. First, there is no consensual definition for low, high, and very high ED use. Different definitions than those chosen here could have led to different findings. Second, the study results were difficult to compare with the literature as most studies

have compared high ED use with other ED use. Third, structured interviews may be biased due to the patients' ability to recall, and the health records that were used reflected service use only within the participating networks. Finally, the diversity of healthcare systems may limit the generalization of the study findings, especially in countries that don't have public healthcare coverage for deprived populations.

CONCLUSION

This study was innovative in the way it compared low, high, and very high ED users among patients with MHD in Canada, and by using both patient structured interviews and health records. The findings confirmed that higher ED use was associated with complex patient health issues and higher perceived barriers to unmet needs. Patients with very high overall ED use had the most severe conditions, including greater housing vulnerability and isolation, and more suicidal behaviors. They also used more primary care services, possibly because of their severe chronic physical health conditions.

Recurrent ED use over the years also distinguished very high ED users from low users. By contrast, the risk of high and very high ED use was reduced in patients with 1–2 hospitalizations/year, which underlines the potential benefits and pertinence of hospitalization for some patients. Overall, barriers to care should be reduced and better access and continuity of outpatient care provided for the most vulnerable patients, integrating crisis resolution and supported housing services. This may reduce the number of patients with MHD in the ED, decreasing wait times and improving care in the ED.

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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. This study was funded by the Canadian Institutes of Health Research (CIHR, grant number: 8400997).

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Bridging the Gap: Evaluation of an Electrocardiogram Curriculum for Advanced Practice Clinicians

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Section Editor: Niels Rathlev, MD
Submission history: Submitted April 21, 2023; Revision received November 17, 2023; Accepted November 22, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18085

Background: Training programs for advanced practice providers (APP) often have significant variability in their curriculum, including electrocardiogram (ECG) education. Despite limitations in formal ECG training, APPs in the emergency department (ED) may be the first practitioner to interpret an ECG. Foundations of Emergency Medicine (FoEM) offers free, open-access curricula that are widely used for resident education. We sought to improve APP ECG interpretation skills by implementing the FoEM ECG I course.

Methods: This was a single-site, pre- and post-intervention study of 23 APPs at our high-acuity, urban ED. In the fall of 2020, APP learners enrolled in a FoEM ECG I course led by faculty and senior resident instructors. The course consisted of six virtual, small-group, active-learning ECG workshops. Participants completed a 15-question multiple-choice test before, immediately after, and six months post-intervention to quantify knowledge acquisition. Additionally, a pre- and post-intervention knowledge, attitudes, and practices survey was administered on ECG interpretation skills and to evaluate the course. We evaluated change in ECG knowledge scores using a Wilcoxon signed-rank test. Changes in self-assessed knowledge were evaluated using an ordinal logistic mixed-effects regression.

Results: A total of 23 APPs enrolled in the course. Knowledge assessments showed APPs improved from the pre-test (median 9/15, interquartile range [IQR] 7–11) to the post-test (median 12/15, IQR 10–13; $P = 0.001$). Test scores did not significantly change from the post-test to the delayed post-test (median 12/15, IQR 12–13; $P = 0.30$). Respondents' subjective rating of their skill did not significantly change ($P = 0.06$). Respondents reported no change in their likelihood of approaching an attending when uncertain of the correct interpretation of an ECG ($P = 0.16$). Overall, 91% were satisfied with the course and 96% agreed that the course difficulty was appropriate.

Conclusion: The FoEM ECG course provided a standardized curriculum that improved APP knowledge for interpreting ECGs. Despite this, the course did not alter APPs' willingness to approach physicians for guidance with interpretation of abnormal ECGs. These findings may inform expansion of this concept for other programs who desire formalized APP ECG education. [West J Emerg Med. 2024;25(2)155–159.]

INTRODUCTION

Advanced practice providers (APP), comprising physician assistants (PAs) and nurse practitioners (NPs), have a substantial presence in emergency departments (ED) in the United States. Emergency departments employed 77% of APPs in 2006, increasing from 28% in 1997.[1] There are over 13,000 PAs and over 10,000 NPs currently practicing in the acute care setting.[2,3] It is estimated that APPs see 21% of all

ED visits and the proportion of high acuity services independently billed by APPs is increasing.[4,5] Some models of ED care, such as practitioner-in-triage, often employ APPs as the first point of contact for patients and are tasked with ordering initial diagnostics such as electrocardiograms (ECG).[6,7]

Despite the volume and acuity of patients treated by APPs in the ED, a relatively small proportion of APPs have received formalized postgraduate training in emergency medicine (EM), with 10% of PAs and 21% of NPs having completed such training.[2,8] Both the American Academy of Emergency Nurse Practitioners (AAENP)[9] and the Society of Emergency Medicine Physician Assistants (SEMPA)[10] identify ECG interpretation as a requisite skill for APPs practicing in EM. However, no consistent approach is applied nationwide to address this lack of EM-specific training.[11,12]

Foundations of Emergency Medicine (FoEM) is a free, open-access curriculum that is widely used and validated in EM resident education.[13,14] FoEM offers standardized, level-specific, core content that primarily targets resident physicians in EM. The FoEM ECG I course is composed of six units that review fundamental concepts in ECG interpretation using a flipped classroom approach (Appendix 1).[15] Implementation guidelines, unit summaries, challenge ECGs, and interpretation guides are all found on the FoEM website, which may be accessed by program leaders after free registration.[16] We sought to address a gap in training and improve APP ECG interpretation skills by implementing the FoEM ECG I course.

Population Health Research Capsule

What do we already know about this issue?
Advanced practice providers (APP) are responsible for seeing a significant number of patients in many ED settings, yet their in-training and post-training curricula are variable.

What was the research question?
Would the implementation of the Foundations of Emergency Medicine (FoEM) ECG I course improve electrocardiogram interpretation skills of APPs?

What was the major finding of the study?
Knowledge assessments improved from the pre-test (median 9/15, IQR 7–11) to the post-test (median 12/15, IQR 10–13; $P = 0.001$).

How does this improve population health?
Use of the FoEM ECG I curriculum for APP learners led to an improvement in ECG knowledge, while maintaining attending physician guidance in the setting of uncertainty.

METHODS

Study Population and Design

We included APPs in this single-site study if they currently practiced at a large, urban, county hospital and were enrolled in the FoEM ECG I course during October 2020-June 2021. While enrollment in the course was required to staff higher acuity ED zones, participation in the study was voluntary. Participants reviewed unit summaries and practiced select ECGs prior to each workshop. During the workshop, APPs were divided into small groups to collaboratively review four challenge ECGs with interpretation and discussion prompts. Upon completion of small-group discussion, faculty or senior resident instructors facilitated interactive sessions with all learners, reviewing core concepts and ECG challenge answers.

Study participants completed a knowledge, attitudes, and practices (KAP) survey at the beginning and completion of the course (Appendix 2). Additionally, we obtained objective knowledge acquisition through a 15-question multiple-choice assessment administered in October 2020 (pre-intervention), December 2020 (immediate post-intervention), and June 2021 (delayed post-intervention). This study was deemed exempt by the Institutional Review Board of Emory University.

Statistical Analysis

We described categorical variables using frequencies and percentages. Continuous and scale variables were described using medians and interquartile ranges (IQR). We evaluated the change in ECG knowledge scores between the pre-test, post-test, and delayed post-test sessions using the Friedman repeated-measures rank-order ANOVA. Ordinal self-assessment variables were evaluated using a mixed-effects ordinal logistic regression. We used mixed effects to account for multiple responses from individual study participants. Odds ratios (OR) and 95% confidence intervals (CI) are presented from the regressions. Two-tailed *P*-values ≤ 0.05 were considered significant. We conducted statistical analyses using R version 4 (R Core Team, Foundation for Statistical Computing, Vienna, Austria).

RESULTS

A total of 23 APPs enrolled, with the majority identifying as female (74%) with a median age of 37 (IQR 33–40) years

(Table 1). Learners were primarily family nurse practitioner (FNP) (48%), followed by physician assistant PAs (26%) and FNP-emergency nurse practitionerENPs (22%). They reported a median of five years of postgraduate experience in EM (IQR 3–6), and a small proportion reported completing formalized postgraduate training in EM (13%).

Self-assessed confidence of ECG interpretation was higher in the post-test assessment compared to the pre-test assessment; however, the difference was not significant (odds ratio [OR] 2.94 (95% confidence intervalCI 0.94–9.1), $P = 0.06$) (Figure 1A). In contrast, the objective knowledge assessments (Figure 1B-D) indicate that ECG interpretation improved ($P < 0.001$). Post-hoc tests indicated that post-test scores (median 12/15, IQR10–13) were significantly greater than pre-test scores (median 9/15, IQR 7–11; $P < 0.001$). Delayed post-test scores (median 12/15, IQR 12–13) did not differ from post-test scores ($P = 0.30$) indicating that the improved understanding was largely maintained over time.

On the KAP survey, APPs reported improved confidence in detecting an ST-segment elevation myocardial infarction (STEMI) on ECG ($P = 0.01$) (Appendix 3). No overall change was noted in confidence to interpret a life-threatening arrhythmia ($P = 0.27$). Participants were no more or less likely to approach an attending physician for help regarding an uncertain ECG before and after the ECG curriculum ($P = 0.16$). With respect to participants' view of the course, 21 (91%) reported being satisfied or highly satisfied; 9 (39%) satisfied; and 12 (52%) highly satisfied. Only one participant (4%) was neutral and one (4%) was unsatisfied. Twenty-two participants (96%) believed that the course was taught at the correct level of difficulty: 13 (57%) strongly agreed; and 9 (39%) agreed. Only one participant (4%) was neutral. No respondent disagreed.

Table 1. Demographic characteristics of advanced practice providers enrolled in the Foundations of Emergency Medicine ECG I course, October 2020–June 2021.

Characteristic	Value N = 23
Age, median (IQR)*	37 (33–40)
Gender, n (%)	
Female	17 (74%)
Male	6 (26%)
Certification, n (%)	
AGNP**	1 (4%)
FNP$^{\alpha}$	11 (48%)
FNP-ENP$^{\beta}$	5 (22%)
PA$^{¥}$	6 (26%)
Postgraduate experience, median (IQR)	5 (3–6)
Completed emergency medicine postgraduate training program, n (%)	3 (13%)

*IQR, interquartile range; **AGNP, adult gerontology nurse practitioner; $^{\alpha}$FNP, family nurse practitioner; $^{\beta}$FNP-ENP, family nurse practitioner - emergency nurse practitioner; $^{¥}$PA, physician assistant.

DISCUSSION

The FoEM ECG I curriculum was administered to APP learners and evaluated using a pre- and post-intervention, self-reported KAP survey in conjunction with an objective measure of knowledge acquisition. There was an improvement in objective knowledge and retention, a trend toward improved confidence in ECG interpretation, and a significant improvement in STEMI identification. Despite these improvements, there was no change in the APPs' likelihood of reaching out to physicians for assistance with ECG interpretation.

A unique advantage of our study is its demonstration of measurable improvement in clinically relevant ECG interpretation. While this is encouraging with respect to the ease and efficiency of the course, what is more impressive is the retention of knowledge over time. The APPs commonly work in triage and lower acuity areas and are often the first practitioners to evaluate patients in the ED.[6,7] To detect many life-threatening illnesses, prompt ECG acquisition and interpretation is essential. Thus, APPs should be able to interpret ECGs when a physician is not immediately available, as may be the case in some practices.[17] Despite the importance of ECG interpretation, APPs often find this clinical skill challenging, with one study demonstrating 50% proficiency of ECG interpretation among graduating PAs, a metric commensurate with the baseline competency demonstrated in our cohort.[18] In this study, we were able to increase and maintain competency at 80%, underscoring the value added by the FoEM ECG I course. Despite this increased knowledge, APPs were just as likely to reach out to a physician for ECG interpretation guidance, showing that the course did not decrease reliance on physician knowledge and judgment.

Our study demonstrated that APPs, despite showing increased knowledge following the course, only gained confidence in identifying STEMIs on ECG, but did not improve confidence in other domains of ECG interpretation following the FoEM ECG I course. This represents a mismatch in perceived and actual ECG interpretation competence. This may reflect limited individual time spent on each module and/or modules focused on more specific ECG pathologies. Further studies may evaluate whether confidence may be improved with continued training and exposure to more diverse ECG findings.

While implementing the course and showing it was effective from a knowledge, attitudes, and behaviors standpoint is of paramount importance, an educational program must also be well-received by the learner. Our study demonstrated very high levels of satisfaction with the course

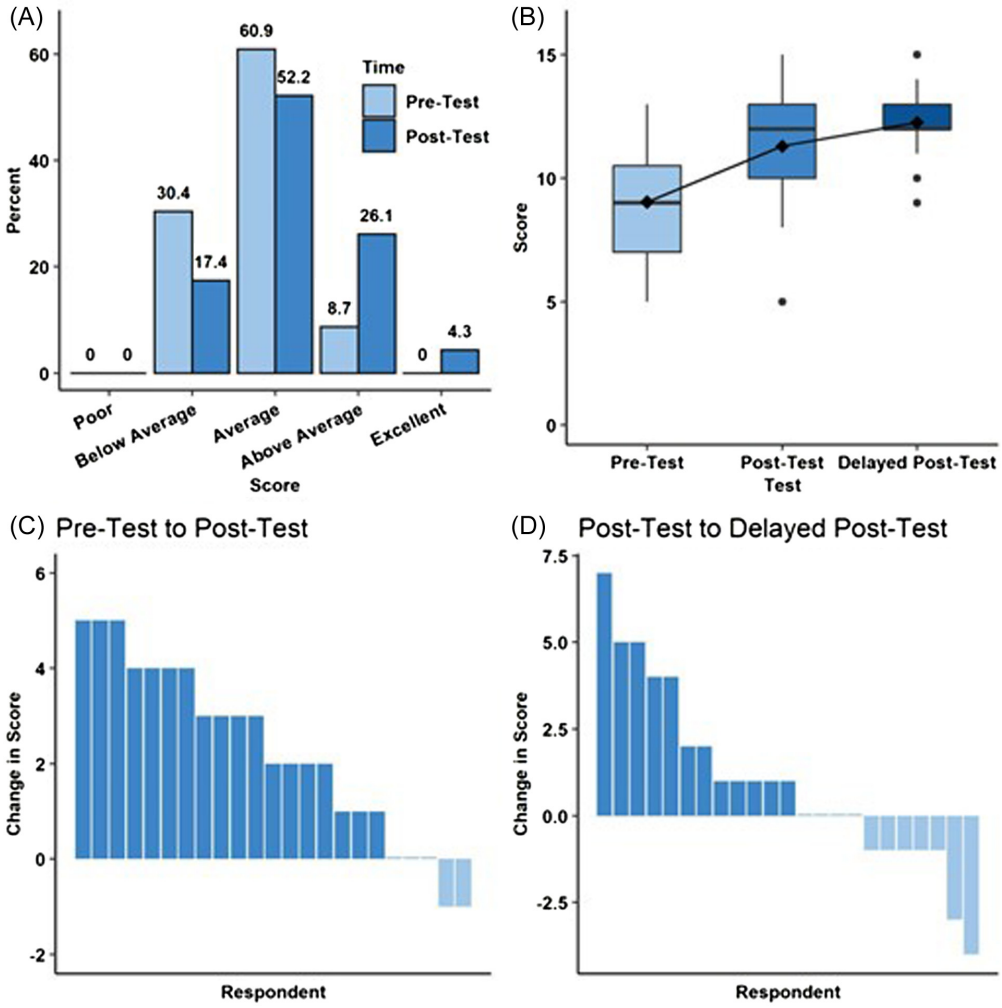

Figure 1. Advanced practice provider perceived and objective knowledge acquisition before and after foundations of emergency medicine (FoEM) Electrocardiogram Gram (ECG) I course. A) Self-assessment of respondents' understanding of ECG interpretation as a function of time. B) Boxplot depicting knowledge test scores as a function of time. C) Waterfall plot depicting the change in knowledge test scores from pre-test to post-test for each individual respondent. D) Waterfall plot depicting the change in knowledge test scores from post-test to delayed post-test for each individual respondent.

among our APPs, along with APPs reporting that the concepts taught were appropriate for their level of training. This translates into more engagement and knowledge acquisition and retention in the curriculum, in fitting with prior studies looking at APPs and case-based education.[19]

LIMITATIONS

Our study limitations included a small sample size with a relatively homogeneous study population (eg, primarily NPs, all practicing at a single county hospital). Additionally, our study cohort did not reflect the roughly 50/50 distribution of NPs and PAs practicing in acute care settings, with our group only having 26% PA representation. Finally, our study did not include a control group which did not receive training thereby allowing for the possibility of test/retest effects.

CONCLUSION

Formalized postgraduate ECG interpretation training for APPs in EM is at best inconsistent, yet both SEMPA and AAENP list ECG interpretation as a necessary skill for practicing in EM.[9,10] In response to this, we implemented the FoEM ECG I course and found that it was easy to implement, led to improved ECG knowledge and confidence in ECG interpretation, and was well received by the APP group. These results may inform the use of this free, structured ECG curriculum at both academic and community-based programs that support continuing education for APPs. Future studies should investigate the impact of increased sample sizes, more variable practice locations and departmental designs, and a higher proportion of PAs, all of which would serve to make the data more reflective of the APP population as a whole and, therefore, more generalizable.

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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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Stage B Heart Failure Is Ubiquitous in Emergency Patients with Asymptomatic Hypertension

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Section Editor: Fred Severyn, MD
Submission history: Submitted March 23, 2023; Revision received November 21, 2023; Accepted December 19, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.17990

Introduction: Hypertension is the leading risk factor for morbidity and mortality throughout the world and is pervasive in United States emergency departments (ED). This study documents the point prevalence of subclinical heart disease in emergency patients with asymptomatic hypertension.

Method: This was a prospective observational study of ED patients with asymptomatic hypertension conducted at two urban academic EDs that belong to an eight-hospital healthcare organization in New York. Adult (≥18 years of age) English- or Spanish-speaking patients who had an initial blood pressure (BP) ≥160/100 millimeters of mercury (mmHg) and second BP ≥140/90 mm Hg, and pending discharge, were invited to participate in the study. We excluded patients with congestive heart failure, renal insufficiency, and atrial fibrillation, or who were pregnant, a prisoner, cognitively unable to provide informed consent, or experiencing symptoms of hypertension. We assessed echocardiographic evidence of subclinical heart disease (left ventricular hypertrophy, and diastolic and systolic dysfunction).

Results: A total of 53 patients were included in the study; a majority were young (mean 49.5 years old, [SD 14–52]), self-identified as Black or Other (n = 39; 73.5%), and female (n = 30; 56.6%). Mean initial blood pressure was 172/100 mm Hg, and 24 patients (45.3%) self-reported a history of hypertension. Fifty patients completed an echocardiogram. All (100%) had evidence of subclinical heart disease, with 41 (77.4%) displaying left ventricular hypertrophy and 31 (58.5%) diastolic dysfunction. There was a significant relationship between diastolic dysfunction and female gender [x^2 (1, n = 53) = 3.98; $P = 0.046$]; Black or other race [x^2 (3, n = 53) = 9.138; $P = 0.03$] and Hispanic or other ethnicity [x^2 (2, n = 53) = 8.03; $P = 0.02$]. Less than one third of patients demonstrated systolic dysfunction on echocardiogram, and this was more likely to occur in patients with diabetes mellitus [x^2 (1, n = 51) = 4.84; $P = 0.02$].

Conclusion: There is a high probability that Black, Hispanic, and female patients with asymptomatic hypertension are on the continuum for developing overt heart failure. Emergency clinicians should provide individualized care that considers their unique health needs, cultural backgrounds, and social determinants of health. [West J Emerg Med. 2024;25(2)160–165.]

INTRODUCTION

Hypertension is the leading risk factor for morbidity and mortality throughout the world and is pervasive in United States emergency departments (ED).[1,2] It is a common misconception that high blood pressure found during the ED visit is related to pain or anxiety; however, studies show that elevated blood pressure in the ED reliably identifies hypertension in an overwhelming majority of patients[3] and is an independent risk factor for having a major cardiovascular event after discharge.[4]

The clinical policy recommended by the American College of Emergency Physicians (ACEP) for patients who have persistent asymptomatic hypertension in the ED *without* signs and symptoms of acute target organ injury includes prompt referral to primary care.[5] However, this clinical policy is outdated and inconsistently adhered to.[6] Furthermore, of the patients who are referred, less than half adhere to recommendations regarding follow-up, regardless of their insurance status or access to routine medical care.[7] Automating recommendations for follow-up using the electronic health record is one way to ensure adherence to the ACEP policy;[8] however, this is not useful or meaningful to patients when it is not followed by any clinician-to-patient communication about the importance of follow-up. Besides, this policy does not consider the emerging evidence that an overwhelming majority of emergency patients, particularly Blacks, with asymptomatic hypertension show evidence of subclinical heart disease,[9,10] with upper limits reaching more than 90.7% in one sentinel study by Levy et al.[9]

This study documents the point prevalence of subclinical heart disease in the first 50 ED patients enrolled in an ongoing study. This was our first step to explore unique ways for improving healthcare delivery for this high-risk patient population in our ED.

METHODS

Study Design, Sample, and Setting

This was a prospective observational study of emergency patients with asymptomatic hypertension. Data collection began after receiving institutional review board approval (#18-00197). The study was conducted at two urban academic EDs that provide care to a diverse patient population, serving the local communities of Harlem, New York City. Harlem has a concentrated burden of hypertension and is among the poorest neighborhoods in New York City. More than two-thirds of the residents are a racial or ethnic minority.[11]

Data collection began in 2018 at one ED site and stopped twice due to 1) lack of funding to continue participant recruitment, and 2) a pause in research activities at the recruiting institution in response to the COVID-19 pandemic. In late 2021, an additional site was added to boost patient recruitment. Annually, there are about 100,000 patient visits in each ED, and there is a state-of-the-art electronic information system to facilitate data collection across sites. The estimated prevalence of patients who visit the ED at each site who have uncontrolled asymptomatic hypertension is 48%–50%.[12]

Adult (≥18 years of age) English- or Spanish-speaking patients, who had an initial blood pressure (BP) ≥160/100 millimeters of mercury (mm Hg) and second BP ≥140/90 mm Hg and were pending discharge, were invited to participate in the study. We excluded patients with congestive heart failure, renal insufficiency, and atrial fibrillation, or who were pregnant, a prisoner, cognitively unable to provide informed consent, or experiencing symptoms of hypertension, such as chest pain, paresthesia, or shortness of breath.

Protocol Change

Initially we also excluded patients if they had taken blood pressure medication within the prior three months; however, beginning at study participant number 44, we modified our protocol to include all patients regardless of whether they had taken medication within the previous three months. We revised the study protocol to be more inclusive, specifically to avoid excluding patients who might have untreated conditions and to ensure that all individuals, including those potentially in need of intervention, could be considered in our research. This change in protocol allowed for a more comprehensive assessment of the study population and also assisted with our recruitment.

Data Collection Procedure

Approximately three days/week from 8 AM to 4 PM, a research coordinator enrolled and obtained informed consent electronically from patients who met inclusion criteria. Study data were collected and managed using REDCap (Research Electronic Data Capture)[13,14] electronic data capture tools hosted at our institution.[1,2] REDCap is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.[13,14]

Each morning of patient recruitment, the research coordinator used Microsoft Teams (Microsoft Corp, Redmond, WA) to inform the sonographer that recruitment had begun.[15] Before approaching any patient in the ED, the research coordinator used the Epic chat feature (Epic Systems Corp, Verona, WI) to inform the ED attending physician that his/her patient met inclusion for the study and would be approached.[15] If an electrocardiogram (ECG) was not conducted as part of usual care, the ECG was conducted by the research coordinator. The bedside echocardiogram was conducted by one member of the study ultrasound team,

which included one ED sonographer, four emergency physicians, and one cardiologist, each trained on the study protocol. Each echocardiogram took approximately 10 minutes to complete at bedside.

Measures

Demographic Measures

Study measures were obtained by electronic data extraction and included the patient's first and second systolic and diastolic BP level since arrival to the ED, age, gender, race/ethnicity, past medical history, smoking history, and access to primary care. All data were double entered into the REDCap database by two members of the research team to assure accuracy of chart review and data entry. Our protocol was set such that any differences were reconciled by the principal investigator (KS); however, no differences were identified.

Echocardiogram

Three endpoints were obtained and modeled after the American College of Cardiology, American Heart Association (ACC/AHA), Heart Failure Society of America, and Levy et al.[9,20]:

1. *Left ventricular hypertrophy (LVH).* Defined as present if left ventricular septal thickness was ≥ 1.1 centimeter (cm) or absent if left ventricular septal thickness was <1.1 cm. (Left ventricular free wall thickness was measured in the parasternal long view at end diastole.)
2. *Systolic dysfunction.* Ejection fraction noted as normal (≥55%) or abnormal (<55%).
3. *Diastolic function.* Evaluated by estimating left atrial pressure using the E/e' ratio. Diastolic dysfunction was present if E/e'(septal) was ≥15, if E/e'(lateral) was ≥12, if septal e' was <8 cm/sec, or if lateral e' was <10 cm/sec.[3] Grade of diastolic dysfunction was not determined for this initial analysis.

Electrocardiogram

The study diagnosed LVH with ECG findings that satisfied the Cornell voltage criteria (when the sum of the R wave in lead aVL and the S wave in lead V3 is >20 mm in women and 23 mm in men). Data obtained from the ECG included heart rate, PR interval, and the QRS interval number.

Data Analysis Plan

We exported data from REDCap to SAS analytic software version 9.4 (SAS Inc, Cary, NC) for data analysis. Demographic variables are presented as percentages (%) or means (*M*) and standard deviations. Evidence of subclinical heart disease was dichotomized as abnormal/normal and presented as percentages. We conducted bivariate analyses to test for significant relationships between independent variables (age, gender, race/ethnicity, past medical history, body mass index, smoking history, and access to primary care) and subclinical heart disease.

RESULTS

Characteristics of Sample

A total of 53 patients were examined. (Two patients did not complete an echocardiogram and one patient did not complete an echocardiogram and ECG due to time constraints.) The majority of the sample were young (mean 49.5 years old, [SD 14–52]), self-identified as Black or Other (n = 39; 73.5%), and female (n = 30; 56.6%). 31 were Hispanic race (58.5%) and 30 female (56.6%). Mean initial BP was 172/100 mm Hg, and 24 patients (45.3%) self-reported a history of hypertension; 36 (68%) had taken their antihypertensive medication within the prior three months. Mean body mass index was 31.9, which correlates to Obesity Class I or moderately obese.[17] Fifteen patients (28.3%) were current smokers, and 12 (28.3%)] had a history of diabetes mellitus. Thirty-one (58.5%) reported they had a primary care physician (Table 1).

Echocardiogram

Of the 50 patients who completed an entire echocardiogram, 100% had evidence of subclinical heart disease; 41 (77.36%) showed evidence of LVH and 31 (58.49%) diastolic dysfunction. We performed a chi-square test of independence to assess the relationship between subclinical heart disease and our independent variables. There was a significant relationship between diastolic dysfunction and female gender [x^2 (1, n = 53) = 3.98; P = 0.046]; Black or other race [x^2 (3, n = 53) = 9.138; P = 0.03] and Hispanic [x^2 (2, n = 53) = 8.03; P = 0.02]. Less than one-third of patients demonstrated systolic dysfunction on echocardiogram, and this was more likely to occur in patients with diabetes mellitus [x^2 (1, n = 51) = 4.84; P = 0.02]. There were no other differences between our independent variables and our main outcome, subclinical heart disease.

One participant was missing an ECG. Of 49 participants, five demonstrated evidence of LVH.

DISCUSSION

We found that subclinical heart disease is ubiquitous in ED patients with asymptomatic hypertension. Our findings are consistent with those of Levy et al (2012), who were the first to document the alarming prevalence of structural heart changes in ED patients with asymptomatic hypertension, particularly among Blacks who sought care in the ED of an inner city.[9] Our study adds to the existing literature that Black and Hispanic patients who have asymptomatic hypertension diagnosed in the ED have a high probability of having myocardial target organ damage, that is consistent

Table 1. Demographic characteristics and subclinical heart disease.

Measure	Variable	Statistic N = 53 (%)
Independent variables – demographic characteristics	Age, mean (SD)	49.47 (14.5)
	Gender, n (%)	
	Female	30 (56.6)
	Male	23 (43.4)
	Race, n (%)	
	White	5 (9.4)
	Black or other	48 (90.6)
	Ethnicity, n (%)	
	Non-Hispanic	27 (49.1)
	Hispanic or other	31 (58.5)
	Blood pressure, mean mm Hg	
	1st systolic blood pressure	172.13 (15.1)
	1st diastolic blood pressure	100.74 (15.0)
	2nd systolic blood pressure	162.27 (17.5)
	2nd diastolic blood pressure	95.37 (16.5)
	Hypertension history, yes	24 (45.3%)
	Took blood pressure medicine within 3 months	36 (68.0%)
	Smoker, yes	15 (28.3%)
	Diabetes mellitus history, yes	12 (22.6%)
	Body mass index, mean (SD)	31.93 (8.9)
	Primary care physician, yes	31 (58.5)
Dependent variable – subclinical heart disease	Subclinical heart disease, yes	50 (100)
	Diastolic dysfunction, yes	31 (58.5)
	Left ventricular hypertrophy, yes	41 (77.4)
	Systolic dysfunction, yes	10 (19.6)

with a diagnosis of Stage B heart failure according to the ACC/AHA.[18]

Congestive heart failure is a progressive disorder (Stages A, B, C, and D) that often begins with left ventricular systolic dysfunction and results in symptoms from fluid overload and poor end-organ perfusion.[18] Stage B heart failure encompasses patients who are asymptomatic and have evidence of structural heart abnormalities, such as LVH, systolic or diastolic dysfunction.[18] Asymptomatic left ventricular systolic dysfunction has an estimated prevalence of 3–6% in the community,[19] which is significantly less than our study findings of 19%. Prendergast et al[10] (2015) found the point prevalence of subclinical heart disease in emergency patients with asymptomatic hypertension to be nearly 40%, also significantly less than our findings of 100%. To our knowledge, no other study exists that documents the point prevalence of subclinical heart disease in ED patients with asymptomatic hypertension. Both Levy et al (2012) and Prendergast et al (2015) conducted their studies in inner-city Detroit and inner-city Chicago, respectively—settings similar to ours.[9,10]

In randomized trials, individuals with asymptomatic left ventricular systolic dysfunction have high rates of incident heart failure and death, increased cardiovascular mortality[19–21]; all-cause mortality[20]; and nonfatal cardiovascular events, such as myocardial infarction and stroke.[20,22] While the relative contribution of each condition (systolic and diastolic dysfunction, or LVH) to overt congestive heart failure is unknown, from the lens of emergency medicine and population health, identifying patients with asymptomatic hypertension is of utmost importance, regardless.

Our study demonstrates that ED patients with asymptomatic hypertension are on the continuum to overt heart failure, which has serious consequences. A considerable number of missed opportunities occur, which contribute to delays in diagnosis, suboptimal treatment, increased morbidity and mortality and, above all, an exacerbation of

disparities related to hypertension among Blacks. Studies suggest referral rates are 5%.[12] Despite the many knowledge, attitudinal, and organizational barriers that exist,[6,23,24] the identification and management of asymptomatic hypertension is critical to prevent the progression of the disease and its complications.

LIMITATONS

The results of our study must be interpreted considering its limitations, which include its small sample size and study design. We analyzed only the first 50 patients of an ongoing study, which limits the ability to generalize to larger populations. Additionally, our prospective observational study design limits the ability to draw conclusions about the progression of congestive heart failure or other cardiovascular events over time. Lastly, we did not evaluate subclinical heart disease in normotensive patients. Nonetheless, this study has strengths in that it documents the significant burden of Stage B heart failure in the emergency population with asymptomatic hypertension.

IMPLICATIONS

Emergency clinicians should recognize the prevalence of asymptomatic hypertension in Black patients and provide individualized care that considers their unique health needs, cultural backgrounds, and social determinants of health. This includes providing adequate follow-up care and support to prevent hypertension-related complications and improve overall health outcomes.

CONCLUSION

In this study we documented the point prevalence of subclinical heart disease in the first 50 ED patients who were enrolled in an ongoing study, as our first step to explore unique ways for improving healthcare delivery for this high-risk patient population in our emergency department. While subclinical heart disease was ubiquitous, we conclude that female, Black, and Hispanic patients who have asymptomatic hypertension diagnosed in the ED have a high probability of already being on the continuum for developing overt heart failure.

ACKNOWLEDGMENTS

We express our sincere appreciation to the ancillary staff, staff nurses, and medical staff of the Mount Sinai Emergency Department for their invaluable contributions to this study. Our gratitude extends to the patients whose participation made this research possible. Special thanks to the Souffront Collaboratory members, including nursing leadership Ashley Caceras MSN, RN, Lucio Baretto DNP, AGACNP-BC, APRN-BC, RN, CCRN, NE-BC, CPXP, CLSSBB, MICN, and Olivia Sgambellone BSN, RN, CEN whose guidance and support enriched the collaborative nature of this study.

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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. This project was funded by the Department of Emergency Medicine at the Icahn School of Medicine at Mount Sinai, the Center for Nursing Research and Innovation at the Mount Sinai Health System, and the Gordon and Betty Moore Foundation through the Betty Irene Moore Fellowship for Nurse Leaders and Innovators (GBMF9048). There are no other conflicts of interest or sources of funding to declare.

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Performance of Intra-arrest Echocardiography: A Systematic Review

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Section Editor: Joseph Shiber, MD
Submission history: Submitted August 21, 2023; Revision received December 8, 2023; Accepted December 21, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18440

Introduction: Intra-arrest transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE) have been introduced in adult patients with cardiac arrest (CA). Whether the diagnostic performance of TTE or TEE is superior during resuscitation is unclear. We conducted a systematic review following PRISMA guidelines.

Methods: We searched databases from PubMed, Embase, and Google Scholar and evaluated articles with intra-arrest TTE and TEE in adult patients with non-traumatic CA. Two authors independently screened and selected articles for inclusion; they then dual-extracted study characteristics and target conditions (pericardial effusion, aortic dissection, pulmonary embolism, myocardial infarction, hypovolemia, left ventricular dysfunction, and sonographic cardiac activity). We performed quality assessment using the Quality Assessment of Diagnostic Accuracy Studies Version 2 criteria.

Results: A total of 27 studies were included: 14 studies with 2,145 patients assessed TTE; and 16 with 556 patients assessed TEE. A high risk of bias or applicability concerns in at least one domain was present in 20 studies (74%). Both TTE and TEE found positive findings in nearly one-half of the patients. The etiology of CA was identified in 13% (271/2,145), and intervention was performed in 38% (102/271) of patients in the TTE group. In patients who received TEE, the etiology was identified in 43% (239/556), and intervention was performed in 28% (68/239). In the TEE group, a higher incidence regarding the etiology of CA was observed, particularly for those with aortic dissection. However, the outcome of those with aortic dissection in the TEE group was poor.

Conclusion: While TEE could identify more causes of CA than TTE, sonographic cardiac activity was reported much more in the TTE group. The impact of TTE and TEE on the return of spontaneous circulation and further survival was still inconclusive in the current dataset. [West J Emerg Med. 2024;25(2)166–174.]

Keywords: *cardiac arrest; resuscitation; transthoracic echocardiography; transesophageal echocardiography.*

INTRODUCTION

Ultrasound (US) is considered a valuable diagnostic tool when there is a clinical suspicion for a specific reversible cause in patients with cardiac arrest (CA).[1] The use of US during resuscitation has become more common because of its non-invasive and readily accessible characteristics.[2,3]

Transthoracic echocardiography (TTE) has been introduced in resuscitative scenarios in recent decades.[2,4,5] However, previous studies have shown that TTE lengthens a single pause for more than 17 seconds,[6,7] possibly delaying chest compressions. Also, devices such as mechanical chest compression systems or defibrillation pads would interfere with image acquisition. By contrast, transesophageal echocardiography (TEE) could overcome such limitations, allowing real-time visualization of the heart without interrupting chest compressions.[8] However, the disadvantages of TEE include high cost, the need for advanced operator skills, and the potential for iatrogenic trauma due to its invasive nature. Whether the diagnostic performance of TTE or TEE is superior during resuscitation is unclear. We conducted a systematic review of intra-arrest TTE and TEE on target conditions including pericardial effusion, cardiac tamponade, aortic dissection, pulmonary embolism (PE), myocardial infarction (MI), hypovolemia, left ventricular (LV) dysfunction, and sonographic cardiac activity.

Population Health Research Capsule

What do we already know about this issue?
Transthoracic echocardiography (TTE) delays chest compressions; transesophageal echocardiography (TEE) offers real-time visualization without interrupting compressions.

What was the research question?
Is the diagnostic performance of TTE superior to TEE?

What was the major finding of the study?
The etiology of cardiac arrest (CA) was identified in 13% of patients through TTE and in 43% of patients through TEE.

How does this improve population health?
While TEE could identify more causes of CA sonographic cardiac activity, it was reported much more in the TTE group. The impact of TTE and TEE on further survival are inconclusive.

METHODS

We performed a systematic review following the latest statement of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA 2022). This review protocol was submitted to the International Prospective Register of Systematic Reviews (PROSPERO) on March 17, 2022 (registration number: CRD42022310670).

Data Sources and Search Strategy

Two independent investigators searched literature published up to April 30, 2023, in PubMed, Embase, and Google Scholar without language or study-type restriction. Eligible trials were identified with the following keywords: "echocardiography, CA, resuscitation or rescue."

Study Selection

Two authors (YH and WL) independently examined references using titles and abstracts. Full texts of relevant studies were retrieved. The study selection criteria were framed using the PICOST (Population, Intervention, Comparator, Outcome, Study Design, Time frame) format as described in Table 1.

Data Extraction and Quality Assessment

The two authors (YH and WL) extracted data from eligible studies including authors, publication year, study design, case numbers, gender, age, application of TTE or

Table 1. Eligibility criteria for study selection.

	Inclusion criteria	Exclusion criteria
Population	Adult non-traumatic patients with out-of-hospital and in-hospital cardiac arrest	Traumatic arrest and pediatric population
Intervention	Intra-arrest TTE/TEE	Post-arrest TTE/TEE
Comparative	Standard resuscitation according to ALS guidelines	
Outcome	Identification of the target conditions	
Study type	Observational studies (prospective and retrospective) and interventional studies (randomized and non-randomized)	Case reports and case series, animal studies, review articles, guidelines, and editorials
Time	No limitations on the publication period	

TEE, transesophageal echocardiography; *TTE*, transthoracic echocardiography; *ALS*, Advanced Life Support.

TEE, sonographers, sonographic diagnoses, reference standard, and rate of return of spontaneous circulation (ROSC) or survival. Quality assessment was performed using the Quality Assessment of Diagnostic Accuracy Studies Version 2 (QUADAS-2) criteria, which is an adequate tool for diagnostic test accuracy in systematic reviews.[9] The two authors independently evaluated each included study; any inconsistency or disagreement was resolved upon detailed discussion.

Outcome Measures

The primary outcome was the incidence proportions of target conditions including pericardial effusion, cardiac tamponade, aortic dissection, PE, MI, hypovolemia, LV dysfunction, and sonographic cardiac activity by intra-arrest TTE/TEE.

Data Synthesis, Statistical Analysis, and Sensitivity Analysis

Due to marked heterogeneity among the included studies, conducting a robust meta-analysis was not feasible. Thus, we used a narrative synthesis to present the study results. We calculated the pooled incidence proportions of target conditions of TTE and TEE and present them as proportion and 95% confidence intervals (CI) using Comprehensive Meta-Analysis V4.0 software (Biostat Inc, Englewood, NJ).

RESULTS

Literature Search and Study Selection Results

Our literature search identified a total of 333 results from PubMed, Embase, and Google Scholar. After duplicates were removed, we screened 308 titles for inclusion with 34 excluded for not meeting the study criteria. We also excluded 31 meta-analyses or systematic reviews and 61 case reports, case series, and animal studies. Of the 182 remaining studies that underwent a thorough full-text retrieval and review, we selected 27 for final review (Figure).[2,3,10–34]

Summary of Studies

Eleven studies assessed TTE,[2,3,10–20] 13 assessed TEE,[10,13,21–33] and three included both (Supplementary Table 1).[10,13,34] Of the total 2,701 patients included, 2,145 received TTE, and 556 received TEE. One patient was excluded due to a traumatic rupture of the thoracic aorta.[21] Nine studies included patients with out-of-hospital CA (OHCA), seven included patients with in-hospital CA, and another 11 assessed a mix. Echocardiography was performed by emergency physicians in 17 studies.

Risk of Bias and Concerns of Applicability

A high risk of bias or applicability concerns in at least one domain was present in 20 studies (74%) (Table 2). The risk of bias was unclear in 10 studies (38%) due to a lack of information regarding patient selection. The risk was high in 15 studies (58%) due to a convenience sample; only one study rated low risk enrolled a consecutive sample.[14] In two studies in which TTE, TEE, or blood sampling analysis was performed at the discretion of physicians[19] the risk of bias was rated high because of concern for the index test. The risk of bias was unclear in 23 studies (88%) related to a lack of standardized reference and information regarding the flow and timing. Low risks of bias related to reference standards and flow and timing were rated in the other four studies in which all images were reviewed (ie, uniform confirmatory testing) and inter-rater reliability was assessed.[26,31,32,34]

The risk of bias for applicability was high for patient selection in nine studies (35%) because of the enrollment of patients with hemodynamic instability or pulseless electrical activity.[2,11–14,22,26–28] For applicability to the index test, four studies were evaluated with a high risk due to large variations in diagnostic assessment.[10,13,19,34] Four studies in which reference standards were provided were rated with a low risk of applicability in reference standards.[26,31,32,34] However, the remaining were unclear.

Performance of TTE and TEE Among the Target Conditions

Transthoracic echocardiography and TEE found positive findings in 51% (1,101/2,145) and 47% (264/556) of patients, respectively. The most common finding was the presence of sonographic cardiac activity in 855 patients (830 in the TTE group and 25 in the TEE group). The etiology of CA was identified in 13% (271/2,145) of patients with TTE and 43% (239/556) of patients with TEE (Table 3, Supplementary Table 2). A high incidence proportion was observed in the target condition in the TEE group, particularly in those with aortic dissection. However, the outcome of patients with aortic dissection was poor.

The summary of detailed sonographic findings is listed in Supplementary Table 3.

Intervention According to Sonographic Findings

Excluding patients with sonographic cardiac activity, the effect on management was observed in 38% (102/271) of patients receiving TTE and 28% (68/239) of those receiving TEE. The most common intervention was pericardial effusion drainage, which was performed in 51% (58/113) of patients in the TTE group, and 51% (18/35) in the TEE group. Surgery was performed on one patient (1/10, 10%) with suspected aortic dissection in the TTE group[17] and two (2/54, 4%) in the TEE group.[2] Thrombolysis/embolectomy was performed in seven patients (7/34, 21%) and 28 patients (28/70, 40%) with suspected PE in the TTE[3,16] and TEE[10,24,25,27,30,31] groups, respectively. Coronary angiography or bypass was performed on one patient (1/4, 25%) with suspected MI by TTE[17] and 11 patients (11/28, 39%) by TEE.[21,24,25] Administration of fluid

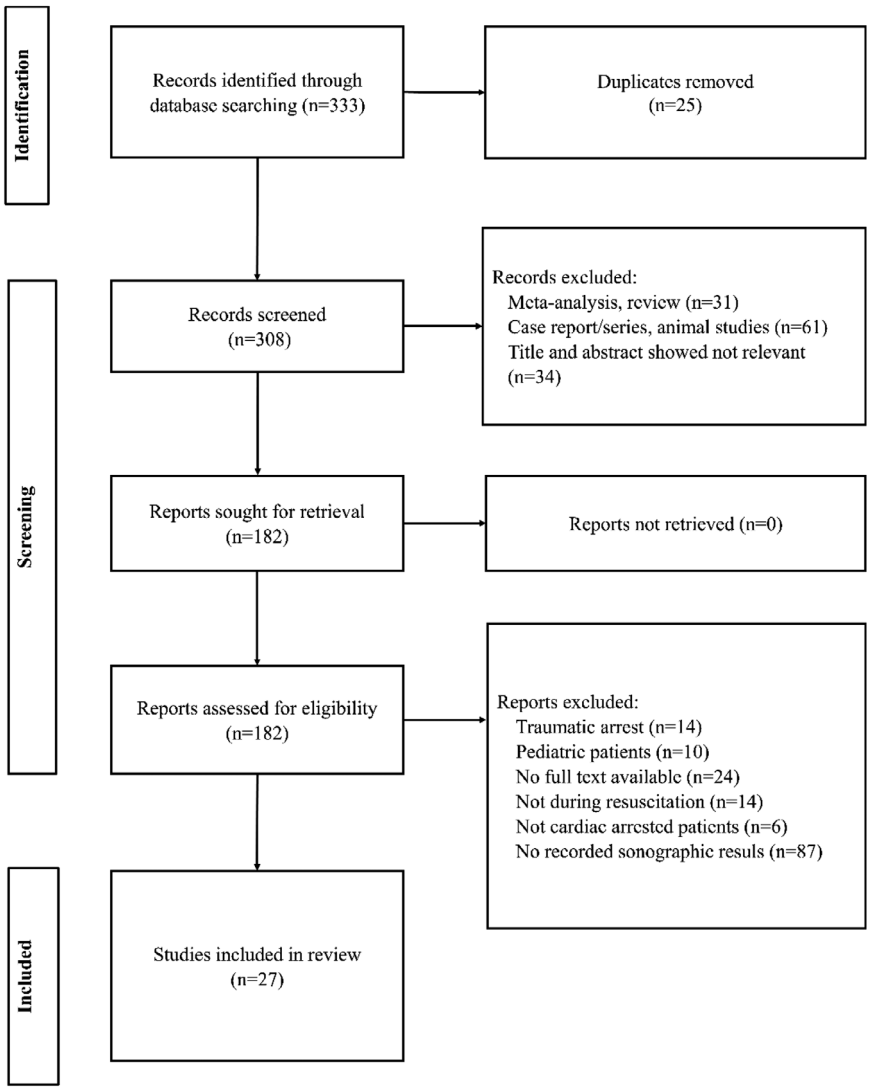

Figure. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram.

was reported in 13 patients (13/26, 50%) with hypovolemia by TTE,[2,12] and four patients (4/6, 67%) by TEE.[13,24,25] Inotropic therapy was administered in 26% (22/84) of patients with LV dysfunction by TTE[2] and 11% (5/46) by TEE.[25,27]

DISCUSSION

Intra-arrest TTE was performed in 2,145 patients in 14 studies, and TEE was used in 556 patients in 16 studies. Both TTE and TEE found positive findings in nearly one-half of the patients. The etiology of CA was identified in 13% of patients with TTE and 43% of patients with TEE. Prompt therapy was administered in 38% of patients with TTE-positive findings and 28% of those with TEE-positive findings. In the TEE group, a higher incidence proportion was observed in identifying the etiology of CA, particularly for those with aortic dissection. However, a high degree of heterogeneity in reference standards and small-sample size precluded further meta-analysis for the diagnostic performance of intra-arrest TTE and TEE.

The major weakness of the included studies is that the reference standards are inconsistent. Applying a uniform standard to all target conditions is not easy, and image review may be an effective solution.[26,31,32,34] The autopsy can be regarded as the gold standard and was performed in three studies,[21,22,25] but the reference standards are diverse in patients with ROSC. Using specific management as reference standards to judge target conditions is not feasible. For example, patients with suspected PE do not receive pericardiocentesis. Also, even failure in pericardiocentesis does not indicate the absence of pericardial effusion. By contrast, pericardial effusion drainage is rarely performed in a small amount of effusion. True-positive cases were often reported, but verification bias existed. Information was limited in the true-negative, false-positive, or false-negative cases. Therefore, this systematic review presented the

Table 2. The quality assessment of diagnostic accuracy studies (QUADAS)-2 risk of bias assessment of the included studies.

	Risk of bias				Concerns regarding applicability		
Study	**Patient selection**	**Index test**	**Reference standard**	**Flow and timing**	**Patient selection**	**Index test**	**Reference standard**
Transthoracic echocardiography							
Varriale et al (1997)	H	L	U	U	L	H	U
Kürkciyan et al (2000)	L	H	L	L	L	H	L
Tayal et al (2003)	U	L	U	U	H	L	U
Breitkreutz et al (2010)	H	L	U	U	H	L	U
Chardoli et al (2012)	H	L	U	U	H	L	U
Shillcutt et al (2012)	H	L	U	U	H	H	U
Flato et al (2015)	L	L	U	U	H	L	U
Gaspari et al (2016)	H	L	U	U	L	L	U
Zengin et al (2016)	U	L	U	U	L	L	U
Chua et al (2017)	U	L	U	U	L	L	U
Lien et al (2018)	H	L	U	U	L	L	U
Balderston et al (2021)	H	L	U	U	L	L	U
Heikkilä1 et al (2023)	U	H	U	U	L	H	U
Lien et al (2023)	H	L	U	U	L	L	U
Transesophageal echocardiography							
Varriale et al (1997)	H	L	U	U	L	H	U
van der Wouw et al (1997)	U	L	U	U	L	L	U
Comess et al (2000)	U	L	U	U	H	L	U
Kürkciyan et al (2000)	L	H	L	L	L	H	L
Miyake et al (2004)	H	L	U	U	H	L	U
Lin et al (2006)	U	L	U	U	L	L	U
Mentsoudis et al (2006)	U	L	U	U	L	L	U
Shillcutt et al (2012)	H	L	U	U	H	H	U
Hilberath et al (2014)	H	L	L	L	H	L	L
Burrage et al (2015)	U	L	U	U	H	L	U
Arntfield et al (2016)	U	L	U	U	U	L	U
Teran et al (2019)	H	L	U	U	L	L	U
Jung et al (2020)	U	L	U	U	L	L	U
Kim et al (2020)	H	L	L	L	L	L	L
Jung et al (2022)	H	L	L	L	L	L	L
Poppe (2023)	H	L	U	U	L	L	U

H, high risk of bias; *L*, low risk of bias; *U*, unclear risk of bias.

incidence of target conditions and could not further explore whether TTE or TEE was better during resuscitation.

One of the most important indicators of the likelihood of ROSC or survival is the presence of sonographic cardiac activity.[35] Sonographic cardiac activity was much more frequently detected by TTE than by TEE (830 vs 25) in our review. Interestingly, regional wall motion abnormality suggestive of MI and LV dysfunction was detected in the presence of sonographic cardiac activity. Even adding the numbers of these conditions, the total number was still higher in patients with TTE. Whether it occurred due to taking a longer time to set up TEE (possibly resulting in resuscitation time bias[36]) was uncertain. Further studies are needed to determine whether TEE can better characterize intra-arrest myocardial movement or cardiac activity detected by TEE is under-reported. The impact of TTE and TEE on

Table 3. Pooled results of target findings on transthoracic echocardiography and transesophageal echocardiography in patients with cardiac arrest.

Findings	Transthoracic echocardiography N; incidence proportion [95% CI]	Transesophageal echocardiography N; incidence proportion [95% CI]
Pericardial effusion	113; 0.068 [0.046; 0.100]	35; 0.117 [0.056; 0.226]
Cardiac tamponade	30; 0.059 [0.041; 0.083]	25; 0.095 [0.036; 0.228]
Aortic dissection	10; 0.023 [0.008; 0.064]	54; 0.119 [0.074; 0.186]
Pulmonary embolism	34; 0.053 [0.021; 0.126]	70; 0.220 [0.116; 0.378]
Myocardial infarction	4; 0.022 [0.002; 0.192]	28; 0.291 [0.131; 0.528]
Hypovolemia	26; 0.044 [0.013; 0.142]	6; 0.147 [0.067; 0.291]
LV dysfunction	84; 0.181 [0.086; 0.343]	46; 0.535 [0.170; 0.866]
Sonographic cardiac activity	830; 0.488 [0.374; 0.604]	25; 0.243 [0.138; 0.390]

LV, left ventricular; *CI*, confidence interval.

ROSC and further survival was still inconclusive in the current dataset.

The most common intervention was pericardial effusion drainage during resuscitation. The outcomes varied depending on the etiology of effusions. One patient with cardiac tamponade and LV free wall rupture secondary to transmural MI by TTE died after an exploratory thoracotomy.[14] Return of spontaneous circulation was not achieved in one patient with tamponade and aortic dissection by TTE.[17] One patient had cardiac tamponade that was not visible on TTE owing to poor acoustic windows but was evident on TEE and survived after surgical treatment.[21] One patient with tamponade and right ventricular rupture survived to discharge after receiving an emergent wall repair.[25] Early termination of resuscitation was conducted in six patients with tamponade due to myocardial rupture and one patient with tamponade due to aortic dissection by TEE.[21,31]

The incidence of aortic dissection was higher by TEE, which was related to direct visualization of the aortic root and descending aorta by the long-axis and short-axis views. However, the data should be cautiously interpreted because Jung et al reported 19 patients [30] and Kim et al reported 10 patients,[31] which could skew the results. Moreover, the outcomes were poor in that only one patient with TTE[20] and two with TEE[23] had ROSC.

Pulmonary embolism is the most reported finding by TEE, which illustrates the thrombi directly[13,22,24,25,27,30] or obstruction to color flow in the pulmonary artery.[10] Transthoracic echocardiography uses the indirect sign of right ventricular dilatation, indicative of PE.[2,3,14–16] However, false-positive and false-negative cases were reported, and not all the patients received thrombolysis or thrombolectomy. Van de Wouw et al reported one had a TEE diagnosis of PE but no embolus was found at autopsy.[21] Comess et al reported bilateral peripheral pulmonary emboli at autopsy but not seen by TEE.[22] Jung et al reported one patient with initial negative TEE findings had thrombi in the main pulmonary artery at the final review, and one patient with saline bubbles in the pulmonary artery was misinterpreted as PE.[30]

Gaspari et al reported one of the 15 patients with suspected PE receiving thrombolysis survived hospital discharge.[3] Chua et al reported one of four patients suggestive of massive PE by TTE receiving thrombolysis survived to discharge.[16] Although the ROSC rates of PE by TTE or TEE were still lower, they were better than those of aortic dissection.

The sonographic finding suggestive of MI on intra-arrest TTE and TEE is regional wall motion abnormality in the presence of sonographic cardiac activity. Van de Wouw et al reported two patients had MI at autopsy that could not be demonstrated with TEE owing to lack of spontaneous rhythm.[21] Lien et al reported extensive anterior wall akinesia of the left ventricle that was identified in one patient with pulseless electrical activity.[17]

A low LV end-diastolic volume is a characteristic finding indicative of hypovolemia by TTE[2] and TEE.[13,24] Fluid resuscitation was reported in two studies of TTE,[2,12] and three studies of TEE.[13,24,25] Lactated Ringer solution infusion in OHCA increased the likelihood of prehospital ROSC[37]; however, the information regarding the details of fluid was lacking in the included studies.

Reduced LV function presented as a common finding by intra-arrest TTE and TEE. Instead of precise measurement, reduced LV function is estimated by visual assessment (eyeballing) via ECHO of an ejection fraction less than 45–55%.[13,14,18] Also, the ventricular function could be assessed only during intervals of spontaneous cardiac contraction.[22] Inotropic therapy was administered in one-fourth of patients with LV dysfunction by TTE[2] and one-tenth of those by TEE.[25,27]

Intra-arrest TTE is a convenient imaging modality, but it is challenged by the technical difficulty in obtaining adequate cardiac windows during the pauses and potential delays in chest compressions.[7] Transesophageal echocardiography has been recognized as an alternative without interfering with ongoing resuscitation efforts. It provides real-time feedback on the location of chest compressions and the quality of cardiopulmonary resuscitation (CPR).[38] However, TEE has disadvantages such as high cost, high level of operator skill training required, and potentially iatrogenic trauma including oropharyngeal esophageal and gastric lacerations, and perforation.[39] Three studies reported no complications or delays in resuscitation procedures.[22,32,33] The transgastric view was excluded from the TEE protocol to avoid potential complications or to lessen interference with the chest compression procedure.[30,31]

LIMITATIONS

There were limitations in this review. First, the selected studies were highly heterogeneous, small-sized samples, with a lack of reference groups and standardized confirmation tests. Most of the patients were collected from a convenience sample from a single institution. Beyond the selection bias, resuscitation facilities and interventions for specific diseases may differ depending on the institution's capability, limiting the generalizability. Future studies assessing the diagnostic accuracy of US in patients with CA should avoid methodological flaws; a randomized controlled trial comparing TTE with TEE would be a solution. Second, the detailed training background of sonographers was unclear in some of the included studies.[10,13,19,21,23–25,34] The 2022 guidelines suggest US can be performed by experienced personnel without interrupting CPR.[1] Third, the timing of the introduction of TTE and TEE was not clear in the studies; so resuscitation time bias could not be estimated.[39] Lien et al used US within 10 minutes of Advanced Life Support (ALS), and Gaspari et al introduced US after five minutes of ALS.[3,17] On the other hand, Jung et al and Kim et al introduced TEE after 10 minutes of ALS.[30,31] Lien et al reported that TTE was performed in patients with longer resuscitation time.[20]

Lastly, the impact of TTE and TEE on ROSC and further survival was not thoroughly discussed. The etiology of CA was identified in 13% of patients with TTE and 43% of patients with TEE. Among them, approximately 20–25% of patients with each target condition achieved ROSC except those with aortic dissection (10%). However, the resuscitation data associated with ROSC such as witnessed arrest, early ALS, and early defibrillation were not presented. Also, patients with early ROSC before US was attempted were excluded from some studies.[3,30] Future research would focus on evaluating the values of TTE and TEE on ROSC, hospital survival, or long-term neurological outcomes.

CONCLUSION

Transesophageal echocardiography could identify more causes of cardiac arrest than transthoracic echocardiography. However, sonographic cardiac activity, indicative of better rates of return of spontaneous circulation, was reported much more in the TTE group. The impact of TTE and TEE on ROSC and further survival was inconclusive in the current data. A high degree of heterogeneity in patient selection and a lack of reference standards precluded further meta-analysis for the diagnostic performance of intra-arrest TTE and TEE.

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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. This study received grant funding from the National Science and Technology Council, Taiwan (NSTC 112-2410-H-002-171). There are no other conflicts of interest or sources of funding to declare.

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Staffing Patterns of Non-ACGME Fellowships with 4-Year Residency Programs: A National Survey

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Section Editor: Benjamin Schnapp, MD
Submission history: Submitted September 13, 2023; Revision received November 10, 2023; Accepted December 7, 2023
Electronically published February 28, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18454

Introduction: Emergency medicine (EM) is one of few specialties with variable training lengths. Hiring a three-year graduate to continue fellowship training in a department that supports a four-year residency program can lead to conflicts around resident supervision. We sought to understand hiring and clinical supervision, or staffing, patterns of non-Accreditation Council for Graduate Medical Education (ACGME) fellowships hosted at institutions supporting four-year residency programs.

Methods: We performed a web-based, cross-sectional survey of non-ACGME fellowship directors (FD) hosted at institutions supporting four-year EM residency programs. We calculated descriptive statistics. Our primary outcome was the proportion of programs with four-year EM residencies that hire non-ACGME fellows graduating from three-year EM residencies.

Results: Of 119 eligible FDs, 88 (74%) completed the survey. Seventy FDs (80%) indicated that they hire graduates of three-year residencies. Fifty-six (80%) indicated that three-year graduates supervise residents. Most FDs (74%) indicated no additional requirements exist to supervise residents outside of being hired as faculty. The FDs cited department policy, concerns about quality and length of training, and resident complaints as reasons for not hiring three-year graduates. A majority (10/18, 56%) noted that not hiring fellows from three-year programs negatively impacts recruitment and gives them access to a smaller applicant pool.

Conclusion: Most non-ACGME fellowships at institutions with four-year EM programs recruit three-year graduates and allow them to supervise residents. This survey provides programs information on how comparable fellowships recruit and staff their departments, which may inform policies that fit the needs of their learners, the fellowship, and the department. [West J Emerg Med. 2024;25(2)175–180.]

INTRODUCTION

Emergency medicine (EM) is one of few specialties in the United States with variable training lengths.[1,2] Most residencies implement a three-year model, while only 20% implement a four-year model.[3–5] There is little data to support either training length.[3–7] Some argue that four-year graduates have more time to gain confidence, develop procedural skills, develop academic interests, and gain experience supervising learners. Advocates of three-year programs argue that an extra year as faculty would provide these same experiences.[1,8,9] These personal biases may impact recruitment and hiring of

three-year graduates at institutions supporting four-year residency programs.[6,7]

When an institution hosting a four-year residency hires a three-year graduate into fellowship training, this can lead to conflicts around clinical supervision, or staffing, of residents related to perceptions of seniority and quality of training.[1,9] There are currently no best practices or guidelines to inform programs on how to address this situation. The situation is further complicated as non-Accreditation Council for Medical Education (ACGME) fellowships frequently lack uniform rules that govern recruitment, program requirements, and clinical responsibilities.[10] No studies currently evaluate the prevalence of these issues or examine variability in recruitment, hiring, and clinical responsibilities of trainees at non-ACGME fellowships. In this study, we sought to understand the hiring and staffing patterns of non-ACGME fellowships hosted at institutions with four-year EM residency programs.

METHODS

Study Design and Participants

This was a cross-sectional survey of fellowship directors (FD) of non-ACGME fellowships hosted at institutions supporting a four-year EM residency program. We conducted the survey between January–April 2023. This study was deemed exempt by our institutional review board (HUM00221519). In November 2022, we generated a list of 54 four-year EM residency programs from the Emergency Medicine Residents' Association (EMRA) Match roster and Electronic Residency Application Service directory.[11–13] We identified non-ACGME fellowships offered using each program's webpage, the Society for Academic Emergency Medicine Fellowship Directory, and the Society for Clinical Ultrasound Fellowships directory.[14,15]

Survey Development and Distribution

We developed the survey based on Panacek's general survey principles, literature review, and expert opinion to provide content validity evidence.[6,16–18] All authors have experience developing survey studies, and the group (including four current or former FDs) iteratively piloted and revised the survey for optimal phrasing, survey length, functionality, and appropriate mix of suggested and open-ended responses, which provided content and response process validity evidence.[18] We used Qualtrics (Qualtrics XM, Provo, UT), a web-based survey platform, to distribute the survey via email with a personalized link for each FD to collect and analyze the data. We sent weekly reminders to FDs' institutional emails, with an option to decline participation, for eight weeks. We then sent personalized weekly reminder emails for an additional four weeks. We collected individual responses to the survey anonymously.

Outcomes and Data Analysis

We asked FDs to report their fellowship type, years in current role, and demographic data such as number of clinical sites, program environment (academic, county, community, etc), and geographic location. Our primary outcome was the proportion of programs affiliated with four-year EM residencies that hire non-ACGME fellows graduating from three-year EM residencies. We also asked clarifying questions to better understand their staffing model, and recruiting, hiring, and clinical oversight policies. The survey included space for comments so that the FDs could provide context to their answers, but we did not analyze these for themes. The full survey is available in Appendix A1. We analyzed the data using Excel 365 (Microsoft Corporation, Redmond, WA) to generate descriptive statistics and analysis. We assessed the association between categorical variables using the Fisher exact test. We did not calculate an a priori sample-size estimate as we attempted to capture a 100% response rate.

RESULTS

Of 54 four-year EM residencies in the US, 32 institutions offered at least one non-ACGME fellowship with a total of 128 fellowships identified (median 3.5; range 1–10). We received 88 responses after excluding nine opt-outs and one blank response (88/119) for a response rate of 73.9%. Program and FD characteristics are listed in the Table. Free text responses are included in Appendix A2.

Of the 88 responses, 70 FDs (80%) reported hiring graduates of three-year EM programs for their respective fellowships. Fifty-six FDs (80%) who accept three-year graduates indicated that their fellows can supervise EM residents. We found variation in who fellows could supervise. The most common policy (40%) was that fellows can supervise EM postgraduate-year (PGY)-3 residents and below. Most FDs (74%) indicated that they had no additional requirements to supervise residents outside of being hired on as faculty. Full survey results appear in the Figure.

Programs with multiple clinical sites are more likely to hire three-year graduates. Ten of 23 programs (57%) with one clinical staffing site hired three-year graduates compared to 88% (57/65) of sites with two or more clinical sites ($P < 0.001$). The FDs reported the implementation of various strategies to mitigate potential conflicts. One program hosts a joint fellowship curriculum for their fellows, which incorporates instruction on bedside teaching, giving feedback, and teaching various skills. Other FDs reported that their programs prevented their fellows from staffing in high acuity areas or delay working with residents.

Twenty-seven FDs (50%) cited department policy as the reason for their hiring and staffing policies. Selected comments from other FDs included concerns about quality and length of training and resident complaints. Others

Table. Demographic details of the fellowships represented in our survey of fellowship directors of non-ACGME fellowship programs.

Demographics	Number of responses (%)
Fellowship type	
Admin/operations	14 (15%)
Cardiology and resuscitation	1 (1%)
Climate and health policy	1 (1%)
Digital health	1 (1%)
Disaster medicine	3 (3%)
Global health/international medicine	7 (7%)
Health humanities	1 (1%)
Health policy	1 (1%)
Medical education	18 (19%)
Neurologic emergencies	1 (1%)
Pediatric ultrasound	1 (1%)
Physician wellness	1 (1%)
Research	9 (9%)
Simulation	5 (5%)
Social medicine	3 (3%)
Ultrasound	22 (23%)
Wilderness medicine	3 (3%)
Program region	
Central (IL, IN, IA, KS, MI, MN, MO, NE, OH, WI)	13 (15%)
Northeast (CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT)	45 (51%)
Southern (AL, AR, FL, GA, KY, LA, MS, NC, OK, PR, SC, TN, TX, VA, WV)	0 (0%)
Western (AZ, CA, CO, NM, NV, OR, UT, WA)	30 (34%)
Category of primary residency site*	
Academic (university based)	81 (82%)
Community	0 (0%)
County	15 (15%)
Other	3 (3%)
Category of non-ACGME fellow's primary clinical site*	
Academic (university based)	74 (46%)
Community	46 (29%)
County	23 (14%)
Other	17 (11%)
Number of clinical sites non-ACGME fellows clinically staff	
1	22 (25%)
2	33 (38%)
3	26 (30%)
4	6 (7%)

*Respondents could select more than one type of clinical site.

reported their clinical environment was not conducive to separating fellows from residents. Seven FDs reported wanting to avoid PGY-4 fellows staffing PGY-4 residents. One FD indicated that "because we are a 4-year program, we want to acknowledge to our residents that 4 years is what we think is required for graduation."

Among the programs not hiring fellows from three-year programs, 56% (10/18) of FDs noted that this policy

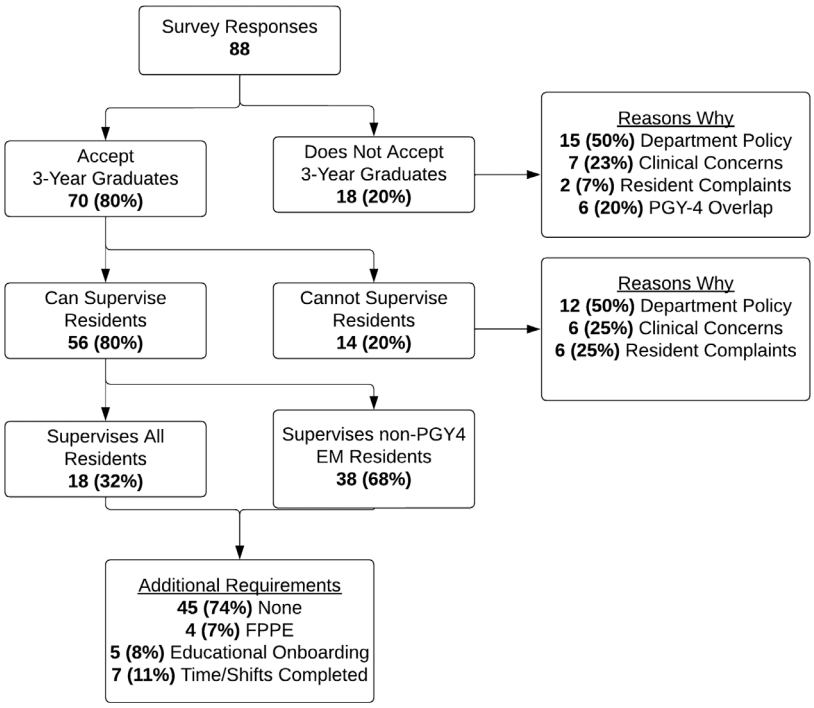

Figure. Flow diagram detailing the survey response hierarchy of fellowship directors of non-Accreditation Council for Graduate Medical Education fellowships regarding clinical supervision patterns for 3-year emergency medicine (EM) residency graduates at institutions with a 4-year EM program.
EM, emergency medicine; *PGY*, postgraduate year; *FPPE*, focused professional practice evaluation.

negatively impacted their fellowship recruitment and gave them access to a smaller pool of applicants.

DISCUSSION

To our knowledge this study is the first to describe staffing patterns of non-ACGME fellowships hosted at institutions with four-year EM residencies. Most of the FDs we surveyed hire three-year graduates as fellows, and most programs permit three-year graduates to staff residents with no additional requirements beyond being hired. We also identified potential negative impacts on fellowships as they restrict their applicant pool. One FD indicated that their fellowship was mostly going unfilled due to their recruitment policy. Another indicated that the financial sacrifice of a four- vs three-year residency may unintentionally favor recruitment of those without financial need or burden, especially since the debt load of EM applicants is reportedly higher than for other medical specialties.[1]

Some programs offer their fellows alternative clinical sites – such as Veterans Affairs hospitals, freestanding EDs, or urgent cares. By staffing multiple locations, non-ACGME fellows can work without a resident presence. This flexibility allows programs to hire three-year graduates and permits fellows to interface with residents academically without having to supervise them clinically. This allows for a training environment conducive to the needs of all learners' growth and development.

The FDs cited clinical concerns and department policy as the main reasons for their staffing and hiring policies. There is a lack of objective data that four-year graduates outperform three-year graduates clinically or on the qualifying written board exam, suggesting that this may be rooted in bias.[1,6,7] In the absence of robust data to support the clinical capabilities of trainees from either three- or four-year programs, the principles of competency-based medical education (CBME) may offer solutions.[19] The principles of CBME require demonstration of competency and decouple attainment of competency from time-in-training.[19] The use of CBME to determine readiness for unsupervised practice through a process known as "promotion in place" has been piloted by some residency programs and may be a useful model to replicate in determining fellow readiness for staffing, regardless of PGY status.[19,20] If we remove the focus from time-bounded training and focus on demonstrated skill acquisition, programs may design processes to onboard three-year graduates by focusing on developing and assessing appropriate skills for supervision of trainees.

Future studies could explore who sets departmental policies regarding fellow staffing, evaluate fellow and resident perceptions of staffing policies, and compare

career outcomes of fellows working in various staffing environments.

LIMITATIONS

We may not have captured all non-ACGME fellowships at four-year institutions. We did not identify fellowship directories besides ultrasound, which may have led to sampling bias. We attempted to mitigate this by searching specific program websites for listed fellowships. The FDs who did not participate in our study may represent a unique population with different hiring and staffing patterns. We did not identify non-ACGME fellowships hosted at four-year EM programs in the southern US, nor did we receive responses from primarily community EM programs, which could also have biased our results. We did not survey ACGME-accredited fellowships, as fellows vary in the way they "maintain their primary Board skills."[21] Some ACGME fellowships (eg, critical care, emergency medical services) do not require minimum clinical hours in the emergency department, which leads to a qualitatively different experience from non-ACGME fellowships, where fellows are appointed as clinical faculty.[2,21,22]

CONCLUSION

Our results indicate that most non-ACGME fellowships hosted at institutions with four-year EM programs recruit graduates of three-year programs and allow them to supervise residents. This survey data provides program information on how comparable fellowship programs recruit and staff their departments, which may inform policies that fit the needs of their learners.

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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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Changes in Residency Applicant Cancellation Patterns with Virtual Interviews: A Single-site Analysis

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Section Editors: Abra Fant, MD, and William Edward Soares, MD
Submission history: Submitted October 1, 2023; Revision received February 7, 2024; Accepted February 21, 2024
Electronically published March 14, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18487

Background: Residency programs transitioned to primarily virtual interviews due to the COVID-19 pandemic. This shift raised questions regarding expectations and patterns of applicant cancellation timeliness. The purpose of this study was to examine changes in applicant cancellations after transitioning to virtual interviews.

Methods: This was a retrospective cohort study of interview data from a three-year emergency medicine residency at a tertiary-care academic medical center. Using archived data from Interview Broker, we examined scheduling patterns between one in-person (2019–2020) and two virtual interview cohorts (2020–2021 and 2021–2022). Our outcomes were the overall cancellation rates relative to interview slots as well as the proportion of cancellations that occurred within 7 or 14 days of the interview date.

Results: There were 453 interview slots and 568 applicants invited. Overall, applicants canceled 17.1% of scheduled interviews. Compared with in-person interviews, applicants canceled significantly fewer virtual interviews (in person: 40/128 (31.3%), virtual year 1: 22/178 (12.4%), virtual year 2: 15/143 (10.5%), $P = 0.001$). Conversely, applicants canceled significantly more virtual interviews within both the 14-day threshold (in person: 8/40 (20%), virtual year 1: 12/22 (55.5%), virtual year 2: 12/15 (80%), $P < 0.001$) and the 7-day threshold (in person: 0/40 (0%), virtual year 1: 3/22 (13.6%), virtual year 2: 4/15 (26.7%), $P = 0.004$).

Conclusion: While limited, at our site, changing to a virtual interview format correlated with fewer cancellations overall. The proportion of cancellations within 14 days was much higher during virtual interview seasons, with most cancellations occurring during that time frame. Additional studies are needed to determine the effects of cancellation patterns on emergency medicine recruitment. [West J Emerg Med. 2024;25(2)181–185.]

INTRODUCTION

Historically, residency applicants traveled to US programs for in-person interviews. In 2020, the COVID-19 pandemic led the Coalition for Physician Accountability (COPA) to recommend that residency programs conduct only virtual interviews.[1] Proponents of virtual interviews cited cost and safety as potential upsides, and applicants have reported overall satisfaction with virtual interviews and more advantages than barriers.[2–4] However, programs have expressed continued doubts about some aspects of virtual recruitment.[2]

Even before the pandemic, there were no established rules across specialties regarding an acceptable timeframe for interview cancellations. For emergency medicine, the Emergency Medicine Resident Association (EMRA) recommended at least two weeks' notice in their 2019 "EMRA and CORD Student Advising Guide."[5] In 2020, the first year of virtual interviews, email communication on the Council of Residency Directors in Emergency Medicine (CORD) listserv suggested that program directors' acceptable cancellation thresholds ranged from 48 hours to 10 days prior to the interview date.[6] Ultimately, CORD stated that seven days was recommended for applicants in a 2020 blog post about interviewing during the pandemic, while other publications still recommended two weeks.[7,8] Currently, the 2023 CORD Application Process Improvement Committee and the 2022–2023 National Resident Matching Program (NRMP) agreement have advised applicants to cancel no later than 1–2 weeks before their interview dates.[9,10]

Virtual interviews may be here to stay, as evidenced by recent COPA and Association of American Medical Colleges (AAMC) statements, as well as the 2023-24 CORD guidelines.[11–13] Understanding patterns of virtual interview cancellation behavior may help program directors, applicants, and their advisors prepare for a successful Match. To characterize the effects of virtual recruitment on interview cancellations, we compared in-person interview cancellation patterns to those of virtual recruitment cycles at our academic emergency medicine (EM) residency.

METHODS

This was a retrospective cohort study at a three-year EM residency sponsored by a tertiary-care, academic medical center in an urban setting in the south-central United States. This residency is an established program (founded in 1984) with a class size of 10 residents per year, which increased to 12 residents for the 2022 Match. The University of Arkansas for Medical Sciences Institutional Review Board (IRB) approved this study in exempt status.

Our program began using the online interview scheduling software Interview Broker (The Tenth Nerve, LLC, Lewes, DE; www.interviewbroker.com) in Fall 2019 to invite applicants to interview. In Fall 2020, interviews transitioned from in person to virtual and additional slots were added, with CORD continuing to recommend virtual interviews for EM residencies in subsequent cycles. Similar to in-person interviews, applicants for virtual interviews are invited in a 1:1 applicant to slot ratio and given 48 hours to respond before another applicant is invited.

Using archived data from Interview Broker, we examined scheduling patterns between the in-person interview cohort (2019–2020 season) and two virtual interview cohorts (Virtual Year 1: 2020–2021 and Virtual Year 2: 2021–2022). Unfortunately, cancellation data prior to the initiation of Interview Broker at our site was not available. A single investigator abstracted data from Interview Broker in aggregate form by academic year using overall counts of relevant variables, including number of interview slots, days, invitations, interviews scheduled/unscheduled (ie, no applicant response received)/declined, cancellations, and the timing of those cancellations relative to the interview date. We defined an interview cancellation as an interview that was scheduled, canceled, and never rescheduled; interviews that were rescheduled were considered completed. Demographic variables were not available as Interview Broker only records the student's name and AAMC ID; accessing additional information would have required querying the Electronic Residency Application Service, which was not covered in our exempt IRB agreement.

Our outcomes were the overall proportion of interview cancellations relative to interview slots, as well as the proportion of interview cancellations that occurred within 14 days of the interview date and within seven days of the interview date. Descriptive statistics were performed. We performed comparisons using chi-squared or the Fisher exact test as some observations were uncommon. All comparisons were two-sided with $\alpha = 0.05$. Analyses were performed using SPSS Statistics for Macintosh Version 28.0 (IBM Corporation, Armonk, NY).

RESULTS

Over three years, there were 453 interview slots and 568 applicants invited. Most of the interview slots were virtual (71.7%). Overall, the program sent out 1.25 interview applications per slot and applicants canceled 17.1% of scheduled interviews (Table 1). We found a significant decrease in the proportion of overall cancellations relative to filled interview slots, with 40/128 (31.3%), 22/178 (12.4%), and 15/143 (10.5%) cancellations for in-person, virtual year 1, and virtual year 2, respectively ($P < 0.001$). When analyzed further and adjusting for multiple comparisons, the decrease was significant when comparing in person vs. either virtual year, but not when comparing the two virtual years.

While fewer interviews were canceled, the proportion of virtual interview cancellations that occurred within 14 days of the interview date was significantly higher (in person: 8/40 (20%), virtual year 1: 12/22 (55.5%), virtual year 2: 12/15 (80%), $P < 0.001$). Similarly, more virtual interviews were canceled within seven days of the interview date (in person: 0/40 (0%), virtual year 1: 3/22 (13.6%), virtual year 2: 4/15 (26.7%), $P = 0.004$), although these numbers were low overall. In both the 14 and 7 day cancellation analyses, these data indicated a year-over-year increase, meaning in both 14 and 7 day comparisons we saw a significant increase in cancellations between in person and virtual year 1, and again saw a significant increase between virtual year 1 and virtual year 2. See Figures 1 and 2 for graphical breakdown of the

Table 1. Breakdown of in-person and virtual interview cohorts; total counts provided unless otherwise specified.

Interviews and Cancellations Interview group	In person	Virtual year 1	Virtual year 2
Number of interview days	15	16	16
Number of interview slots	128	180	145
Number of applicants invited	195	206	167
Number of invitations per interview slot	1.52	1.14	1.15
Total interview slots filled	128	178	143
Number of unscheduled invitations (ie, no applicant response received)	14	1	3
Number who declined without scheduling	13	5	6
Overall cancellations (% of scheduled)	40 (31.3%)	22 (12.4%)	15 (10.5%)
Number who canceled < 7 days (% of canceled)	0 (0%)	3 (13.6%)	4 (26.7%)
Number who canceled 7–14 days (% of canceled)	8 (20%)	9 (40.9%)	8 (53.3%)
Number who canceled >14 days (% of canceled)	32 (80%)	10 (45.5%)	3 (20.0%)
Overall declined, unscheduled, or canceled (% of total invited)	67 (34.4%)	28 (13.6%)	24 (14.3%)

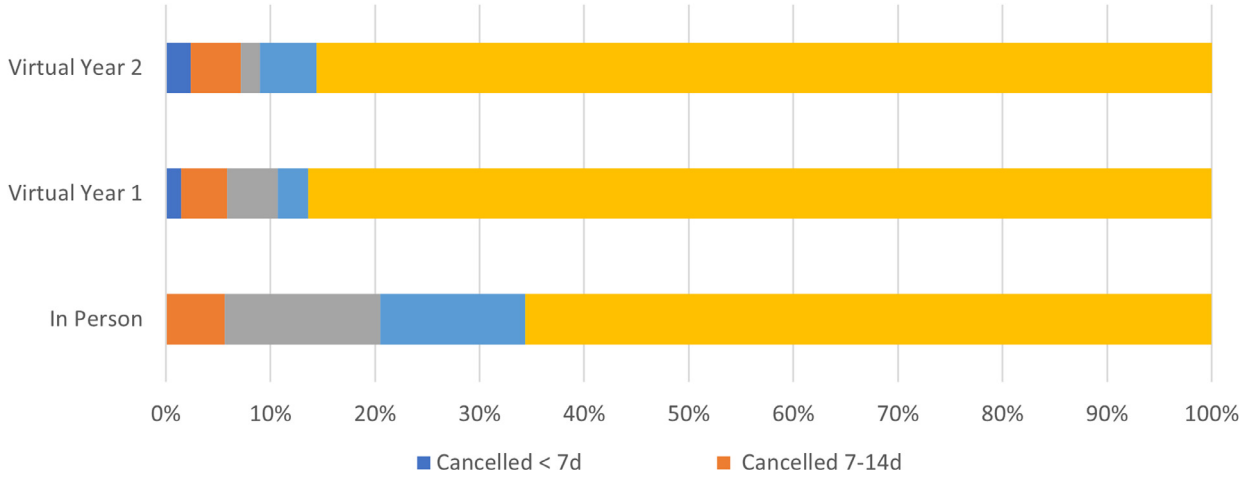

Figure 1. Overall distribution of invited applicants.

overall distribution of invited applicants and interview cancellation rates.

DISCUSSION

Compared with in-person interviews, applicants to our program were less likely to cancel their virtual interview. Of those who did cancel, several virtual applicants canceled within seven days, and most cancellations occurred within 14 days of the interview date. For in-person interviews, applicants were traditionally instructed to cancel as soon as possible and at least two weeks prior to the interview date.[5] As discussed previously, recommendations for EM virtual interview cancellations have ranged from 48 hours to two weeks, with the NRMP currently recommending at least 1–2 weeks in advance.[10] Our results suggest that short-notice cancellations (ie, less than two weeks) by students may be more common in the virtual era.

We are not aware of literature regarding the specific timing of virtual interview cancellations, but our finding of fewer overall cancellations is consistent with Lewkowitz et al's findings that maternal-fetal medicine fellowship virtual interviews had a lower rate of cancellations compared with in-person interviews (39.1% vs 72.3%).[14] This could stem from the reduced time and cost required to interview virtually.[15,16]

Unfortunately, fewer interview cancellations overall could contribute to interview hoarding and an inequitable distribution of interviews. The AAMC and some specialties have expressed concerns about higher quality applicants receiving invitations for and scheduling excessively high numbers of interviews and leaving lower tier students with

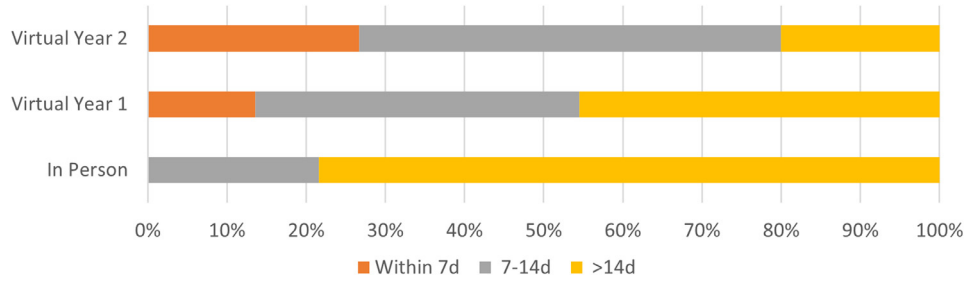

Figure 2. Interview cancellations by length of time from interview. *d*, day.

fewer options.[15,17] While this has not been studied in EM specifically, the Emergency Medicine Consensus Statement on the 2020–2021 Residency Application process suggested an interview limit of 17 interviews and encouraged applicants not to interview at their less-preferred programs lower on their list to "make these slots available to other students," indicating a potential concern for the effects of hoarding such as "peers not matching and/or programs not filling."[18]

Short-notice interview cancellations pose a few other challenges for residency programs. Previously, filling an in-person interview slot required finding a replacement who could still arrange travel to the interview location, which is no longer relevant for virtual interviews. Nonetheless, the NRMP requires that programs provide no less than 48 hours for applicants to respond to interview invitations.[10] If applicants are canceling only a few days before an interview, filling the open spot may be a challenge since programs cannot invite more than one applicant at a time per spot. Short-notice cancellations can also be problematic as interviewers may have to review candidates' applications well in advance of the interview date. With short-notice cancellations, this could mean lost time for interviewers who had already reviewed those applications or inadequate time to review the replacements.

Conversely, program directors want to avoid interviewing applicants who are not interested in their program, and a cancellation—even on short notice— provides an opportunity to interview an applicant with greater interest in the program. In our case, we had only four open interview spots over the first two virtual years (two unfilled per year), indicating that we filled most canceled spots. Therefore, while no official opinion exists, program directors may not mind short-notice cancellation as long as the interview schedule is full. In fact, they may prefer for the applicant not to feel pressured to interview at a program in which they are uninterested only because they are concerned about canceling, with short notice being viewed as unprofessional. As virtual interviews appear to be here to stay, understanding cancellation patterns will be important for programs, especially in balancing the timing cancellations with new invitations so programs can ideally maintain a full interview schedule.

LIMITATIONS

This study was limited to one specialty at a single institution, therefore the generalizabilty of these findings to other institutions or specialties is unclear, especially given the small sample size and limited pre-post period. The changing landscape of EM residency recruitment may also affect the generalizability of these findings. Unfortunately, we had only one year of in-person interview data as we did not keep these records prior to the use of Interview Broker, which could have introduced bias. We also had an increase in resident complement during virtual year 2, which may have confounded the results. Unfortunately, we were unable to include demographic data, which might have helped to identify additional cancellation patterns. Lastly, examining trends in those who reschedule interviews was not performed in this study and may be of value in future investigations, as some downsides discussed with short-notice cancellations (eg, filling empty slots; having time to review applications) would still occur in applicants who are rescheduling with short notice.

CONCLUSION

Compared with in-person interview cycles, applicants to our residency program were significantly less likely to cancel virtual interviews. However, the majority of virtual cancellations that did occur were within 14 days of the interview date and nearly one-fifth occurred in under seven days. Additional studies, ideally multisite that include applicant demographic data, are needed to determine how cancellation patterns affect EM recruitment and match outcomes in the virtual era.

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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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Virtual Interviews and the Pediatric Emergency Medicine Match Geography: A National Survey

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Section Editors: Kendra Parekh, MD, and Chris Merritt, MD
Submission history: Submitted November 15, 2023; Revision received February 10, 2024; Accepted February 21, 2024
Electronically published March 14, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18581

Introduction: Virtual interviews (VI) are now a permanent part of pediatric emergency medicine (PEM) recruitment, especially given the cost and equity advantages. Yet inability to visit programs in person can impact decision-making, leading applicants to apply to more programs. Moreover, the cost advantages of VI may encourage applicants to apply to programs farther away than they might otherwise have been willing or able to travel. This could create unnecessary strain on programs. We conducted this study to determine whether PEM fellowship applicants would apply to a larger number of programs and in different geographic patterns with VI (2020 and 2021) as compared to in-person interviews (2018 and 2019).

Methods: We conducted an anonymous national survey of all PEM fellows comparing two cohorts: current fellows who interviewed inperson (applied in 2018/2019) and fellows who underwent VIs in 2020/2021 (current fellows and those recently matched in 2021). The study took place in March–April 2022. Questions focused on geographic considerations during interviews and the match. We used descriptive statistics, chi-square and *t*-tests for analysis.

Results: Overall response rate was 42% (231/550); 32% (n = 74) interviewed in person and 68% (n = 157) virtually. Fellows applied to a median of 4/6 geographic regions (interquartile range 2, 5). Most applied for fellowship both in the same region as residency (216, 93%) and outside (192, 83%). Only the Pacific region saw a statistically significant increase in applicants during VI (59.9% vs 43.2%, $P = 0.02$). There was no statistical difference in the number of programs applied to during in-person vs VI (mean difference (95% confidence interval 0.72, –2.8 – 4.2). A majority matched in their preferred state both during VI (60.4%) and in-person interviews (65.7%). The difference was not statistically significant ($P = 0.45$).

Conclusion: While more PEM fellowship applicants applied outside the geographic area where their residency was and to the Pacific region, there was no overall increase in the number of programs or geographic areas PEM applicants applied to during VI as compared to in-person interview seasons. As this was the first two years of VI, ongoing data collection will further identify trends and the impactof VI. [West J Emerg Med. 2024;25(2)186–190.]

INTRODUCTION

Since 2020, virtual interviews (VI) have been preferred for trainee recruitment.[1] With the benefits of lower cost and greater equity, it is likely to remain a permanent part of recruitment, despite a general preference for face-to-face interviews.[2–5] The VI process and associated perceptions have been described in the literature.[2,3,6–9] The inability to visit a program in person can impact decision-making during ranking,[4,10–14] and an increased number of applications could create undue strain on programs.[15–17]

Geographic location, sense of "fit," and program leadership were described as major contributors to applicants' rank preference.[18] A national cohort of pediatric emergency medicine program directors (PEM PD), in a joint statement, raised concern that VI could lead applicants to apply to more programs and to programs farther away than they may be willing or able to travel.[10] We conducted this study to determine whether PEM fellowship applicants would apply to a larger number of programs and in different geographic patterns with VI (2020 and 2021) as compared to in-person interviews (2018 and 2019).

What do we already know about this issue?
Virtual interviews are a permanent part of recruitment. They offer cost and equity advantages while posing challenges to both applicants and programs.

What was the research question?
Did PEM fellowship applicants apply to a larger number of programs and in different geographic patterns with VI as compared to in-person interviews?

What was the major finding of the study?
VI did not have a significant impact on the number of programs or geographic areas applicants applied to.

METHODS

Design and Participants

This was an anonymous, self-administered, cross-sectional, web-based survey of PEM fellows in the United States. Participation was voluntary, and no incentive was provided for completion. The study was exempted by the institutional review board at Yale University, with informed consent implied by completion of the survey by participants.

Survey Development

The survey questionnaire was developed through iterative feedback and a modified Delphi process to determine item importance. Thirteen PEM PDs with expertise in performance and evaluation participated in multiple rounds of revisions and editing. Pilot testing was conducted with two pediatric hospital medicine fellows who had applied to the match during VIs and two pediatric chief residents who were also interviewing for fellowships using VI, at the lead institution. Revisions were made based on pilot feedback (survey provided in Supplementary Appendix 1). The survey included multiple-choice questions about location of residency, states applied to and interviewed for fellowship, preferred location for fellowship, states visited in person for the purpose of the match, and state matched in. It also asked fellows to indicate states of residence of immediate family (parents, siblings, or partners) and about compelling reasons (other than family) that may have led fellows to favor a state or region (free text). Geographic regions were defined as Northeast, Southeast, Midwest, Southwest, Rocky Mountain, and Pacific regions.[19]

Survey Distribution

The survey was reviewed and approved by the American Academy of Pediatrics (AAP) Section on Emergency Medicine (SOEM) PD survey subcommittee prior to distribution on Qualtrics (Qualtrics, Provo, UT) to all PEM PDs, via the AAP SoEM PD Committee listserv. The PDs forwarded the survey link to their current and incoming fellows (those recently matched to start in July 2022). Each PD completed a separate questionnaire indicating the total number of current and recently matched fellows to whom they forwarded the survey.

Analysis

Participants were divided into two groups: VI (2020 or 2021) and in person (2018 or 2019). We performed descriptive statistics including frequencies, percentages, means with standard deviations, and medians with interquartile range (IQR). Chi-square tests compared categorical variables and t-tests, continuous variables with 95% confidence intervals (CI). We considered a two-tailed alpha of <0.05 to be statistically significant. We conducted analyses in IBM SPSS Statistics version 28 (IBM Corporation, Armonk, NY).

RESULTS

The PDs reported that they forwarded the survey to 406 current fellows and 144 incoming fellows. The response rate for current fellows was 35% (143/406) and for incoming fellows, 61% (88/144). Overall, the response rate was 42% (231/550). Of the total respondents, 62% (143/231) were current fellows and 38% (88/231) incoming. Two fellows (1%) did not complete residency in the US, and 12 (5%) applied to PEM fellowship more than once.

All incoming fellows had undergone VI, whereas 48% of the current fellows had undergone VI (69/143). Overall, 32% of respondents (74/231) interviewed in person and 68% (157/213) virtually. There was no statistical difference in the number of programs applied to during in-person vs VI (mean difference (95% CI): .72 [−2.8, 4.2]) (Appendix 2 Table).

Data describing the geographic training and location preference of participants are presented in the table in appendix 2. Fellows applied to a median of four of the six geographic regions (IQR 2, 5). Most participants applied for fellowship in the same geographic region as their residency (216, 93%) and outside their residency region as well (192, 83%). Only the Pacific region saw a statistically significant increase in applicants during VI (59.9% vs 43.2%, $P = 0.02$) (Table 1).

Less than half of respondents had immediate family members living in the same state as residency (N = 111, 48%), fellowship (N = 90, 39%), or their preferred match state (N = 95, 41%). Compelling reasons to apply to an area included familiarity with location (N = 128, 55%); similar location to residency (N = 65, 28%); and a desire to train in a new area (N = 53, 23%). Partner's employment was an important factor for 89 (38%), salary and cost of living for 76 (33%), and school for children for 20 (9%).

DISCUSSION

Our results show that VI may allow some candidates to explore and consider regions they may not have otherwise due to logistical or financial constraints, without increasing the number of programs, regions or states they apply to. These results are consistent with the 2021 NRMP survey where 52% reported no impact of the VI on the number of programs applied to.[5] Residency programs have reported an increase in matched internal candidates during VI.[11,12,20,21] In PEM, a pre-pandemic study of PDs showed that 29% of fellows completed residency at the same institution.[22] While we did not have data at the institutional level, there was no significant increase in fellows matching within the state of their residency program with VI. This suggests that VI were not a significant detriment to applicants ranking programs and geographic areas, despite the absence of opportunities to meet in person and visit programs. This also allows programs to have access to a larger and potentially more diverse pool of candidates.[9]

Proximity to family was not a significant consideration for most applicants and was not impacted by VI. Residency

Table 1. Influence of virtual interviews on applicant behavior and outcomes.

	In-person interviews (N = 74)	Virtual interviews (N = 157)	Statistical significance (*P* value or 95% CI)
Applied to region for fellowship, N (%)			
Northeast	59 (79.7)	123 (78.3)	0.81
Southeast	41 (55.4)	102 (65)	0.16
Midwest	50 (67.6)	111 (70.7)	0.63
Southwest	38 (51.4)	86 (54.8)	0.63
Rocky Mountains	31 (41.9)	73 (46.5)	0.51
Pacific	32 (43.2)	94 (59.9)	0.02
Applied to same geographic region as residency, N (%)	71 (98.6)	145 (94.8)	.278
Applied outside geographic region as residency, N (%)	56 (77.8)	136 (88.9)	0.03
Number of regions applied to, mean (SD)	3.4 (1.8)	3.8 (1.8)	Mean difference (95% CI): .36 (−.15, .89)
Number of states applied to, mean (SD)	9 (7.3)	9.7 (6.8)	Mean difference (95% CI): .73 (−1.2, 2.7)
Number of programs applied to, mean (SD)	13.3 (12.8)	14 (12.5)	Mean difference (95% CI): .72 (−2.8, 4.2)
Number of programs interviewed at, mean (SD)	7.2 (4.7)	6.9 (5.2)	Mean difference (95% CI): −3.1 (−1.7, 1.1)
Matched in preferred state, N (%)	46 (65.7)	84 (60.4)	0.46
Matched in same state as residency, N (%)	31 (42%)	59 (38%)	0.58
Preferred to match in state with immediate family present, N (%)	36 (52.9)	59 (46.8)	0.42
Went to visit state/program, N(%)	9 (14)	23 (17)	0.61

CI, confidence interval.

applicants reported geography, quality of life, case variety, curriculum, institutional reputation, expertise in areas of interest, and program size as key factors.[23] Applicants to PEM highlighted familiarity with the region or wanting to explore a new area as factors for exploring programs in different regions.

LIMITATIONS

Limitations of this study include the smaller response rate of the current fellows as compared to the incoming fellows. This low response rate limited the sample size of the in-person cohort, impacting the statistical significance of our results. This differential response from the incoming fellows may have been due to desirability bias where this cohort of applicants may have tended to state that they matched in their preferred state. To minimize this, we designed our study to be fully anonymous and self-administered, and the questions were worded to retain objectivity of the answers. Respondents may also have experienced recall bias regarding the states and programs to which they applied. This bias could potentially have contributed to the lower response rate among the current fellows who had interviewed in 2018/2019, 3–4 years prior to the survey date, compared to the more recent applicants who had a more recent recollection of the questions asked in the survey.

Another limitation is that we didn't explicitly ask the total number of fellows in each class cohort; however, since the PEM fellowship class size in the US doesn't vary significantly from year to year (by virtue of the approved fellowship positions available), the denominator is expected to be relatively constant.

This study was not designed to look at the rates of applications to individual programs nor assess the post-match opinions of programs and fellows regarding the results of the match. This information would provide a deeper insight into the impact of the recruitment process; however, it is also prone to bias as fellows only experience training at a single institution. We also did not take into consideration the concentration of PEM programs by region or the available fellowship slots per program or region. However, the objective of this study was to look at the differences before and during VIs, and there was not a significant change in available fellowship slots or programs during these years. As the number of pediatric fellowship applicants rises, further investigation into the impact of VIs is necessary to gain a deeper understanding of its implications and to optimize this process both for applicants and programs.[24]

CONCLUSION

While more PEM fellowship applicants applied outside the geographic area where their residency was and to the Pacific region, there was no overall increase in the number of programs or geographic areas that PEM applicants applied to during VI during the first two years of its institution, as compared to in-person interview seasons. Ongoing monitoring of the interview and match seasons will help identify future trends and impact of VIs.

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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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Analysis of Anonymous Student Narratives About Experiences with Emergency Medicine Residency Programs

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Section Editors: Jeffrey Druck, MD, and Michael Gottlieb, MD
Submission history: Submitted March 15, 2023; Revision received October 18, 2023; Accepted November 21, 2023
Electronically published February 5, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.17973

Background: Academic emergency medicine (EM) communities have viewed anonymous online communities (AOC) such as Reddit or specialty-specific "applicant spreadsheets" as poor advising resources. Despite this, robust EM AOCs exist, with large user bases and heavy readership. Insights about applicants' authentic experiences can be critical for applicants and program leadership decision-making. To date, there are no EM studies to qualitatively assess EM AOC narratives during the application cycle. Our goal was to perform a qualitative analysis of students' EM program experiences through a publicly available AOC.

Methods: This was a qualitative analysis of a publicly available, time-stamped, user-locked AOC dataset: "Official 2020–2021 Emergency Medicine Applicant Spreadsheet." We extracted and then de-identified all data from selected sub-sheets entitled "Virtual Interview Impressions" and "Rotation Impressions." Four investigators used constant comparative method to analyze the data inductively, and they subsequently met to generate common themes discussed by students. Preliminary thematic analysis was conducted on a random sample of 37/183 (20%) independent narratives to create the initial codebook. This was used and updated iteratively to analyze the entire narrative set consisting of 841 discrete statements. Finally, two unique codes were created to distinguish whether the identified sub-themes, or program attributes, were likely "modifiable" or "non-modifiable."

Results: We identified six major themes: living and working conditions; interpersonal relationships; learning experiences, postgraduate readiness, and online/virtual supplements. Common sub-themes included patient population (13%); resident personality (7%); program leadership personality (7%); relationship with faculty/leadership (6%); geography (4%); practice setting (4%); program reputation (4%), and postgraduate year-3 experiences (4%). Modifiable sub-themes outnumbered non-modifiable sub-themes, 60.7% to 39.3%.

Conclusion: In this analysis of selected medical students' narratives in an AOC, the majority of identified themes represented topics that may serve as external feedback for EM residency programs and their clerkships. Selective use of AOCs may set a precedent for future program assessments by applicants and inform program leadership of important programmatic elements in the eyes of applicants. It elucidates important themes in their interactions or learning experiences with programs and creates opportunities for learner-centric program improvement. [West J Emerg Med. 2024;25(2)191–196.]

INTRODUCTION

The academic community has traditionally viewed anonymous online communities (AOC) as poor resources for advising, recommending that students be wary of them or avoid them altogether.[1] Common themes addressed against these forums include lack of commenter professionalism,[2–4] information inaccuracy,[5] and breach of ethics via malicious posting of falsified, incomplete, or privileged information.[2,3] Prior studies have also shown that anonymous AOC commenters may not necessarily reflect the entire applicant population.[6] Within emergency medicine (EM), students report information from AOCs such as Reddit and Student Doctor Net (SDN) as the "least trustworthy" compared to other advising resources.[7]

Despite this, most specialties, including EM, have robust AOCs for medical students, boasting large user bases and robust discussion threads with heavy readership.[8–11] Within these anonymous forums, students discuss diverse topics about the application process, specialty-specific questions, and student experiences applying to, rotating at, or interviewing with specific programs.[12,13] For example, studies identify "program-specific information" as a common theme in otolaryngology- and radiology-applicant AOCs; however, their findings were limited in characterizing specific topics discussed.[12,13] There is also a consolidated, annually renewed, and user-generated Google Spreadsheet circulating within EM forums with a stated goal to "provide a central location for applicants to research different residency programs, view information about other applicants and where they are applying, and share information about away, interviews, and general advice."[14]

For EM, the discussion of authentic, program-specific experiences, such as the student's interview day experience and interaction with residents, have historically been ranked as the top two factors in impacting their rank order, making this information highly valuable to both applicants and program stakeholders.[15] Our primary goal was to characterize what prospective EM applicants discuss in an AOC forum regarding their experiences with specific programs. Our secondary goal was to identify potentially useful information for program improvement and development.

METHODS

This was a qualitative, retrospective review of a publicly available AOC for EM rotations in 2020–2021. It was submitted for institutional review board review through Thomas Jefferson University and determined to not meet the definition of human subjects research. We analyzed extracted data from an online, time-stamped, and user-locked Google Sheet entitled "Official 2020–2021 Emergency Medicine Applicant Spreadsheet," whose link can be found within popular AOCs such as Reddit, SDN, and Discord.[14] "The Spreadsheet" allows anonymous individuals to post requested information regarding specific EM programs. The spreadsheet contains multiple sub-pages, or "sheets," to address different types of information an applicant might seek. This includes sheets listing program-specific facts such as "Program Benefits" and "Program Information"; sheets describing student experiences with a program like "Rotation Experience," "Virtual IV (Interview) Impressions," or "Name and Shame"; and sheets addressing miscellaneous application topics such as "Rejection/Wait List" or "Dropped Interviews" to help applicants coordinate logistics.

With permission from the page administrator, confirmed to be a current EM resident, we created a replica of the spreadsheet on September 12, 2021, for the purpose of this study. Upon review of all available sheets within the spreadsheet, the sub-pages entitled "Virtual IV" and "Rotation Impressions" were purposefully sampled via group consensus for analysis as they were felt to most likely include students' direct impressions of programs. In contrast, we excluded sub-pages such as "Name and Shame" from qualitative analysis due to high likelihood of containing caustic and controversial narratives. As the purpose of this study was to investigate "what" is being said, not "who" is discussing them or to "whom" it is addressed, one investigator transferred all comments from the selected pages into a single dataset while removing potentially identifying user or program information.

We performed qualitative analysis primarily using the constant comparative method,[16] where excerpts of raw data are organized into groups according to attributes and those groups are further structured to formulate a new theory. The selected sub-pages yielded 183 individual narratives discussing students' impression of the de-identified programs. A random number generator was used to select 20% of individual narratives as a convenience sample for investigators to inductively create a working codebook, de novo. All duplicates were identified and removed, until the excerpts were all unique. The dataset was independently analyzed by the investigators [ME, JG, RR, XCZ] to identify thematic content within each narrative for inductive coding. Individually identified themes were compared among investigators to generate common themes. These themes were organized into major "themes" and "sub-themes" to create the initial codebook. This was used by a single investigator (JG) to code the entire dataset. Additional sub-themes identified during this process were updated into the codebook under existing major themes. Upon completion, all themes and their associated excerpts were reviewed by the remaining investigators to ensure coding consensus. The entire dataset was reviewed until no additional themes were identified (see Appendix 1).

Upon reviewing the final codebook, we created two additional thematic categories: 1) potentially "modifiable"

program attributes and 2) less likely or "non-modifiable" program attributes. Drawing upon our collective experiences, we defined "modifiable" subthemes as attributes most likely under the direct control of the education leadership and "non-modifiable" subthemes as attributes that are either truly non-modifiable or would require significant input from outside stakeholders to change. This distinction was made with the understanding that different programs have different abilities to modify certain attributes.

RESULTS

From 183 comments, 841 discrete statements were identified and coded. We identified six themes: working conditions; interpersonal relationships; learning experience; living conditions; postgraduate readiness; and online/virtual supplement, as shown in Figure and Table 1. The top two encoded themes—working conditions and interpersonal relationships—comprised 572 (68%) of the total coded statements (324 [38.5%] and 248 [29.5%], respectively).

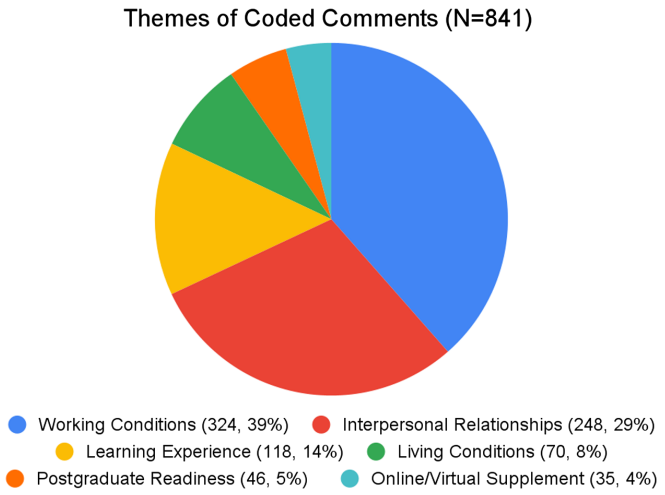

Figure. Thematic categories of coded statements, including the number of individual statements and percentage of total statements.

Sub-themes identified within each theme (see Appendix 1 for a full listing of sub-themes with their corresponding number of coded statements) were then subdivided to represent modifiable and non-modifiable clerkship/program aspects (Tables 2 and 3). Modifiable sub-themes outnumbered non-modifiable sub-themes (60.7% vs 39.3%). The sub-themes housed within the theme of interpersonal relationships represented the largest single category of modifiable attributes with 248 (29.5%) statements. Comments on working conditions and learning experience were the second and third largest categories, with 109 (13%) and 118 (14%) comments, respectively. The majority of non-modifiable sub-themes were found within the theme of working conditions with 215 (25.6%) individual comments, which represented 65% of all non-modifiable comments. The second largest non-modifiable sub-theme was within the theme of living conditions, including comments on the local geography, cost of living, or nearby amenities.

DISCUSSION

Anonymous online communities have been historically viewed by clerkship and residency program leadership as unreliable forums for student discussion that foster confabulation of facts and operates on rumors and hearsay, a communication tool of the disgruntled, and not a resource to be taken seriously.[1–3,5–7] This is the first study to describe, in detail, the narrative content of students discussing their program impressions on an AOC. Our findings suggest that many of the discussed items are common considerations for a student seeking to find the ideal next stage of training.

Table 1. Identified themes with representative comments coded to each.

Theme	Representative comment
Working conditions	"...academic institution means a lot of consults sometimes, some 12-hour shifts (but mix of 8s and 12s), 50% of shifts as an intern are overnight...no debriefing process after codes/traumas..."
Interpersonal relationships	"Every program mentions family feel but having rotated here it was truly tight knit. Faculty and resident hang outs often including beach trips."
Learning experience	"Most attendings tolerate students, and the rest are really proactive about teaching and getting the students involved...When it does settle a bit, residents are enthusiastic about your education for the most part. You'll get to do almost any procedure you want because the residents have already done them a thousand times before."
Living conditions	"Area right outside of [location] can be a pro or a con. Probably [would] have to deal with a lot of traffic and high cost of living."
Postgraduate readiness	"Really old program, so alumni all over the country to help with job placement (last class 1/2 community, 1/4 fellowship, 1/4 academic). With 4 different hospitals, variety of training is very good and will be prepared for any type of job coming out."
Online/virtual supplement	"Best ED tour, literally took a GoPro from the ED department to the actual ED so you could actually see the ED."

Table 2. Modifiable major themes and sub-themes determined by author consensus by a clerkship or residency program; percentages are of the total number of comments, N = 841.

Themes	Sub-themes	#	Total coded comments
Working conditions	Perks (funding for travel/activities, food, lounge, parking, etc)	37	109 (13.0%)
	DEI (includes LGBTQ+)	27	
	Relationship with other specialties	23	
	Wellness	20	
	Scutwork	2	
Interpersonal relationships	Residents	76	248 (29.5%)
	Other leadership/faculty personality	76	
	PD personality	56	
	Responsiveness to upward feedback	16	
	Opportunity for upward feedback	14	
	Generic	8	
	Objective experience	2	
Learning experience	Procedures	25	118 (14.0%)
	Didactics/conference	20	
	On-shift teaching	17	
	Autonomy	16	
	POCUS	12	
	Pediatric training	12	
	EMS/prehospital training	5	
	Scholarly tracks	5	
	Research	5	
	Personal patient load	1	
Online/virtual supplement	Virtual interview day	28	35 (4.2%)
	Virtual tour	4	
	Virtual rotation	2	
	Website	1	

DEI, diversity, equity, inclusion; *PD*, program director; *POCUS*, point-of-care ultrasound; *EMS*, emergency medical services.

Mentors in EM have historically encouraged prospective EM applicants to inquire about interpersonal interactions and resident working conditions within a specific program. Our analysis reveals that students are also seeking more information and commenting on many of the same factors we have been advising them to seek out.[17]

Moreover, analysis of the sub-themes reveals a unique trend toward potentially modifiable program attributes that, if addressed, could be mutually beneficial for programs and applicants. Topics such as perceived resident wellness, diversity, equity, and inclusion, opportunities for upward feedback, and effectiveness of on-shift teaching are all under the control of a program to potentially improve. Many of these topics are of rising importance to students.[18,19] The availability of this information raises a very interesting question for programs and recruitment: if programs were aware of these discussed topics and the student comments relative to each topic, would a program be likely to change internal element(s) to make itself more appealing to students?[20]

In light of the recent National Resident Matching Program (NRMP) results from 2022 and the continued downtrend of applications in 2023,[21,22] many EM programs must contend with a smaller applicant pool, which reduces the likelihood of filling programs, and overall program competitiveness for applicant recruitment. While we cannot predict future trends, our specialty has faced declining student applications for two years in a row with a rising number of residency programs and positions over the last several years. As traditional matching patterns begin to falter, residency leadership should consider addressing critical elements from AOCs, instead of ignoring them as tradition dictates.

An interesting final observation from our study is the relatively scarce number of comments from students on

Table 3. Non-modifiable major themes and sub-themes determined by author consensus by a clerkship or residency program; percentages are of the total number of comments, N = 841.

Themes	Sub-themes	#	Total coded comments
Working conditions	Patient population (underserved, volume, trauma, pathology etc)	66	215 (25.6%)
	Practice setting (community, academic, county, Lvl 1, HCA, etc)	66	
	Program reputation/prestige/age	21	
	Work hours	17	
	Ancillary healthcare staff	15	
	EHR	12	
	Salary	9	
	Metrics	6	
	Moonlighting	3	
Living conditions	Geography	53	70 (8.3%)
	Amenities	11	
	Cost of living	6	
Postgraduate readiness	Fellowships	17	46 (5.5%)
	Jobs	13	
	PGY4 experience (length of training)	12	
	PGY3 experience (length of training)	4	

HCA, Hospital Corporation of America; *EHR*, electronic health record; *PGY*, postgraduate year.

virtual or online components of a program. Our dataset reflected the first application cycle during the COVID-19 pandemic with radical paradigm shifts in away-rotation restrictions and students exploring virtual interview processes for the first time. Despite these unprecedented large-scale changes, only 4.2% of the total comments focused on the "virtual" aspect of program recruitment. This is in stark contrast to the significant amount of time spent by institutions and national organizations on virtual rotations, virtual tours, ongoing virtual interviews, virtual residency fairs, and virtual hangouts for students to socialize with residents. The data remains unclear based on this information from a single year to explain this lack of commentary. It may perhaps be due to lack of student participation in virtual rotations, given this was their first year being available as a rotation option, or perhaps virtual rotations were just simply not seen as appealing, thus demanding less discussion time on AOCs. Further analysis of subsequent years would be needed to fully analyze the effectiveness of virtual options for student applicants.

LIMITATIONS

Potential limitations rest largely on data fidelity.[2,3,5] Prior studies have also shown that AOC commenters may not necessarily reflect the entire applicant population.[6] There is limited-to-no demographic information provided on the analyzed AOC. Additionally, the 183 narratives analyzed from the spreadsheet are relatively low compared to the number of applicants ranking EM as their preferred specialty or the 273 EM programs in existence at the time of 2021 NRMP Match.[21] This may have put our analysis at risk of not reaching thematic saturation. Nevertheless, based on our collective experiences as EM residency applicants and as EM application advisers, we did not find any identified sub-themes particularly surprising or controversial. Although only a single AOC was analyzed in this study, we believe it to be fairly representative of commonly recurring student opinions and observations. For the purpose of this study, we specifically selected two sub-pages with the highest density of meaningful commentary for analysis; there is the potential that comments from other pages may reveal further themes or sub-themes.

CONCLUSION

Our qualitative analysis of a single anonymous online community revealed six major themes discussed among students with regard to EM residency programs: working conditions; interpersonal relationships; learning experience; living conditions; postgraduate readiness; and online/virtual supplement. Most of the sub-themes to these categories represented aspects of clerkships and residency programs that are potentially modifiable by the program leadership. These findings suggest that AOC narratives cover several topics that may serve as useful external feedback for EM residency programs or clerkships. Iterative review of program-specific AOC narratives

could serve as additional data in determining whether a program's internal improvement efforts are noticed by students. Additional studies may help characterize the level of interest by key program stakeholders to consider and make changes based on feedback from AOC sources.

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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. This research was funded in part by an EMRA Be the Change Grant awarded in 2021.

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Rapid Cycle Deliberate Practice Training for Simulated Cardiopulmonary Resuscitation in Resident Education

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Section Editors: David Thompson, MD, and Dan Mayer, MD
Submission history: Submitted March 3, 2023; Revision received November 21, 2023; Accepted November 27, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.17923

Background: Simulation-based medical education has been used in medical training for decades. Rapid cycle deliberate practice (RCDP) is a novel simulation strategy that uses iterative practice and feedback to achieve skill mastery. To date, there has been minimal evaluation of RCDP vs standard immersive simulation (IS) for the teaching of cardiopulmonary resuscitation to graduate medical education (GME) learners. Our primary objective was to compare the time to performance of Advanced Cardiac Life Support (ACLS) actions between trainees who completed RCDP vs IS.

Methods: This study was a prospective, randomized, controlled curriculum evaluation. A total of 55 postgraduate year-1 internal medicine and emergency medicine residents participated in the study. Residents were randomized to instruction by RCDP (28) or IS (27). Stress and ability were self-assessed before and after training using an anonymous survey that incorporated five-point Likert-type questions. We measured and compared times to initiate critical ACLS actions between the two groups during a subsequent IS.

Results: Prior learner experience between RCDP and IS groups was similar. Times to completion of the first pulse check, chest compression initiation, backboard placement, pad placement, initial rhythm analysis, first defibrillation, epinephrine administration, and antiarrhythmic administration were similar between RCDP and IS groups. However, RCDP groups took less time to complete the pulse check between compression cycles (6.2 vs 14.2 seconds, $P = 0.01$). Following training, learners in the RCDP and IS groups scored their ability to lead and their levels of anticipated stress similarly (3.43 vs 3.30, ($P = 0.77$), 2.43 vs. 2.41, $P = 0.98$, respectively). However, RCDP groups rated their ability to participate in resuscitation more highly (4.50 vs 3.96, $P = 0.01$). The RCDP groups also reported their realized stress of participating in the event as lower than that of the IS groups (2.36 vs 2.85, $P = 0.01$).

Conclusion: Rapid cycle deliberate practice learners demonstrated a shorter pulse check duration, reported lower stress levels associated with their experience, and rated their ability to participate in ACLS care more highly than their IS-trained peers. Our results support further investigation of RCDP in other simulation settings. [West J Emerg Med. 2024;25(2)197–204.]

INTRODUCTION

Despite advances in resuscitation science and training, cardiac arrest remains the third leading cause of death in the United States.[1] Millions of clinicians receive Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) training, yet patients' survival rates vary considerably.[2,3,4] Immediate recognition of cardiac arrest, high quality cardiopulmonary resuscitation (CPR), and timely defibrillation are the mainstays of care.[5,6] Effective education is crucial to execute these principles, improve team performance, and enhance outcomes.[7]

Simulation-based medical education (SBME) is well established in medical training and graduate medical education (GME). In SBME, learners gain experience from a realistic clinical scenario without the possibility of causing harm to a patient.[8] Learners are given the freedom to develop skills through practice and gain valuable feedback via debriefing. As a result, SBME has been associated with improved skill development and patient outcomes.[9,10,11]

Rapid cycle deliberate practice (RCDP) is an innovative simulation strategy that uses iterative practice and feedback to achieve skill mastery. Developed from Anders Ericsson's work on deliberative practice, RCDP allows for advanced learning through repetition and skill refinement.[12] It was originally described by Hunt in 2014 and implemented in pediatric resuscitation training.[13] In RCDP, learners begin a simulated scenario, but in contrast to the classical post-simulation debrief, the case is frequently paused by the instructor. Each break serves as an opportunity for corrective instruction, coaching, feedback, and subsequent supervised repitition.[13]

Over the last decade there has been an increased focus on RCDP training in resuscitation, with most studies focused on pediatric trainees.[13,14] When compared to the standard immersive simulation (IS) approach, RCDP has demonstrated shorter time to initial chest compression and defibrillation in pediatric medicine trainees, improved chest compression fraction in adult medical trainees, and better skill retention.[13,14,15,16] Even more recently, we have seen RCDP implemented into procedural training where it has also demonstrated positive learner outcomes. Groups trained in RCDP demonstrated better preparedness for intubation and post-procedure care in pediatric airway management.[17] Similarly, RCDP-based training has been suggested for the donning and doffing of personal protective equipment, and our obstetric colleagues have proven its utility for forceps-based deliveries.[18,19]

Instruction based in RCDP has strong evidence to support its use in areas of medical education that are algorithmic in nature, and/or require a high degree of procedural skill. The American Heart Association (AHA) recognized this as recently as 2020, recommending that deliberate practice be incorporated into BLS and ACLS training, simultaneously identifying it as an educational strategy warranting further research.[7] Despite this call to action, there has been a paucity of literature evaluating RCDP in ACLS training for the care of adult patients, regardless of learner type.[20] We sought to address this knowledge gap through the evaluation of RCDP for ACLS as it is applied to postgraduate year (PGY)-1 residents in GME. We did this through a comparison of time to completion of critical ACLS actions between RCDP and IS groups (our primary objective). As a secondary objective, we compared resident perceptions between RCDP- and IS-trained groups.

Population Health Research Capsule

What do we already know about this issue?
Rapid cycle deliberate practice (RCDP) is a simulation strategy that uses iterative practice and coaching to achieve skill mastery and is effective in procedural instruction.

What was the research question?
Is RCDP or immersive simulation (IS) more effective in training residents to perform cardiopulmonary resuscitation (CPR)?

What was the major finding of the study?
RCDP shortens pulse checks, and learners reported less stress and greater confidence performing CPR.

How does this improve population health?
Resuscitation instruction based in RCDP shows promise as a tool to enhance residents' mastery of lifesaving CPR skills.

METHODS

Study Design

In July 2022, we conducted a prospective, randomized, controlled study approved by the institutional review board.

Setting and Participants

The study was conducted in an accredited simulation center that is part of a large academic teaching hospital and involved 43 internal medicine (IM) and 12 emergency medicine (EM) PGY-1 residents who had obtained ACLS certification in the two weeks preceding this study. No other coaching or instruction regarding the care of a pulseless patient was provided prior to study implementation. All 55 residents participated voluntarily in the study. Faculty facilitators of all simulation sessions were IM and EM faculty who were board certified in their respective fields. Each

facilitator underwent formal IS- and RCDP-facilitator training prior to involvement in the study. Facilitators were not blinded to the study objectives.

Protocol

In the week prior, residents were provided with a description of the study and an electronic copy of the informed consent document to allow for a detailed and private review. Each of the 55 participants then provided written informed consent on the date of their scheduled simulation event. Our study used five teams for each instructional intervention. Each team was comprised of five or six members who were randomly assigned to either RCDP or IS, for a total of 55 participants (28 in RCDP groups, 27 in IS groups). While there was a fixed and limited number of available participants (IM and EM interns), we performed a post-hoc power analysis to establish a basis for future work. With an $\alpha = 0.05$, this study had 29% power to detect a large effect size ($d = 1$) for primary outcomes and 71% power to detect a medium effect size ($w = 0.3$) for secondary outcomes (G*Power 3.1.9.7). We used an online randomization generator (https://www.randomizer.org/) to divide participants into 10 teams, with five teams for each instructional method.

Due to scheduling differences, IM and EM participants were separated and completed their respective experiences on different days. The IM faculty facilitated all IM resident sessions. To minimize confounding related to the effectiveness of the individual facilitator, the two IM faculty facilitators led both the RCDP and the IS sessions for the IM residents. The 12 EM participants completed their experience the following week in two teams of six, one of which was assigned to RCDP and the other to IS. The EM faculty facilitated both EM resident sessions. All faculty facilitators were trained in implementation of RCDP and IS. This training was provided by certified healthcare simulation instructors in our internationally accredited institutional simulation center. No faculty facilitators were involved in the extraction of performance data.

The same two embedded simulation participants (ESP) functioned as nurses for all sessions. The ESPs in all sessions were registered nurses and certified healthcare simulation educators employed by our institutional simulation center. The ESPs were instructed to assist only with care tasks when directly asked for specific task assistance (eg, locating care items) but did not trigger initiation of individual task completion or provide guidance on task performance.

Following informed consent, learners were asked to complete a pre-simulation survey to establish baseline learner characteristics. The survey queried each participant's prior level of experience as well as self-perceived ability to lead and participate in the care of a pulseless patient. The surveys also assessed the learner's anticipated and prior experienced stress associated with code leadership and participation. Each measure was assessed using a five-point Likert-type scale.

Immersive Simulation Protocol

All IS teams were provided with the same scripted pre-brief, which described the basic tenets of simulation and informed participants that they would be caring for a pulseless patient. Teams were not instructed regarding the assignment of clinical roles but were allowed to self-assign as they deemed appropriate. The IS teams were then activated by an ESP functioning in the role of a nurse who brought the participants to the care area and asked participants to evaluate an unresponsive patient.

Once outside the patient's room, participants assumed care for the patient without further coaching or intervention. The IS participants were permitted to navigate the patient's case without interruption, while physician facilitators observed their actions from a simulation control room with audio and visual surveillance of the simulation area. The IS learners were allowed to navigate their case without interruption until the fourth pulse check or until 30 minutes had elapsed, at which time facilitators initiated return of spontaneous circulation and the case was terminated. Given the nature of the IS educational sessions, learners did not have the opportunity to rotate roles. Learners then returned to the briefing room, and physician facilitators debriefed based on observed performance according to a standardized debriefing guide and until total case time reached 45 minutes. The guide emphasized coaching regarding resuscitation and time-sensitive interventions that matched the primary outcome measures (eg, time to identification of pulselessness, time to initiation of chest compressions, etc).

RCDP Simulation Protocol

All RCDP groups were given a standard pre-brief that described the basic tenets of simulation. Groups were then provided with an introduction to the simulation modality assigned to them. Teams were not instructed regarding the assignment of clinical roles but were allowed to self-assign as they deemed appropriate. The RCDP teams were activated by an ESP who brought the participants to the care area and asked them to evaluate an unresponsive patient while physician facilitators observed at the bedside. The RCDP groups rotated roles, allowing them the opportunity to direct the resuscitation and receive feedback.

In addition to their standardized training, all facilitators were provided with an RCDP coaching guide, which was focused on the same resuscitation and time-sensitive interventions as the immersive case debriefing guide. Facilitators provided real-time coaching and feedback based on the RCDP coaching guide. Cases were then restarted, rewound, or resumed according to facilitator discretion. Total learner simulation and debriefing time was 45 minutes for each RCDP case.

Protocol Overlap

Upon completion of debriefing and closure of their respective cases, all participants returned to the briefing space. Maintaining separation of initial RCDP vs IS groups, a subsequent IS session was completed by all participants during which audio and visual recordings were obtained. Data abstraction of times to completion of critical ACLS actions was obtained from this session. Participants were activated a second time by the ESP to care for an additional, unresponsive patient. Learners were allowed to role assign and complete the case without intervention from the ESP or facilitator.

Primary Outcome Measures

Time to completion of critical actions was used as a surrogate for proficiency in the performance of an ACLS-based resuscitation. These critical actions were defined by research team consensus after reviewing ACLS protocols. Time zero was determined based upon learner entry into the care area, and times to completion of resuscitative time-based interventions were extracted through video review by the primary investigator. To mitigate bias from faculty working with their own residents, data abstraction from video recordings was performed by the primary investigator, who was not involved in simulation session facilitation. The primary investigator was blinded to RCDP vs IS group assignment at the time of data abstraction. Times from room entry to first pulse check, first chest compression, backboard placement, defibrillator pad attachment, initial rhythm analysis, initial defibrillation, initial epinephrine administration, and antiarrhythmic administration were recorded. The duration of pause between compression cycles was also obtained for each session.

Secondary Outcome Measures

Learners were queried using pre- and post-experience surveys, which were distributed in paper format immediately before and after the simulation sessions. We developed the surveys based on Kirkpatrick's theory of educational training and evaluation, focusing primarily on level 1 and 2 analyses.[21] All survey items used a 1–5 Likert-type scale to quantify all qualitative questions, and survey response rates for all surveys were 100%. Prior to the educational intervention, learners were asked to rate their self-perceived ability to participate in and ability to lead a code (1 not at all capable, to 5 extremely capable). They were also asked to rate their anticipated stress associated with participation and leadership of a code (1 not at all stressful, to 5 extremely stressful). Finally, they were queried regarding the number of simulated codes they had participated in or led, as well as the number of actual codes they had participated in or led.

Following the education intervention, learners were asked to again rate their self-perceived ability to participate in and lead a code. They were also asked to rate the overall effectiveness of their experience (1 not at all effective, 5 extremely effective). Finally, learners were asked to rate the stress level they perceived to be associated with participating and leading their simulated experience (1 not at all stressful, to 5 extremely stressful).

Statistical Analysis

First, we compared prior simulated and genuine CPR experiences as leader and as participant for RCDP and IS groups, using the Cochran-Mantel-Haenszel test, given the ordinal nature of the Likert-type scale. We defined simulated experiences as those involving CPR training that did not involve the care of a patient. Genuine experiences were defined as those involving the CPR-based resuscitation of a coding patient. We then compared the time-based differences between RCDP and IS groups using a Student *t*-test or a Wilcoxon test when there was substantial deviation from normality. Our sample size for all primary outcome measures was 10 teams. We compared mean time differences between the two groups for first pulse check, first chest compression, pause duration, backboard placement, defibrillator pad placement, first rhythm analysis, first defibrillation, first epinephrine administration, and amiodarone administration.

Our sample size for all secondary outcome measures was 55 individuals. We also compared pre- and post-training survey data between the two groups using the Cochran-Mantel-Haenszel test given the ordinal nature of the Likert-type scale. The learner's experience as code leader and participant and overall effectiveness of experience were also included in the post-training survey. Ability to lead, ability to participate, anticipated stress leading, and anticipated stress participating were included in both surveys. Finally, we compared stress leading and stress participating in pre- and post-training for both groups using a generalized Stuart-Maxwell test to evaluate the improvement after training.[22] We used an alpha level of 0.05 for all statistical tests. A Benjamini-Hochberg false discovery rate adjustment was applied for multiple comparisons. All programs were written in SAS 9.4. (SAS Institute Inc, Cary, NC).

RESULTS

Prior Learner Experience

Prior learner experience was similar between the groups and did not appear to be a significant confounder (Table 1). The numbers of experiences are reported as medians with minimum and maximum values due to lack of normal distribution.

Primary Outcome: Time-based Differences

Although there were trends toward shorter mean times to completion of critical actions for RCDP vs IS groups, we observed only one category with a statistically significant

Table 1. Cardiopulmonary resuscitation experience prior to simulation.

	Group	Median	Min	Max	*P*-value
Simulation leader	IS	1	0	17	0.34
	RCDP	2	0	6	
Genuine leader	IS	0	0	40	0.81
	RCDP	0	0	3	
Simulation participant	IS	3	0	50	0.46
	RCDP	3.5	0	15	
Genuine participant	IS	2	0	75	0.67
	RCDP	2	0	25	

IS, immersive simulation; *RCDP*, rapid cycle deliberate practice.
*Genuine refers to experiences in actual patient care scenarios.

difference: CPR mean pause duration in seconds was 6.20 vs 14.20 seconds ($P = 0.01$) in RCDP vs IS groups (Table 2).

Secondary Outcome: Ability and Stress

For stress levels and self-reported ability, learners provided ratings on a five-point Likert-type scale. We present the mean values in Tables 3 and 4. Prior to training, RCDP and IS learners rated their anticipated stress of leading and participating in CPR similarly (4.36 vs 4.00 ($P = 0.44$); 3.18 vs 3.00 ($P = 0.08$), respectively). The RCDP and IS learners also rated their pre-training ability to lead as well as participate in the event similarly (2.50 vs 2.37 ($P = 0.75$); 3.61 vs 3.52 ($P = 0.59$) (Table 3). There was no significant difference in the anticipated stress levels of future events following training, whether considering the role of leader ($P = 0.93$) or participant ($P = 0.98$) (Table 4). Similarly, there was no significant difference in experienced stress as a leader between RCDP and IS learners ($P = 0.93$) and the overall effectiveness of the experience was rated similarly between groups ($P = 0.09$). However, RCDP learners reported lower levels of experienced stress as a participant ($P = 0.01$)

Table 3. Pre-simulation mean Likert-type ratings.

	Group	Median	Min	Max	*P*-value
Ability to lead	IS	2	1	4	0.75
	RCDP	3	1	3	
Ability to participate	IS	3	3	5	0.59
	RCDP	4	2	5	
Stress anticipated as leader	IS	4	3	5	0.44
	RCDP	4	3	5	
Stress anticipated as participant	IS	4	2	4	0.08
	RCDP	3	2	5	

IS, immersive simulation; *RCDP*, rapid cycle deliberate practice.

(Tables 3, 4). When we compared pre- and post-training responses regarding anticipated stress, the anticipated stress of future resuscitation experiences dropped significantly for both leader and participant categories following training, regardless of instructional method.

DISCUSSION

Learners receiving RCDP instruction showed a significantly shortened pause duration, reduced stress, and improved self-perceived CPR skills compared to IS. The RCDP instruction also shortened various time-based ACLS metrics, although statistical significance was not reached due to the small sample size. A reduced pause duration carries notable clinical significance. Pause duration is an important metric of high-quality CPR and is associated with improved patient outcomes.[23,24] Reduced pause duration has a significant impact on terminating arrhythmias and increasing return of spontaneous circulation, while increased pause duration is associated with a decrease in survival.[26]

Although there is a paucity of literature comparing RCDP to IS in the care of an adult patient, what little data that does exist demonstrates improvements in chest compression fraction in RCDP vs IS groups.[20] Many of these prior studies

Table 2. Rapid cycle deliberate practice vs immersive simulation time in seconds.

	RCDP mean time (±SD)	IS mean time (±SD)	*P*-value
First pulse check	4.00 (±1.00)	5.60 (±1.52)	0.25
First chest compression	12.40 (±3.13)	15.20 (±2.95)	0.27
Backboard placement	40.40 (±31.33)	193.40 (±183.36)	0.25
Pad placement	66.40 (±12.56)	74.80 (±20.75)	0.46
First rhythm analysis	73.60 (±13.50)	111.20 (±37.63)	0.25
First defibrillation	93.00 (±17.46)	150.60 (±63.49)	0.25
First epinephrine	131.60 (±28.75)	158.20 (±55.21)	0.41
Pause duration	6.20 (±2.07)	14.20 (±6.53)	0.01
Antiarryhthmic	376.60 (±94.25)	438.80 (±99.19)	0.41

IS, immersive simulation; *RCDP*, rapid cycle deliberate practice. Time is in seconds.

Table 4. Post-simulation mean Likert-type ratings.

	Group	Median	Min	Max	*P*-value
Ability to lead	IS	3	3	5	0.77
	RCDP	3	3	4	
Ability to participate	IS	4	3	5	0.01
	RCDP	4.5	4	5	
Stress anticipated as leader	IS	3	2	5	0.93
	RCDP	3	2	4	
Stress anticipated as participant	IS	2	1	3	0.98
	RCDP	2	1	4	
Stress experienced as leader	IS	3	3	5	0.93
	RCDP	3	2	5	
Stress experienced as participant	IS	3	2	4	0.01
	RCDP	2	1	3	
Overall effectiveness	IS	4	3	5	0.09
	RCDP	5	4	5	

IS, immersive simulation; *RCDP*, rapid cycle deliberate practice.

were done in pediatrics, but the results should have clinically similar interpretations as those completed in adults.[13–16] Hunt et al conducted the only prior study examining time-based metrics as a surrogate for proficiency and found RCDP to be superior for instruction of BLS interventions in junior medical students.[27] Our results add to this work through the further examination of time-based metrics and learner perceptions. Although limited, these results lend further credibility to the argument that RCDP may be superior to IS for ACLS training.

While RCDP-trained learners in our study exhibited trends toward other favorable ACLS metrics, there were no other statistically significant differences. Prior work has demonstrated improvement in time to defibrillation, initial chest compression, and backboard placement with RCDP training in pediatric resuscitations.[13,15,20] Our work does not independently support these findings; however, our trends are in line with existing literature.

Time to first defibrillation suggested favorability in the RCDP group (93 vs 150 seconds [sec]), although differences did not reach statistical significance. This distinction is important, however, as the RCDP group was able perform this action within the AHA's "Get with the Guidelines" recommendation of first defibrillation in less than two minutes. Similarly, time to first epinephrine administration in RCDP vs IS (131 vs 158 sec), suggests reduced time in the RCDP group without reaching statistical significance. Both groups performed within the five-minute metric outline from "Get with the Guidelines" recommendations. As both groups performed well with this action, obtaining statistical significance may prove difficult. It is unclear why other metrics such as pad placement or administration antiarrhythmic showed no significant change between groups. These actions are dependent on a variety of factors in a team focused on CPR, and as Lemke et al suggest, they may be difficult to measure effectively.[15]

As previously noted, our study was underpowered, which played a role in the absence of statistically significant differences for many of our outcome measures. The Likert-scale measures were better powered, as they represented 55 individual survey responses as opposed to the 10 total teams divided in two for each instructional method. For comparison, Hunt et al studied the performance of 81 individual pediatric residents who participated in the post-intervention assessment and found that RCDP improved learner confidence, but there was no control group for comparison or power calculation.[13] De Castro et al used five teams for their RCDP group and four teams for their control group, with an 80% power to detect a 20% difference in the primary outcome. The authors found a higher chest compression fraction and shorter times to rhythm identification/defibrillation in the RCDP group. However, due to data loss they were unable to achieve the planned power.[20] Lemke et al studied the greatest number of learners, with 102 participants in 21 teams for their control cohort, and 108 participants in 20 teams for their RCDP cohort and found that RCDP groups demonstrated shorter times to defibrillation. While no formal power calculation was performed, Lemke's work appears to be the best powered thus far.[15] Future work should include more robust powering with larger sample sizes, which will likely require inter-institutional collaboration.

Another factor contributing to our inability to detect significant differences in many time-based metrics may be the learner level studied. By its very nature, RCDP serves as a method to develop perfect practice. Providing the learner with real-time feedback and coaching builds micro-skill development and mastery, as opposed to proficiency alone. This study focused on PGY-1 residents for two reasons. First, in an effort to avoid confounding by variations in training, we studied PGY-1 level learners in their first month of residency. Second, we excluded advanced learners due to concerns that their involvement would confound the study of the junior learner through advancing the performance of the entire group. Conversely, prior work that found differences in similar categories evaluated learners from PGY levels 1–3 or studied larger learner groups.[14,15,27] Therefore, true skill mastery may be more attainable through the inclusion of more advanced learners and may contribute to more statistically significant results.[13,15] Conversely, the inclusion of more advanced learners may influence the entire group, leading to a more uniform performance. This may limit or reduce observable differences between instructional methods.

Hunt et al also notes a dose response with RCDP (ie, increasing experience and repetition fosters improved performance and skill mastery).[13] We studied the learners' first performance, but we did not conduct additional simulated experiences beyond this. Further repetition may have expanded differences in RCDP and IS groups.

A common goal of simulation in medical education is to reduce the stress and anxiety experienced by the learner, and this is especially true for high-stakes scenarios such as the care of a pulseless patient. However, the simulation experience can be independently stressful for learners, and prior work has suggested that RCDP-based instruction may provide an overall preferred experience. This is well illustrated by the work of Chancey et al, whose learners expressed a preference for the frequent interruptions and improved sense of emotional security associated with RCDP instruction.[25] Chancey's learners also reported increased confidence in their own resuscitation skills. Our results support these findings, demonstrating an increased confidence in ability to participate in the RCDP groups. Similarly, our learners reported lower stress levels experienced during their RCDP-based simulation.

LIMITATIONS

Due to the study's nature, blinding participants and facilitators was not possible. Skill retention was not assessed, and the small sample size limits generalizability. Additionally, while all facilitators had undergone standardized training in both instructional methods, individual facilitators may have been more effective at one strategy vs the other. All participating residents completed a standard ACLS course in the two weeks preceding the study. Also, most of the residents had significant experience as part of resuscitation teams (Table 1). As a result, there may have been less of a difference in performance between the two groups. Our study found RCDP was well received by our learners, but the data is limited by learner evaluation at Kirkpatrick levels I and II. While we believe learner perceptions in instruction are important for engagement, future investigations should focus on objective impacts and clinical performance with patient-oriented outcomes.

Surveys were not based on any prior survey instrument but were created, reviewed, and edited by the research team. The surveys were novel instruments, and we did not obtain validity evidence prior to their use. Recall bias was minimized through the implementation of surveys immediately following instruction and performance of the learners. We were unable to eliminate the effects of social desirability bias for our learners and suspect that learners would tend to report improved performance regardless of instructional method. However, the potential for this bias existed in both RCDP and IS groups. Sampling and non-response bias were not factors secondary to our 100% response rate, but due to the nature of our five-point Likert-type question scale, the potential for neutral bias exists.

Due to the frequent interruptions associated with the RCDP method, RCDP participants were able to rotate through each role on the resuscitation team. However, IS groups did not have an opportunity to change roles as a part of their training, and this introduces a confounder in comparing the learner experience as well as proficiency between these instructional methods.

Finally, this study focused on time to completion of critical actions but did not assess the quality of those actions, including factors such as chest compression fraction (CCF). However, CCF has been previously studied and found to be superior in groups undergoing RCDP-based instruction as compared to standard IS.[13,20,27]

CONCLUSION

Rapid cycle deliberate practice was favored by learners for ACLS-based CPR instruction, improving self-perceived skills and reducing pause duration. This suggests RCDP is a valid strategy to teach residents ACLS-based CPR and supports further investigation of RCDP in other settings.

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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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Simulation Improves Emergency Medicine Residents' Clinical Performance of Aorta Point-of-Care Ultrasound

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Section Editor: Shane Summers, MD
Submission history: Submitted August 30, 2023; Revision received December 4, 2023; Accepted December 5, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18449

Purpose: Using point-of-care ultrasound (POCUS) to diagnose abdominal aortic aneurysm (AAA) is an essential skill in emergency medicine (EM). While simulation-based POCUS education is commonly used, the translation to performance in the emergency department (ED) is unknown. We investigated whether adding case-based simulation to an EM residency curriculum was associated with changes in the quantity and quality of aorta POCUS performed by residents in the ED.

Methods: A case-based simulation was introduced to resident didactics at our academic, Level I trauma center. A case of undifferentiated abdominal pain was presented, which required examination of an ultrasound phantom to diagnose an AAA, with a hands-on didactic. We compared the quantity, quality, and descriptive analyses of aorta POCUS performed in the ED during the four months before and after the simulation.

Results: For participating residents (17/32), there was an 86% increase in total studies and an 80% increase in clinical studies. On an opportunity-adjusted, per-resident basis, there was no significant difference in median total scans per 100 shifts (4.4 [interquartile range (IQR) 0–15.8 vs 8.3 [IQR] 3.3–23.6, $P = 0.21$) or average total quality scores (3.2 ± 0.6 vs 3.2 ± 0.5, $P = 0.92$). The total number of limited or inadequate studies decreased (43% vs 19%, $P = 0.02$), and the proportion of scans submitted by interns increased (7% vs 54%, $P = < .001$).

Conclusion: After simulation training, aorta POCUS was performed more frequently, and ED interns contributed a higher proportion of scans. While there was no improvement in quantity or quality scores on a per-resident basis, there were significantly fewer incomplete or limited scans. [West J Emerg Med. 2024;25(2)205–208.]

Keywords: *point-of-care; ultrasonography; simulation; abdominal aortic aneurysm; POCUS; emergency medicine.*

INTRODUCTION

Point-of-care ultrasound (POCUS) of the aorta to diagnose abdominal aortic aneurysm (AAA) is a core emergency ultrasound application and an essential component of emergency medicine (EM) residency education.[1] Emergency department (ED) POCUS has previously been shown to have excellent performance characteristics for the evaluation of AAA.[2] Simulation is a commonly used educational tool for resident ultrasound education, but a scoping review found the majority of prior studies examined changes in confidence, knowledge, and skills rather than objective clinical performance.[3] However, simulation in addition to clinical training has been shown to be effective at translating to clinical performance in other specialties, such as for obstetrics and gynecology residents learning transvaginal ultrasound.[4]

It is critical that emergency physicians learn to quickly identify AAA at the bedside, as this is a time-sensitive and

potentially deadly diagnosis requiring a goal time from presentation to emergency surgery of <90 minutes.[5] We aimed to investigate whether the addition of case-based ultrasound simulation to the existing EM residency curriculum was associated with an increase in the quantity and quality of aorta POCUS performed on ED patients.

Population Health Research Capsule

What do we already know about this issue?
Simulation has increasingly been used to prepare EM residents for less common conditions, such as diagnosing abdominal aortic aneurysm using POCUS.

What was the research question?
Does case-based POCUS simulation affect the quantity or quality of aorta POCUS that residents perform in the ED?

What was the major finding of the study?
Aorta POCUS increased 86%, and the number of limited or inadequate studies decreased (43% vs 19%, $P = 0.02$).

How does this improve population health?
Aorta POCUS simulation training may help physicians who less frequently encounter aortic aneurysm to identify this time-sensitive condition.

MATERIALS AND METHODS

Design, Setting, and Intervention

At our academic, Level I trauma center with a three-year EM residency program and advanced practice provider training program, EM residents have existing simulation-based learning built into their monthly academic conference. However, the use of POCUS is not typically incorporated into simulation at our institution. In Spring 2023, we introduced a new simulated case requiring the use of POCUS for diagnosis of AAA in the setting of undifferentiated abdominal pain. During simulation-based learning, residents are divided into groups of 5–8 residents of varied postgraduate year (PGY) and cycle between the simulation session and other educational activities. In addition to verbal prompts regarding case history, physical exam findings, and patient responses to interventions, residents were asked to use a cart-based ultrasound system (Sonosite PX, Fujifilm, Bothell, WA) to examine an ultrasound phantom abdomen (41903–000, Kyoto Kagaku, Japan) with multiple findings including an infrarenal AAA with intermural thrombus, free abdominal fluid, and normal bowels and renal system. The case concluded with a hands-on didactic led by a POCUS fellowship-trained emergency physician and included time at the end of the simulation for hands-on scanning by residents.

Ultrasound Study Review and Outcomes

All ultrasound studies performed in the ED are submitted through a quality assurance workflow for review by a team of POCUS fellowship-trained faculty. All residents who participate receive credit for performing the POCUS. The submitting resident who performed the POCUS completes a worksheet describing the findings, interpretation, and study limitations. Studies are marked complete if residents indicate that a view was obtained of the suprarenal aorta, infrarenal aorta, and iliac bifurcation and incomplete if one or more of these views was not obtained. Images and worksheets are then sent for review and signature to the faculty caring for the patient with the resident. Faculty can either place the study in an educational archive (if they did not use the study for medical decision-making) or a clinical archive (if they used the study for medical decision-making and wish for the images to transfer to the patient's health record).

Studies are reviewed for quality and assigned a quality score from 1 (worst) to 5 (best) as well as notation of any false positives or false negatives, with EM ultrasound faculty serving as the gold standard. Quality scores 1 and 2 are considered insufficient for diagnosis, with scores of 3–5 considered adequate. We examined cumulative measures of sensitivity and specificity before and after the simulation.

Analysis

We compared the median number of aorta POCUS studies that EM residents performed in the ED in the four months prior to the simulation session to the median number of exams performed in the four months following the simulation session. These quantities were reported as scans performed per 100 shifts per resident and compared using Wilcoxon signed-rank test. We compared mean quality scores over the four months prior to the intervention to the quality scores over the four months after the intervention as described above with the quantity of exams using a paired *t*-test. Proportions of limited studies and training year distribution were compared with Pearson chi-square. The significance level of all tests was set to 0.05 with Bonferroni correction applied where appropriate. Analysis was performed in SPSS for Macintosh, v 28.0 (SPSS Inc, Chicago, IL). This study received institutional review board approval for waiver of signed informed consent.

RESULTS

Over half of residents 17/32 (53%) participated in the simulation session and had at least one clinical shift before

Table. Number of aorta point-of-care ultrasound studies submitted before and after simulation training, stratified by training level of the primary study author by archive. (*): P = < .05 with Bonferroni correction.

	Clinical			Educational			Total		
	Pre	Post	P (X^2)	Pre	Post	P (X^2)	Pre	Post	P (X^2)
Level			.34			<.001			<.001
APP	1 (20%)	1 (11%)		0 (0%)	1 (2%)		1 (4%)	2 (4%)	
PGY-1	0 (0%)	3 (33%)		2 (9%)	25 (58%)	*	2 (7%)	28 (54%)	*
PGY-2	3 (60%)	2 (22%)		12 (52%)	5 (12%)	*	15 (54%)	7 (14%)	*
PGY-3	1 (20%)	3 (33%)		9 (39%)	12 (28%)		10 (36%)	15 (29%)	

APP, advanced practice provider resident; *PGY*, postgraduate year.

and after the simulation session. The distribution of the participating residents as primary study authors is demonstrated in the Table, with a significant increase in the proportion of aorta POCUS submitted by interns. Overall, there was an 86% increase in total studies and an 80% increase in clinical studies after the session. However, when comparing on a per-resident basis while adjusting for clinical opportunities, there was no significant difference in median total scanning frequency per 100 shifts (4.4 [interquartile range (IQR) = 0–15.8] vs 8.3 [IQR = 3.3–23.6], $P = 0.21$). There was also no significant change in average total quality scores on a per resident basis (3.2 ± 0.6 vs 3.2 ± 0.5, $P = 0.92$).

There were no false negative or false positives using faculty review of images as the gold standard. There were no differences in the proportion of studies with agreement vs disagreement with the resident interpretation (100% vs 96%, $P = 0.29$). There was a decrease in the total number of limited or inadequate studies (12/28 (43%) vs 10/52 (19%), $P = .02$ [X^2]). There was no significant change in the proportion of clinical studies submitted as "limited" or "inadequate" (2/5 (40%) vs 4/9 (44%), $P = 0.87$ [X^2]), but the number of educational studies submitted as "limited" or "inadequate" improved (10/23 (44%) vs 6/43 (14%), $P = <.001$).

DISCUSSION

Overall, the total number of aorta POCUS studies performed in the ED after the simulation increased, albeit without a demonstrable change in quantity or quality rating on a per-resident basis. However, there were a number of positive findings, which support the inclusion of ultrasound simulation in residency training, including a significant increase in the proportion of studies contributed by interns and a significant decrease in the proportion of studies that were incomplete or limited.

It seems unlikely that the significant increase in intern POCUS studies was due to content mastery based on compounding clinical experience alone. Aorta POCUS is one of the applications requiring the most experience to gain proficiency, and with previously demonstrated plateau points in interpretation and acquisition at 66 studies and 84 studies, respectively, which were not approached by anyone in our study.[6] The same study found that aorta POCUS quality actually decreases initially with increasing number of scans before it eventually improves above baseline, which may be contributing to the absence of improvement in median quality scores seen in our study.[6]

Much of the published research regarding POCUS simulation reports outcomes related to the assessment of learner experience and skill performance outside the clinical context.[7,8] While these outcomes are important, there is a desire to assess more translational outcomes resulting from simulation interventions.[9,10] There are few translational studies available for direct comparison to the current study. Our simulation experience was delivered as a single session, which is less time-intensive than a prior study of EM interns that found positive clinical effects of simulation-based mastery learning on performance of focused assessment with sonography in trauma.[11] Outside of EM, a randomized trial of ultrasound simulation for obstetrics and gynecology residents that was also more longitudinal than the current study also found positive clinical effects of early simulation training, in addition to clinical practice in first-year residents.[4] Further study is needed to determine whether the case-based simulation approach in our study would be more successful if the training were more time intensive, more longitudinal, and most targeted toward junior learners.

LIMITATIONS

Our findings are subject to the limitations of a before-and-after study, including the possibility that other factors may have contributed to the observed changes other than the simulation; however, we are not aware of any other targeted effort to educate our residents about aorta POCUS during the study period, and believe it is likely most changes were associated with the simulation. Second, this was a study of residents whose categorization of study intent was subject to their signing faculties' preferences. Therefore, we included both educational and clinical archive studies to provide a fair portfolio of each resident's work, although some educational

studies may have not been intended for patient care. Third, EM residents do not get to choose which patients they take care of in the ED (because emergencies are unplanned and unpredictable); so some residents likely had slightly more exposure to patients with indications for aorta POCUS than others. In addition, while we were able to adjust for clinical opportunities based on time spent in the ED, residents often see more patients per hour as they advance through training, and we were unable to account for total patients seen during the study period. Even considering these limitations, we believe the data presented provides an accurate real-world assessment of scanning frequency and quality on ED patients by ED residents.

CONCLUSION

In the four months following a case-based simulation to diagnose abdominal aortic aneurysm using point-of-care ultrasound, the proportion of aorta POCUS studies performed in the ED by interns increased significantly, and the proportion of studies that were incomplete or limited significantly decreased. While there was no overall increase in the median number of scans or mean quality scores when adjusted for clinical opportunities on a per-resident basis, among residents as a whole there was an 86% increase in submitted aorta POCUS studies.

ACKNOWLEDGMENTS

The authors would like to thank the Carver College of Medicine for their Educational Innovation and Scholarship Grant to support the purchase of the ultrasound phantom used in this study, John Keech for his assistance in grant writing, Priyanka Vakkalanka for her assistance in grant writing and manuscript review, and Daniel Miller and Nathaniel Shekem for their assistance implementing the simulation.

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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. This work was supported by an Educational Innovation and Scholarship Grant provided by the Carver College of Medicine at the University of Iowa.

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Foundations of Emergency Medicine: Impact of a Standardized, Open-access, Core Content Curriculum on In-Training Exam Scores

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Section Editor: Danielle Hart, MD
Submission history: Submitted June 28, 2023; Revision received December 9, 2023; Accepted January 12, 2023
Electronically published March 25, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18387

Introduction: Learners frequently benefit from modalities such as small-group, case-based teaching and interactive didactic experiences rather than passive learning methods. These contemporary techniques are features of Foundations of Emergency Medicine (FoEM) curricula, and particularly the Foundations I (F1) course, which targets first-year resident (PGY-1) learners. The American Board of Emergency Medicine administers the in-training exam (ITE) that provides an annual assessment of EM-specific medical knowledge. We sought to assess the effect of F1 implementation on ITE scores.

Methods: We retrospectively analyzed data from interns at four EM residency programs accredited by the Accreditation Council for Graduate Medical Education. We collected data in 2021. Participating sites were geographically diverse and included three- and four-year training formats. We collected data from interns two years before (control group) and two years after (intervention group) implementation of F1 at each site. Year of F1 implementation ranged from 2015–2018 at participating sites. We abstracted data using a standard form including program, ITE raw score, year of ITE administration, US Medical Licensing Exam Step 1 score, Step 2 Clinical Knowledge (CK) score, and gender. We performed univariable and multivariable linear regression to explore differences between intervention and control groups.

Results: We collected data for 180 PGY-1s. Step 1 and Step 2 CK scores were significant predictors of ITE in univariable analyses (both with $P < 0.001$). After accounting for Step 1 and Step 2 CK scores, we did not find F1 implementation to be a significant predictor of ITE score, $P = 0.83$.

Conclusion: Implementation of F1 curricula did not show significant changes in performance on the ITE after controlling for important variables. [West J Emerg Med. 2024;25(2)209–212.]

INTRODUCTION

Residency programs provide education and training to develop competent physicians. Board certification in emergency medicine (EM) requires completion of an Accreditation Council for Graduate Medical Education (ACGME)-accredited training program and a passing score on the Qualifying Examination (QE) and Oral Certification Examination (OCE) administered by the American Board of

Emergency Medicine (ABEM).[1,2] The ABEM In-training Examination (ITE) is an important tool used by training programs to assess medical knowledge and prepare residents for the QE.[1,3] The ITE is designed to reflect the content of the Model of Clinical Practice of Emergency Medicine (EM Model) and has predictive value in estimating the likelihood of individual residents passing the QE.[3] Prior literature suggests that clinical exposure alone leaves significant gaps in fundamental knowledge defined by the EM Model.[4] Residency didactic curricula provide an opportunity to supplement core knowledge; however, the best methods for providing instruction outside of the clinical setting and preparing trainees for successful performance on the ITE are unknown.

Foundations of Emergency Medicine (FoEM) is a national, free, open-access, online EM curriculum that has been widely adopted in the United States.[5,6] FoEM became available in 2015; registration for use of FoEM courses for the 2022–2023 academic year included 237 registered educational programs, serving 6,326 resident physicians.[5,6] FoEM offers standardized, level-specific, core content for EM residents using learner-centric educational strategies that have been shown to benefit learning such as small-group discussion, peer learning, and individualized guidance.[5–11] Foundations I (F1) is a flipped classroom, case-based course targeting postgraduate year (PGY)-1 residents that includes a 30-unit, systems-based curriculum of fundamental content in the EM Model.[5,6,12] Prior literature demonstrates positive effects of the flipped classroom model on learning outcomes.[13–15] The F1 curriculum includes curated self-study resources called "Learning Pathways" for learners to review prior to didactic meetings, in which residents work through multiple F1 cases with a knowledgeable facilitator providing information in an oral-boards style format.[6] The F1 summarizes essential learning points and shares them with learners to fill knowledge gaps and allow for spaced repetition.[6] Although the F1 curriculum is not specifically designed for ITE review, third-party paired assessments for each unit have been available for use since 2017.[6]

Limited outcome data of FoEM F1 established quality and demonstrated high satisfaction among faculty leaders and resident learners.[5,6] However, there has not been an assessment of objective measures such as medical knowledge and ITE performance This information can provide a more comprehensive assessment of the value of implementing such a program. In this study, we sought to evaluate the effect of F1 course implementation on ITE performance in the PGY-1 year. We hypothesized that implementation of the structured F1 curriculum would lead to improved performance on the ITE.

METHODS

We performed a retrospective cohort study of ITE data collected from PGY-1 residents at four ACGME- accredited EM residency programs in the United States before and after implementation of the FoEM F1 curriculum. We selected participating sites that were geographically diverse and included 3- and 4-year training formats. We collected data in December 2021. All PGY-1 residents at participating sites during the study period were eligible to participate. We excluded PGY-1 residents who were missing data.

We determined that to detect a 5% difference in ITE score with 80% power and an alpha of 0.05, we would need to enroll 81 participants in each group (control and intervention) for a total of 162 participants. Our control group consisted of data from PGY-1 residents for the two years prior to implementation at each site. Our intervention group consisted of data from PGY-1 residents for the two years after implementation at each site. Year of F1 implementation ranged from 2015–2018 at participating sites. The lead author from each site abstracted data using a standard form that included program, ITE raw total score, year of ITE administration, United States Medical Licensing Examination (USMLE) Step 1 score, USMLE Step 2 Clinical Knowledge (CK) score, and resident gender. Prior to data abstraction, the author group read each item on the form aloud and trialed abstracting a small portion of representative data to ensure clarity of meaning and consistency in process.

We calculated descriptive statistics for demographic data and ITE performance. We performed regression analyses to explore differences between the intervention and control groups. We first performed univariable linear regression analyses for variables including implementation of F1, residency program, year of ITE administration, USMLE Step 1 score, USMLE Step 2 score, and resident gender with ITE raw score as our outcome of interest. We included variables with a P-value < 0.1 in the univariable regression in a multivariable linear regression with the same outcome variable.We considered variables with a P-value of < 0.05 in the multivariable model as statistically significant. We performed all analyses in SPSS v 27.0 (IBM Corporation, Armonk, NY).

This study was approved by the Institutional Review Board of the David Geffen School of Medicine at UCLA.

RESULTS

We abstracted data from a total of 224 interns. We excluded 44 interns who were missing data. We analyzed data from 180 interns (88 pre-implementation and 92 post-implementation) who had complete data. The demographics of participants with complete data are shown in Table 1. The mean ITE raw score for interns in the control group was 72.15 ± 6.72. The mean ITE score for interns in the intervention group was 72.74 ± 7.93. In the univariable regression analyses, only USMLE Step 1 and USMLE Step 2 CK scores yielded P-values of < 0.1 (Table 2). Because our hypothesis centered on the impact of implementation of the F1 curriculum on ITE scores, we forced this variable as the

Table 1. Demographic data of participating interns.

	Control group n (%) total n = 88	Intervention group n (%) total n = 92
Gender		
Male	32	31
Female	56	60
Non-binary	0	1
Mean USMLE Step 1 score (SD)	232 (14.26)	232 (15.59)
Mean USMLE Step 2 score (SD)	244 (17.02)	246 (14.54)

USMLE, United States Medical Licensing Examination.

Table 2. Results of univariable regression analysis of recorded variables.

Variable	*P*-value
Implementation of Foundations F1 curriculum	0.59
Residency program	0.22
Year of ITE administration	0.14
USMLE Step 1 score	<0.001
USMLE Step 2 CK score	<0.001
Resident gender	0.24

USMLE, United States Medical Licensing Examination; *ITE*, in-training exam; *CK*, clinical knowledge.

last variable after block entry of variables of USMLE Step 1 score and USMLE Step 2 CK score in the multivariable regression analysis, despite it having a *P*-value of 0.59 in the univariable analysis. After controlling for Step 1 score and Step 2 CK score, F1 implementation was not a significant predictor of ITE score, R square change = 0, $P = 0.83$. The data satisfied all assumptions.

DISCUSSION

Our study demonstrates that both Step 1 and Step 2 CK were significant predictors of ITE score. This is consistent with prior literature in multiple specialties demonstrating associations between USMLE scores and ITE performance.[16–19] We found that our intervention group had a slightly higher raw ITE scores however, after controlling for USMLE scores, this increase was not statistically significant, despite being adequately powered. This was somewhat surprising given that F1 provides a consistent structure and comprehensive coverage of content in the EM model and also incorporates teaching methods that have been shown to enhance learning.[2,6–11] However, our results align with previous studies, which have demonstrated that changes in curriculum were not associated with significant differences in ITE performance.[20,21] Specifically, converting an hour of synchronous didactic conference to asynchronous learning, and converting conference lectures to small group, "flipped-classroom" style learning have previously been found to have no significant effect on ITE scores.[20,21]

It is important to note that the objective of F1 is to improve EM core knowledge and application in the clinical environment and is not specifically targeted towards ITE test preparation or performance. Additionally, performance on the ITE may not comprehensively represent learner knowledge of EM. This may be one reason that we did not find significant changes in ITE performance. Additionally, variable implementation and usage of F1 at differing programs could influence potential gains. Although the FoEM courses are standardized, participating programs must address their own unique needs and barriers; this may result in variability in course implementation, including variable use of flipped-classroom style asynchronous resources and paired assessments. It is also important to note that the ITE is administered in February of each year; thus, participating PGY-1 residents in this study were only exposed to approximately seven months of the year-long F1 curriculum prior to the ITE.

It is possible that additional improvements may be seen with additional time spent in the curriculum. The nonsignificant improvement seen in this study may be augmented with implementation of Foundations II (F2), which is designed for PGY-2 residents, and Foundations III (F3), which is designed for PGY-3 and PGY-4 residents. These outcomes merit further investigation. While our study did not find a significant increase in ITE scores compared to standard curricula, it was not worse than standard practice and has additional benefits of a free, standardized, pre-packaged, high-quality, adaptable format with user acceptability.[6]

Overall, the results of this study provide important insights for both the numerous programs already using FoEM and those EM residencies considering incorporating it into their training programs.[6] In addition to prior feasibility and user acceptability data, this study provides an evaluation of objective outcomes, namely knowledge, the first level in Miller's pyramid of clinical competence.[6,22] There are still many unanswered questions. Further investigation into the effect of the F1 curriculum on ABEM QE and OCE performance should be pursued. Additionally, as FoEM is designed to support knowledge application in the clinical space, future work could evaluate the impact of FoEM on other domains of resident performance.

LIMITATIONS

This study has limitations. There may be confounders not accounted for in our analysis that could have influenced results. We did not collect data on specific ITE preparation curricula at participating sites, individual usage of external ITE preparation materials outside of training program curricula, time spent using F1 curriculum, use of paired

assessments, total number of F1 units completed by participating residents, or time spent studying for ITE in general. However, to the best of our knowledge, there were no other major changes to the site's didactic curriculum or methods of preparing trainees for the ITE during the study period. Although the F1 course includes standardized content, participating programs must address their own unique needs and variables that impact the consistency of course administration. There may be differences in the personnel who deliver the content, attendance requirements, etc, which are not accounted for in our study. The results seen in this study may not transfer to other sites where adherence to implementation guidelines is more or less consistent.

CONCLUSION

Our study suggests that the FoEM F1 curriculum is not associated with significant changes in performance on the ITE in EM training programs after controlling for important variables. These results may inform the use and implementation of FoEM courses in EM training programs.

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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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Integrating Hospice and Palliative Medicine Education Within the American Board of Emergency Medicine Model

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Section Editor: Chris Merritt, MD
Submission history: Submitted August 29, 2023; Revision received November 20, 2023; Accepted January 12, 2023
Electronically published March 25, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18448

Background: Hospice and palliative medicine (HPM) is a board-certified subspecialty within emergency medicine (EM), but prior studies have shown that EM residents do not receive sufficient training in HPM. Experts in HPM-EM created a consensus list of competencies for HPM training in EM residency. We evaluated how the HPM competencies integrate within the American Board of Emergency Medicine Milestones, which include the Model of the Clinical Practice of Emergency Medicine (EM Model) and the knowledge, skills, and abilities (KSA) list.

Methods: Three emergency physicians independently mapped the HPM-EM competencies onto the 2019 EM Model items and the 2021 KSAs. Discrepancies were resolved by a fourth independent reviewer, and the final mapping was reviewed by all team members.

Results: The EM Model included 78% (18/23) of the HPM competencies as a direct match, and we identified recommended areas for incorporating the other five. The KSAs included 43% (10/23). Most HPM competencies included in the KSAs mapped onto at least one level B (minimal necessary for competency) KSA. Three HPM competencies were not clearly included in the EM Model or in the KSAs (treating end-of-life symptoms, caring for the imminently dying, and caring for patients under hospice care).

Conclusion: The majority of HPM-EM competencies are included in the current EM Model and KSAs and correspond to knowledge needed to be competent in EM. Programs relying on the EM Milestones to plan their curriculums may miss training in symptom management and care for patients at the end of life or who are on hospice. [West J Emerg Med. 2024;25(2)213–220.]

INTRODUCTION

A third of adults who die will receive emergency department care in the month prior to their death.[1] Emergency physicians need training to provide the high-quality, goal-concordant care that these patients deserve. Hospice and palliative medicine (HPM) is a subspecialty of emergency medicine (EM) that adds an additional focus on symptom management, goal-concordant care, and quality of life, especially for patients with chronic disease or life-threatening conditions, or who are at the end of life.[2] Prior research has shown that current EM residency training lacks instruction in HPM.[3–7] To address this, the American College of Emergency Physicians Palliative Medicine Section published a list of 23 critical developmental milestones in

HPM training for EM residents.[8] However, it is unclear how best to integrate these recommendations into an EM residency curriculum.

Many EM residency curriculums are based on the knowledge needed to pass the EM board certification exams. This knowledge is codified in the American Board of Emergency Medicine (ABEM) Model of the Clinical Practice of Emergency Medicine (EM Model) and a list of knowledge, skills, and abilities (KSA).[9,10] The EM model along with the KSAs are the foundational documents used to create the EM Milestones, a compendium ubiquitously employed in both EM training and assessment. Our goal in this study was to determine where the HPM competencies fit or could fit within the EM Model and KSAs. This mapping could help guide curriculum design or the incorporation of the HPM competencies into testing content.

METHODS

This study was not human subjects research and was deemed exempt from institutional review board review. We compared the 2019 EM Model and the 2021 KSAs to the HPM competencies. The HPM competencies were assigned numerals. The EM Model items were annotated by their number and category. The notations for the KSA categories and codes were used directly from the 2021 document. We divided the KSAs into overarching categories (eg, diagnosis, pharmacotherapy, reassessment) which we then further divided into sets of competencies within that category.[10] Each competency was given a hierarchy in training corresponding to an alphabetic level (with A the most advanced level of competency and E the least). Level A is reserved for advanced knowledge or skills. Level B is the minimal competency level, defined as the minimum skill level every EM resident should attain to graduate. Levels C, D, and E are skills in the development of reaching level B.

As this type of analysis has not been done before, we used a sequential approach with initial independent reviewers, a mediator step, and then final consensus group discussion. The consensus group results were then reviewed by two independent external experts. In the first phase of consensus mapping, two residents (EM postgraduate year (PGY)-2 and EM/internal medicine (PGY-4) and an EM attending independently mapped palliative care competencies using a Microsoft Excel spreadsheet (Microsoft Corporation, Armonk, NY). The three initial concept mappers had independent data sheets and were blinded to each other's determinations. A competency could map onto more than one area of the EM Model. First, keywords from each HPM competency were searched for in the EM Model. If no matches were found, the EM Model was reviewed line by line to determine whether there were conceptual matches. If there was no direct match, but the HPM competency could be incorporated under a topic, this was listed as a potential area for incorporation.

Any topic that did not have at least 2/3 agreement on the initial independent review was reviewed by a fourth emergency physician with expertise in EM resident education and EM Model development. She was blinded to the initial reviewer's names but did have their results. The full group met and reviewed all the mapping until consensus was reached. The consensus tables were then reviewed independently by two additional external HPM board-certified EM attendings involved in resident education at two different EM residency programs. The same process was used for mapping the KSAs.

RESULTS

Incorporation into the Emergency Medicine Model

Fifty-one of 963 EM Model items were tagged in the independent first round of mapping, with 98.7% consensus (951/963) between the initial three independent reviewers on whether an item was or was not tagged as a match. The final review by the independent HPM-boarded EM attendings did not result in adjustments to any of the existing mapping but did add to the potential areas of fit for the HPM competencies that did not directly match onto the EM Model. Table 1 lists the competencies included in the 2019 EM Model (18/23, 78%). Many competencies fit into *EM Model category 20: Other Core Competencies* section, which includes communication skills, transitions of care, cultural competency, and healthcare coordination. Discrepancy discussions centered around management vs diagnosis. The competency *HPM 2: Treating distressing symptoms (eg, nausea/vomiting, dyspnea)* was felt to fit by keyword match under EM Model category *1.0 Signs, Symptoms and Presentations*. However, that category does not mention treatment of symptoms directly. Similarly, *HPM 18: Complications of Cancer* could map to many items in the EM model, but again refers to palliative management of cancer complications rather than diagnosis.

Potential Areas of Fit in the Emergency Medicine Model

Five HPM competencies did not fit into the EM Model. The first two, *HPM 7: Treating common end-of-life symptoms* and *HPM 8: Care for the imminently dying (expecting death within hours to days or recently deceased patient and their family members)*, could be taught under EM Model item *20.4.4.2.2: Systems-based Practice: Withdrawal of support.* This EM Model item could be clarified to ensure that it includes symptom control and end-of-life care. The next, *HPM 11: Caring for patients under hospice care,* could be taught when teaching *20.4.4.2.3: Systems-based Practice: Hospice Referral.* However, the hospice-referral EM Model item better mapped onto *HPM 17*, which includes assessing for and initiating hospice referrals. The team felt that identifying and referring patients to hospice was a separate skillset than caring for patients on hospice. The last two HPM competencies without a clear

Table 1. The hospice and palliative emergency medicine residency education competencies mapped onto the American Board of Emergency Medicine EM Model.

Hospice and palliative competency	Description	EM model item
1	Pain control: a. chronic pain, b. malignant and non-malignant pain.	19.3.1 Anesthesia and acute pain management- regional anesthesia 19.3.2 Anesthesia and acute pain management- procedural sedation 19.3.3 Anesthesia and acute pain management- analgesia
2	Treating distressing symptoms (eg, nausea/vomiting, dyspnea)	1.3.32 Nausea/vomiting 1.3.42 Shortness of breath **unclear whether these EM model elements refer to treating these symptoms or developing a differential diagnosis for these symptoms, but both should be taught.*
3	Difficult communication: a. delivery of bad news (eg, prognosis and death telling) b. conflict resolution (eg, between family members	20.1.2.2 Interpersonal and communication skills- conflict management 20.1.2.4 Interpersonal and communication skills- delivering bad news/death notifications
4	Goals of care discussions: a. assisting families with decision making. b. assisting patients with decision making	20.4.4.1 Health care coordination- advance directives
5	Caregiver support	20.3.4.6 Well-being and resilience- care for the caregiver
6	Non-initiation or stopping of nonbeneficial interventions	19.2 Resuscitation- cardiopulmonary resuscitation 20.1.1.3 Interpersonal skills- patient and family experience of care 20.4.4.2.2 Healthcare coordination- withdrawal of support
9	Bereavement and grieving	14.2.4 Mood disorders and thought disorders- grief reaction
10	Family-witnessed resuscitation	19.2 Resuscitation- cardiopulmonary resuscitation
12	Coping and self-care	20.3.4.1 Well-being and resilience- fatigue and impairment 20.3.4.1.1 Well-being and resilience- sleep hygiene 20.3.4.3 Well-being and resilience- work/life balance
13	End-of-life management in the mass casualty incident/event	20.4.2.2.1 Patient triage and classification
16	Screening for palliative care needs: a. identifying patients who may benefit from HPM specialist referral, b. identifying the imminently dying patient (expected death within hours-days).	20.4.4.2.1 Health care coordination- patient identification for palliative care 20.4.4.2.3 Health care coordination- hospice referral
17	Rapid palliative care assessment: a. aligning diagnostics and therapeutics to patient goals, b. functional, psychosocial, and spiritual assessment, c. assessing for and initiating hospice referrals, d. toolkits to help identify patient needs for appropriate referrals/resources, e. caregiver burden.	20.3.4.6 Well-being and resilience- care for the caregiver 20.4.4.2.3 Healthcare coordination- hospice referral 20.4.4.3.1 Healthcare coordination- activities of daily living/functional assessment

(*Continued on next page*)

Table 1. Continued.

Hospice and palliative competency	Description	EM model item
18	Complications of cancer: a. disease complications (eg, spinal cord compression, hypercalcemia), b. treatment complications (eg, pancreatitis, tumor lysis, neutropenia, acute renal failure).	2.9.2.3 Large bowel- radiation colitis
		2.9.2.5 Large bowel- neutropenic enterocolitis/typhlitis
		3.6.1 Diseases of the pericardium- pericardial tamponade
		8.7 Oncologic emergencies
		8.7.1 Oncologic emergencies- febrile neutropenia
		8.7.2 Oncologic emergencies- hypercalcemia of malignancy
		8.7.3 Oncologic emergencies- hyperviscosity syndrome
		8.7.4 Oncologic emergencies- malignant pericardial effusion
		8.7.5 Oncologic emergencies- spinal cord compression
		8.7.6 Oncologic emergencies- superior vena cava syndrome
		8.7.7 Oncologic emergencies- tumor hemorrhage
		8.7.8 Oncologic emergencies- tumor lysis syndrome
		11.1.4.2 Bony abnormalities-tumor-related fractures
		16.2.3 Disorders of the pleura, mediastinum, and chest wall-pleural effusion
		16.6.2 Pulmonary embolism/infarct- venous thromboembolism
		16.6.2.1 Pulmonary embolism/infarct- massive and submassive embolism
19	Ethical, spiritual, and cultural issues around end-of-life and death	20.1.2.5 Interpersonal and communication skills- cultural competency
20	Advance directives: a. physician order for life-sustaining treatment (POLST), b. medical order for life-sustaining treatment (MOLST), c. five wishes.	20.4.4.1 Healthcare coordination- advance directives
21	ethical and legal issues: a. decision-making capacity, b. futility.	20.3.2.4 Professionalism- medical ethics
		20.4.5.4 Regulatory/legal- consent, capacity and refusal of care- consent, capacity and refusal of care
22	Multidisciplinary team and support systems. (understanding team roles and system resources): a. spiritual chair, b. social chair, c. hospice care eligibility, d. continuing care, e. importance of local and community support systems.	20.1.1.1 Interpersonal skills- inter-departmental and medical staff relations
		20.1.1.2 Interpersonal skills- intra-departmental relations, teamwork, and collaboration skills
		20.4.2.4.1 ED administration- allied health professionals
23	Transitions across care settings, eg, inpatient vs home hospice, palliative care unit	20.4.4.2.1 Healthcare coordination- patient identification for palliative care
		20.4.4.2.3 Healthcare coordination- hospice referral

association with the EM Model were *HPM 14: Trajectories of dying: a. Terminal illness, b. Organ Failure, c. Frailty, d. Sudden Death,* and *HPM 15: Prognostication.* While these competencies necessitate having sound understanding of the natural history of disease as well as physical examination and clinical workup components informing prognosis, these are also skills for explaining the likelihood of death and communicating with patients and families. The team consensus was that these could be taught within the EM Model items *20.1.2.4 Interpersonal and Communication*

Table 2. The palliative emergency medicine competencies incorporate with the 2021 American Board of Emergency Medicine knowledge, skills, and abilities.

	Hospice and palliative medicine competency	KSA code	Description	Level
3	Difficult communication a. delivery of bad news (eg, prognosis and death telling) b. conflict resolution (eg, between family members)	CS17	Use flexible communication strategies to negotiate effectively with staff, consultants, patients, families, and others to provide optimal patient care, recognizing and resolving interpersonal conflicts	B
4	Goals of care discussions: a. assisting families with decision making. b. assisting patients with decision making.	CS3	Elicit patients' reasons for seeking healthcare and their expectations from the ED visit	D
		CS7	Consider the expectations of those who provide or receive care in the ED and use communication methods that minimize the potential for stress, conflict, and miscommunication	B
		CS15	Solicit patient participation in medical decision-making by discussing, risks, benefits, and alternatives to care provided	C
		ES15	Elicit the patient's goals of care prior to initiating emergency stabilization, including evaluating the validity of advanced directives	B
13	End-of-life management in the mass casualty incident/event	DM11	Participate in a mass casualty drill or event in an ED involving multiple patients, prioritizing care, containing potential exposures, and appropriately assigning resources	C
14	Trajectories of dying: a. terminal illness, b. organ failure, c. frailty, d. sudden death.	ES6	Recognize in a timely fashion when further clinical intervention is futile	B
		PE6	Educate patients on the natural course of their disease and impact of possible treatment in relation to prognosis	B
15	Prognostication	ES6	Recognize in a timely fashion when further clinical intervention is futile	B
		ES15	Elicit the patient's goals of care prior to initiating emergency stabilization, including evaluating the validity of advanced directives	B
		PE6	Educate patients on the natural course of their disease and impact of possible treatment in relation to prognosis	B
		TC11	Determine, summarize, and communicate the diagnosis or diagnostic uncertainty, anticipated course, prognosis, disposition plan, medications, future diagnostic/therapeutic interventions, signs and symptoms for which to seek further care and follow-up to patient or surrogate	B
17	Rapid palliative care assessment: a. aligning diagnostics and therapeutics to patient goals, b. functional, psychosocial, and spiritual assessment, c. assessing for and initiating hospice referrals, d. toolkits to help identify patient needs for appropriate referrals/resources, e. caregiver burden.	CS7	Consider the expectations of those who provide or receive care in the ED and use communication methods that minimize the potential for stress, conflict, and miscommunication	B

(*Continued on next page*)

Table 2. Continued.

	Hospice and palliative medicine competency	KSA code	Description	Level
20	Advance directives: a. physician order for life-sustaining treatment (POLST), b. medical order for life-sustaining treatment (MOLST), c. five wishes.	CS6	Elicit information from patients, families, and other healthcare members using verbal, nonverbal, written, and technological skills	D
		ES15	Elicit the patient's goals of care prior to initiating emergency stabilization, including evaluating the validity of advanced directives	B
21	Ethical and legal issues: a. decision-making capacity, b. futility.	CS15	Solicit patient participation in medical decision-making by discussing, risks, benefits, and alternatives to care provided	C
		ES6	Recognize in a timely fashion when further clinical intervention is futile	B
		LI12	Balance patient autonomy with patient protection and advocacy when addressing consent and refusal of care in accordance with legal and ethical standards	B
		TI9	Obtain informed consent from the patient or appropriate surrogate when indicated	B
22	Multidisciplinary team and support systems. (understanding team roles and system resources): a. spiritual chair, b. social chair, c. hospice care eligibility, d. continuing care, e. importance of local and community support systems.	TM1	Organize patient care teams	B
23	Transitions across care settings, eg, inpatient vs home hospice, palliative care unit	CS5	Communicate information to patients and families using verbal, nonverbal, written, and technological skills, and confirm understanding	B
		CS10	Communicate pertinent information to healthcare colleagues in effective and safe transitions of care	C
		TC11	Determine, summarize, and communicate the diagnosis or diagnostic uncertainty, anticipated course, prognosis, disposition plan, medications, future diagnostic/therapeutic interventions, signs and symptoms for which to seek further care and follow-up to patient or surrogate	B
		TC15	Ensure transitions of care are accurately and efficiently communicated between clinicians using best practices	B

Skills: Delivering bad news/Death Notifications and *20.1.1.3 Interpersonal and Communication Skills: Patient and family experience of care.*

Incorporation into the Knowledge, Skills and Abilities

Thirty items of 214 were tagged in the first round with 87% consensus (187/214) between the initial three independent reviewers on whether an item was or was not tagged as a match. Ten of the 23 HPM competencies (43%) mapped onto 16 different KSAs (Table 2). Of the 16 matches within the KSAs, none were advanced skills (level A). All but HPM 13 mapped onto at least one level B skill. A table showing all the HPM competencies and their incorporation within the EM Model and KSAs together is included as Supplemental Data A.

Potential Areas of Fit into the Knowledge, Skills and Abilities

Three additional KSAs were identified as having areas of potential fit or incorporation. *HPM 5: Caregiver support* and *HPM 12: Coping and self-care* could be taught while discussing *CS2: Establish rapport with and demonstrate*

empathy toward patients and their families. Finally, *HPM 16: Screening for palliative care needs* could be taught with *TC18: Correctly determine the appropriate disposition*.

DISCUSSION

This study showed fair to good inclusion of HPM competencies within the published EM KSAs and EM Model, demonstrating that the HPM competencies are represented in the Milestones. However, key topic areas were identified that could improve the focus of EM training in HPM. Demonstrating the overlap of the HPM and EM content may help EM educators ensure that HPM training is incorporated into their curriculums. Lack of training on these topics is a consistent finding in national and international studies, and educators need better ways to incorporate HPM-EM training into residency curriculums.[3–7,11–13] Improved teaching of the HPM-EM competencies has the potential to decrease the care gaps seen in ED symptom management and end-of-life care, including lack of goals of care conversations for critically ill patients.[14,15]

A limitation of the HPM competencies is that they have not been externally assessed or investigated and are based on expert consensus. None of the initial four reviewers were involved in the development of the HPM competencies and they found them to almost all map onto the EM Model or identified places in the EM Model that could be expanded to include them more explicitly. Additionally, the HPM competencies that mapped onto KSAs all met at least one KSA on the minimal competency level. These findings imply that the HPM competencies are skills that are at resident level.

The descriptions in the HPM competencies can add depth to the corresponding EM Milestones for curriculum development and summative evaluation. For example, most residencies provide training or simulations of mass casualty care. The study group envisioned ways in which end-of-life management could be added into that training (HPM 13). Likewise, a lecture on post-cardiac arrest care could incorporate training on the non-initiation or compassionate discontinuation of interventions such as mechanical ventilation (HPM 6). Summative competency assessments at end of training to gain board certification could also incorporate more HPM competency-based questions.

Much of the overlap between the HPM competencies and the EM Model and KSAs was in *Interpersonal and Communication Skills* (EM Model) and the *CS – Communication & Interpersonal Skills* (KSAs). Communication skills, although challenging to teach, are critical in patient-centered care and will likely have an increased emphasis as artificial intelligence and machine learning become more universally integrated into clinical care. Current models for communication instruction rely heavily on role modeling.[16] Residents have suggested that formal training in communication should focus on general communication skills and should provide syntax to use in future discussions.[17] Developing communication skills requires deliberate practice of techniques, including NURSE statements (naming, understanding, respecting, supporting, and exploring) and Ask-Tell-Ask.[17,18] Additionally, educators must become familiar with methods for real-time teaching of communication, such as "Could I add something?"[19]

Trajectories of dying (HPM 7) and prognostication (HPM 8) are two skills used to counsel patients/families with serious illness or at the end of life that did not fit clearly within the EM Model. These are difficult skills, and prior studies have identified some discordance between what families/caregivers understand about a person's death and the underlying causes of death identified by the physician-led team.[20] Thus, this skill should be honed throughout training. It is our experience that EM residents rarely receive explicit education on prognostication, and so we recommend its incorporation into curriculums. Our results further suggest that training on treating end-of-life symptoms, care for the imminently dying, and caring for patients under hospice care could be overlooked by current resident curriculums with strict adherence to the EM Model.

LIMITATIONS

A limitation of this project is that even though a consensus process was used with experts in residency education and HPM, other education experts may interpret the domains and competencies differently. For example, the *EM Model item 20.3.4.6 Well-being and Resilience - Care for the caregiver* was matched to HPM 5 and 17 about patient caregivers. However, this could also be interpreted as resident self-care as it is under the well-being section. Finally, while trained HPM emergency physicians reviewed all the mapping, the initial mapping did include resident input. This could be considered an advantage, as they are experiencing lectures weekly, or are a potential source of bias, as they have not had a full EM curriculum yet.

CONCLUSION

We identified areas of overlap where the HPM-EM subspecialty competencies can be emphasized or integrated into EM Model-based residency curriculums. This knowledge can be used for curriculum planning and incorporating HPM into definitions for competency in EM. These could also be reflected in final summative evaluations for certification.

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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. Lauren T. Southerland has NIH grant funding not pertaining to this study. Diane L. Gorgas is a board member on the American Board of Emergency Medicine. Lauren T. Southerland and Daniel W. Markwalter have contributed to some of the free educational websites mentioned in the discussion. There are no other conflicts of interest or sources of funding to declare.

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The Effect of a Simulation-based Intervention on Emergency Medicine Resident Management of Early Pregnancy Loss

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Section Editor: Abra Fant, MD
Submission history: Submitted November 22, 2023; Revision received January 3, 2024; Accepted January 17, 2024
Electronically published March 25, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18596

Background: The evaluation of patients with first-trimester vaginal bleeding and concern for early pregnancy loss (EPL) frequently occurs in the emergency department (ED), accounting for approximately 1.6% of all ED visits.[1] Unfortunately, these patients consistently report negative experiences with ED care.[2–8] In addition to environmental concerns, such as long wait times, patients often describe negative interactions with staff, including a perceived lack of empathy, the use of insensitive language, and inadequate counseling.[2,3] These patients and their partners often view EPL as a traumatic loss of life and commonly experience prolonged grief reactions, including anxiety and depression.[9–11] Poor satisfaction with care has been associated with worse mental health outcomes.[12] These complaints represent an important opportunity for improvement in emergency medicine (EM) training.[13]

While no published literature to date describes the performance of EM residents in managing patients presenting with EPL, studies suggest that even obstetrics and gynecology (OB/GYN) residents find these interactions challenging.[14,15] Simulation- and didactic-based training has been shown to be beneficial in improving OB/GYN resident EPL counseling and has been associated with improved patient outcomes.[16] To our knowledge, this has yet to be replicated in EM residency training.

Objectives: We aimed to develop and evaluate a simulation-based educational intervention to improve EM resident management of patients presenting with EPL. [West J Emerg Med. 2024;25(2)221–225.]

CURRICULAR DESIGN

The educational intervention consisted of three phases (Figure 1) and was designed to optimize learning based on Kolb's learning cycle.[17,18] Residents were presented with a challenging scenario (concrete experience) and then prompted to reflect on areas for improvement (reflective observation). They then completed an asynchronous module followed by an interactive group discussion (abstract conceptualization). The learning cycle continued through active experimentation via a repeated opportunity to do the simulation, followed by debriefing. This form of repetitive simulation has been shown to be more effective when compared with non-repeated simulation.[19,20]

We implemented the intervention in May 2023 and conducted a pre/post study of its immediate impact, which was deemed exempt by our institutional review board. The intervention took place at the simulation center of the affiliated medical school, during the two-hour period typically allotted for monthly resident simulation-based education. Postgraduate year (PGY) 1–3 EM residents were recruited based on a convenience sample including all residents attending simulation that day. The residents were not informed of the topic of the intervention prior to the day of the study, which is typical of our simulation curriculum.

Six standardized patients (SP) were hired to portray patients experiencing EPL. Six volunteer faculty emergency physicians (two men, four women) observed and evaluated the simulations and provided instruction and debriefing. One faculty OB/GYN physician and one faculty emergency

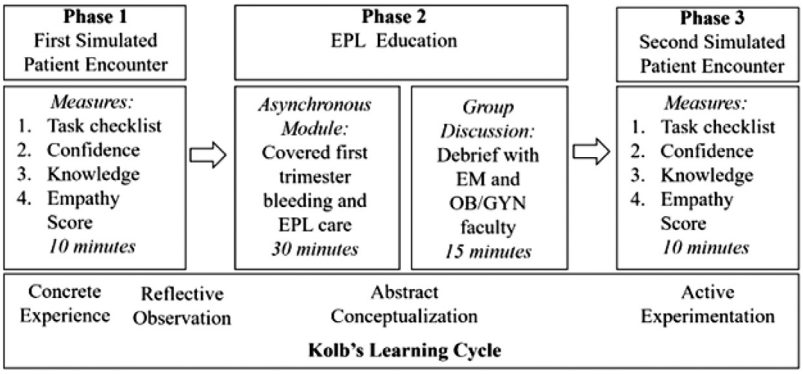

Figure 1. Sequence of an educational intervention for early pregnancy loss counseling.
EPL, early pregnancy loss.

physician (both women) co-facilitated the guided group discussion-based education.

First, residents participated in a 10-minute simulated patient encounter in which they were instructed to care for a SP who portrayed a patient who was eight weeks pregnant and presented with vaginal bleeding. Prior to evaluating the patient, each resident was provided with ultrasound results indicating the pregnancy was nonviable (presumably obtained in triage).

Following the encounter, residents individually debriefed with an EM faculty observer. Residents then had 30 minutes to complete an asynchronous online educational module that included content about the assessment of early pregnancy bleeding; diagnosing and managing ectopic pregnancy; preventing alloimmunization; and EPL counseling. Particular attention was paid to optimizing care to address a patient's physical, emotional, and cognitive needs, a framework recommended by Emond et al.[21] The module was delivered via an interactive educational platform, Rise 360 Articulate (Articulate, New York, NY).[22] After completing the module, residents participated in a 15-minute guided group dialog with EM and OB/GYN faculty, discussing best practices and modeling practical communication skills. Facilitators gave examples of how they would address patients in various scenarios to communicate clearly while also using sensitive language.

Following this discussion, residents repeated the same 10-minute simulated patient encounter followed by individual debriefing with EM faculty. The intervention was designed to accommodate up to 24 residents with the resources described.

IMPACT AND EFFECTIVENESS

To study the immediate impact of the intervention, resident performance was evaluated using four measures: 1) completion of critical actions during the simulation via an 11-item checklist; 2) self-reported confidence; 3) a 10-item multiple-choice test of foundational EPL knowledge; and 4) SP perceptions of resident empathy during the simulation via the modified Jefferson Scale of Empathy (JSE).[23,24] All four evaluative measures were delivered immediately following the initial simulated encounter (Phase 1) and after the final simulation encounter (Phase 3). In addition to these measures, residents were invited to participate in a brief focus group interview, conducted by a non-faculty facilitator (woman), after the intervention to discuss their impressions of the intervention.

Faculty in EM and OB/GYN developed the task checklist to include critical actions and evidence-based best practices in treating patients experiencing EPL. This list was adapted from a checklist employed in a similar study and modified to reflect ED care.[25] Residents were asked to rate their perceived confidence level from least (1) to most (10) confident regarding the following: knowledge about the evaluation and management of patients with first-trimester bleeding; ability to communicate in a sensitive and empathic manner with patients with EPL; and ability to counsel a patient experiencing EPL regarding what to expect after discharge. They also completed a 10-question multiple-choice test, which EM and OB/GYN faculty developed to assess basic objective knowledge. After each simulated encounter, SPs completed the modified JSE, a validated tool for SP evaluation of clinician empathy and communication. The modified JSE includes five questions on a seven-point Likert scale ranging from strongly disagree (1) to strongly agree (7).[23,24] An outline of the simulated case, the module, and the assessment tools are included in the supplemental material accompanying the online article.

Of the 16 residents who participated, 75% identified as men, and there was relatively equal representation of PGY-1 (31.3%), PGY-2 (37.5%), and PGY-3 (31.3%) residents. Residents improved from pre- to post-intervention across all four evaluative measures (Table 1). Before the intervention, few residents provided information about what to expect after discharge, including the potential pain level, the likelihood of passing tissue, return precautions, and long-term emotional ramifications. After the intervention, residents were significantly more likely to use sensitive

Table 1. Resident assessment outcomes pre- to post-intervention.

		Pre	Post	Signed rank	
Measure	**Maximum score**	**Mean (SD)**	**Mean (SD)**	***S***	***P*-value**
Performance checklist	11	4.94 (1.80)	9.50 (1.51)	67.0	<.001
Self-confidence	30	20.06 (3.38)	24.69 (3.50)	68.0	<.001
Knowledge	10	5.84 (1.29)	8.00 (1.41)	45.5	<.001
Empathy	35	21.25 (6.04)	28.06 (5.47)	65.5	<.001

Table 1b. Resident checklist performance.

Checklist item	**Pre n (%)**	**Post n (%)**	***P*-value**
1. Delivers bad news using simple language and with avoidance of non-preferred terms (fetus, embryo)	10 (62.5)	16 (100)	0.03
2. Allows silence for the patient to absorb the news	14 (87.5)	14 (87.5)	1.00
3. Acknowledges patient's emotions	15 (93.8)	15 (93.8)	1.00
4. Dispels guilt	15 (93.8)	16 (100)	1.00
5. Counsels patient about the amount of expected bleeding	2 (12.5)	11 (68.8)	0.004
6. Counsels patient on expected pain	1 (6.3)	10 (62.5)	0.004
7. Counsels patient on the possibility of passing tissue	2 (12.5)	12 (75.0)	0.006
8. Counsels patient on return for severe bleeding	3 (18.8)	14 (87.5)	0.003
9. Counsels patient on return for fever	2 (12.5)	15 (93.8)	0.001
10. Normalizes emotional ramifications of EPL	5 (31.3)	13 (81.3)	0.008
11. Discusses follow-up plan	10 (62.5)	16 (100)	0.030

EPL, early pregnancy loss.

language and to include information about expected outcomes and return precautions (Table 1b).

These results indicate that focused training resulted in immediate improvements in resident performance, particularly regarding counseling and communication. Given the positive results of similar interventions undertaken in other learner populations, this immediate impact likely indicates improved ability to care for patients in clinical practice. Verhaeghe et al published the impact of a three-hour in-situ simulation training for OB/GYN residents, which resulted in long-term improvements in psychologic outcomes as well as reduced need for return visits.[16] As compared to these previous interventions, our curriculum enhanced efficiency by employing an online training module, which covered additional foundational knowledge of early pregnancy bleeding care (including ectopic pregnancy and threatened EPL). This efficiency is particularly important in EM given the breadth of required knowledge.

While the eight residents who participated in the focus group interview generally reported positive feedback, two residents did note that they were confused by the order of the simulation such that they had a diagnosis prior to any interaction with the patient. In the future, this may be ameliorated by providing the residents with more context to the case or simply revising the scenario so that the ultrasound report is received after an initial evaluation and request for imaging. Additionally, the time allotted for the asynchronous module was 30 minutes, but most residents completed it in about 20 minutes, indicating the possibility of additional content or expansion of another aspect of the intervention.

LIMITATIONS AND CONCLUSION

This study describes resident performance in a simulated patient encounter, and we cannot conclude that this reflects actual clinical care. This study only assessed the impact of the training on learning (Kirkpatrick level 2) and did not attempt to evaluate the residents' ongoing clinical behavior or its effect on patients.[26] The study was conducted during one session and, therefore, we cannot infer information about retention of learning. Future work should assess the effect of interventions such as this on clinician behavior and resultant patient outcomes. Faculty evaluators were not blinded during the simulated patient encounters, which could have introduced bias into the evaluation provided via the checklist. This concern is somewhat addressed by the binary

nature of the checklist, in which either a task was performed or it was not. Of the assessment tools, only the modified JSE has been externally validated. Creating and validating EM-specific measurement tools for EPL care would ensure more robust data going forward.

"Participants disproportionately identified as men (75%), as compared to the national average in emergency residencies of 62%.[27] Given the small population from which the study sample was derived, we did not ask participants whether they were cis- or transgender to avoid loss of anonymity. Similarly, we did not ask participants about personal experiences with EPL. Future work could explore the relationship of these characteristics and experiences with clinical performance. Despite these limitations, the results of this study indicate a need for EPL-specific education in EM residency and that a brief, simulation-based intervention was effective in producing immediate improvements. Considering the results of similar studies conducted in other populations, an intervention such as this may result in improved clinical care and long-term patient outcomes in this common, but devastating, presentation.

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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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Root Cause Analysis of Delayed Emergency Department Computed Tomography Scans

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Section Editor: Mark Langdorf, MD, MPHE
Submission history: Submitted January 23, 2023; Revision received October 25, 2023; Accepted December 5, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.17831

Introduction: A solution for emergency department (ED) congestion remains elusive. As reliance on imaging grows, computed tomography (CT) turnaround time has been identified as a major bottleneck. In this study we sought to identify factors associated with significantly delayed CT in the ED.

Methods: We performed a retrospective analysis of all CT imaging completed at an urban, tertiary care ED from May 1–July 31, 2021. During that period, 5,685 CTs were performed on 4,344 patients, with a median time from CT order to completion of 108 minutes (Quartile 1 [Q1]: 57 minutes, Quartile 3 [Q3]: 182 minutes, interquartile range [IQR]: 125 minutes). Outliers were defined as studies that took longer than 369 minutes to complete ($Q3 + 1.5 \times IQR$). We systematically reviewed outlier charts to determine factors associated with delay and identified five factors: behaviorally non-compliant or medically unstable patients; intravenous (IV) line issues; contrast allergies; glomerular filtration rate (GFR) concerns; and delays related to imaging protocol (eg, need for IV contrast, request for oral and/or rectal contrast). We calculated confidence intervals (CI) using the modified Wald method. Inter-rater reliability was assessed with a kappa analysis.

Results: We identified a total of 182 outliers (4.2% of total patients). Fifteen (8.2%) cases were excluded for CT time-stamp inconsistencies. Of the 167 outliers analyzed, 38 delays (22.8%, 95% confidence interval [CI] 17.0–29.7) were due to behaviorally non-compliant or medically unstable patients; 30 (18.0%, 95% CI 12.8–24.5) were due to IV issues; 24 (14.4%, 95% CI 9.8–20.6) were due to contrast allergies; 21 (12.6%, 95% CI 8.3–18.5) were due to GFR concerns; and 20 (12.0%, 95% CI 7.8–17.9) were related to imaging study protocols. The cause of the delay was unknown in 55 cases (32.9%, 95% CI 26.3–40.4).

Conclusion: Our review identified both modifiable and non-modifiable factors associated with significantly delayed CT in the ED. Patient factors such as behavior, allergies, and medical acuity cannot be controlled. However, institutional policies regarding difficult IV access, contrast administration in low GFR settings, and study protocols may be modified, capturing up to 42.6% of outliers. [West J Emerg Med. 2024;25(2)226–229.]

INTRODUCTION

A solution for emergency department (ED) congestion remains elusive. As reliance on imaging grows, computed tomography (CT) turnaround time—from CT order to completion—has been identified as a major bottleneck.[1,2] One study showed that patients who had radiological

diagnostics were 4.4 times more likely to stay over four hours in the ED than those who did not have these tests.[2] Numerous studies have identified strategies to decrease CT turnaround times. White et al mapped the complex process of ED radiology transport and applied systems engineering principles to improve efficiency without increasing resource use.[3] Perotte et al assembled a multidisciplinary stakeholder team to identify barriers and implement solutions to reduce CT turnaround time from 5.8 to 4.6 hours despite a 13.8% increase in the number of scans.[1] Various studies have demonstrated the efficacy of applying Lean and Six Sigma principles.[4,5] Finally, queuing theory has been used to model ED delays with varying levels of resource utilization.[6,7]

There has not yet been a dedicated outlier analysis of delayed CT scans in the ED. In this study we sought to identify factors associated with significantly delayed CT. This is consequential given that patients with ED stays longer than six hours directly contribute to crowding.[8]

METHODS

We performed a retrospective analysis of all CTs completed at an urban, tertiary care ED in Boston, Massachusetts, from May 1–July 31, 2021. During that period, 5,685 scans were performed on 4,344 patients, with a median time from CT order to completion of 108 minutes (Quartile 1 [Q1]: 57 minutes, Quartile 3 [Q3]: 182 minutes, interquartile range [IQR]: 125 minutes). Outliers were defined as studies that took longer than 369 minutes to complete ($Q3 + 1.5 \times IQR$). We defined CT completion time as the point at which the CT technologist marks the study as completed, thereby removing the confounder of radiologist read time.

We systematically reviewed outlier charts and communications between members of the care team to determine factors associated with delay and identified five factors: behaviorally non-compliant or medically unstable patients; intravenous (IV) line issues (eg, IV infiltration, difficult IV access, inadequate IV size); contrast allergies; glomerular filtration rate (GFR) concerns; and delays related to imaging protocol (eg, need/request for contrast administration, including IV, oral, and/or rectal). Confidence intervals (CI) were calculated using the modified Wald method. We performed a kappa analysis to assess for inter-rater reliability. This was done on each category individually as some outlier cases had multiple contributing factors. This study design was approved by our institutional review board with a determination of exemption. We observed 10 of the 12 methods of health record review as outlined by Worster et al, with the exceptions of abstractor performance monitoring and abstractor blinding to hypothesis.[9]

RESULTS

We identified 182 outliers (4.2% of total patients) and excluded 15 cases (8.2%) for CT time-stamp inconsistencies. Of the 167 outliers analyzed, 38 delays (22.8%, 95% CI 17.0–29.7) were due to behaviorally non-compliant or medically unstable patients; 30 (18.0%, 95% CI 12.8–24.5) were due to IV issue;, 24 (14.4%, 95% CI 9.8–20.6) were due to contrast allergies; 21 (12.6%, 95% CI 8.3–18.5) were due to GFR concerns; and 20 (12.0%, 95% CI 7.8–17.9) were related to imaging study protocol. The cause of the delay was unknown in 55 cases (32.9%, 95% CI 26.3–40.4). The distribution of CT types for outlier cases is illustrated in Table 1.

Kappa values ranged from 0.69–0.98 for all the categories (Table 2). Intravenous issues had the lowest degree of agreement, while delays due to allergy protocols had the highest degree of agreement.

DISCUSSION

Our review identified both modifiable and non-modifiable factors associated with significantly delayed CT in the ED. Patient factors such as behavior, allergies, and medical acuity cannot be controlled. However, institutional protocols regarding difficult IV access, contrast administration in low GFR settings, and study protocols may be modified. One of these modifiable factors is IV access: early involvement of an

Table 1. Distribution of outliers in emergency department computed tomography.

Computed tomography type	Number (% total)
Torso (any chest/abdomen/pelvis imaging)	124 (62.0%)
Non-contrast head	37 (18.4%)
Spine	15 (7.5%)
Angiogram head and neck	13 (6.5%)
Face, orbits, soft tissue neck	7 (3.5%)
Extremity	5 (2.5%)

Table 2. Kappa analysis of factors associated with significantly delayed computed tomography.

Factors associated with delay	Kappa (95% confidence interval)
Intravenous line issues	0.69 (0.55–0.83)
Contrast allergy	0.98 (0.93–1.00)
Renal function concerns	0.86 (0.74–0.98)
Behaviorally or medically unstable patient	0.85 (0.75–0.94)
Imaging protocol	0.83 (0.70–0.96)
Unknown	0.86 (0.78–0.95)

IV team or utilization of ultrasound for IV placement may expedite imaging. Our data suggests that 18.0% of outliers can be more efficiently imaged by improving IV placement strategies. Studies have shown that nearly 9% of ED patients have difficult IV access, defined in one paper as requiring ≥3 attempts or an ultrasound-guided line. These patients experience statistically significant delays in establishing IV access, obtaining lab results, and receiving analgesia, as well as experiencing longer ED length of stay.[10] Therefore, the benefits of expeditious IV placement extends beyond enhanced CT throughput.

The second modifiable factor pertains to contrast administration in low GFR settings. There is growing evidence that the risk of acute kidney injury resulting from contrast administration in patients with reduced GFR may have been overestimated.[11] This shift has been attributed to the fact that much of the existing literature was not sufficiently controlled to distinguish between contrast-induced and contrast-associated nephropathy.[11] Institutions may consider revising policies, such as forgoing mandatory pre-hydration or radiologist conversations and amending exiting GFR cutoffs, to expedite imaging.

Judicious protocoling of CT may address a proportion of outliers. One study found that patients who had an abdominal/pelvic CT with only IV contrast had an approximately two-hour shorter ED length of stay when compared to patients who received a CT with oral and IV contrast.[12] This difference was even more pronounced when comparing patients who underwent CT with oral contrast with those who were imaged with no contrast: patients who received no contrast had an approximately four-hour shorter length of stay.[13] Finally, elimination of the routine use of oral contrast in abdominal/pelvic CT has been shown to shorten ED length of stay without affecting diagnostic accuracy.[14] Considered use of contrast may improve CT throughput.

We modified ED workflow to improve CT throughput and address some of the outliers identified in this study. We revised institutional policies regarding contrast administration in low GFR patients and streamlined communication between the ED and radiology teams. Previously, CT in a patient with a GFR of 45–60 milliliters per minute (mL/min) triggered a conversation between radiology and the ED care team regarding oral hydration. Under the new guidelines, patients with a GFR ≥45 mL/min may proceed directly to CT with IV contrast. For GFR 30–45 mL/min, radiology will call the ED team and discuss the merits of administering IV contrast. If the ED team elects to proceed with IV contrast, the volume, timing (pre- or post-CT), and route of fluid hydration are all at the discretion of the ED. Computed tomography throughput is therefore maximized as patients may be hydrated *after* receiving CT. For cases with a GFR ≤30 mL/min, radiology will discuss the merits of IV contrast with the ED team. If contrast is to be administered, one hour of IV pre-hydration is recommended prior to imaging if there is no contraindication. Communication between the ED and radiology teams has been streamlined with the introduction of automated messages that indicate when pre-hydration has been initiated and completed.

Analysis of the communication between the radiology and ED teams revealed that there were often multiple calls regarding a patient's hydration status. We intend to repeat a similar analysis with the above interventions to assess for a change in the number of delayed CT studies due to GFR concerns. We recommend that institutions perform their own analysis of outliers to understand opportunities for improvement and to expedite overall ED throughput.

LIMITATIONS

Limitations of our study include the fact that it was conducted at a single, urban, academic, tertiary-care ED. This population may not be indicative of that seen by other EDs. Furthermore, residents in our ED take ownership of difficult IV placement as part of their training. Thus, difficult IV placement may not be associated with delayed CT in other EDs that have dedicated IV access teams. The GFR cutoffs for contrast administration in our ED are admittedly stringent. Other institutions with less stringent cutoffs may not see as many significantly delayed CT studies due to GFR concerns.

For the purposes of this analysis, patient factors such as behavior, allergies, and medical acuity were considered non-modifiable. Future studies may consider reviewing protocols for allergy prophylaxis or behavioral de-escalation. Finally, we excluded a total of 41.1% of outliers: 8.2% due to CT time-stamp inconsistencies and 32.9% because the cause of the delay could not be identified despite thorough review of outlier charts.

CONCLUSION

We identified modifiable and non-modifiable factors associated with significantly delayed CT in the ED. Interventions such as prompt IV team involvement or utilization of ultrasound for IV placement, revision of institutional policies regarding contrast administration in low GFR settings, and CT protocol consideration may address up to 42.6% of outliers. These interventions may improve CT turnaround times and ED throughput. Future research will extend this analysis by measuring the effect of revised institutional policies regarding contrast administration.

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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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Usability of the 4Ms Worksheet in the Emergency Department for Older Patients: A Qualitative Study

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Section Editors: Stephen Meldon, MD, and Mark Langdorf, MD, MHPE
Submission history: Submitted April 21, 2023; Revision received October 30, 2023; Accepted November 21, 2023
Electronically published January 25, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18088

Introduction: Older adults often have multiple comorbidities; therefore, they are at high risk for adverse events after discharge. The 4Ms framework—what matters, medications, mentation, mobility—has been used in acute and ambulatory care settings to identify risk factors for adverse events in older adults, although it has not been used in the emergency department (ED). We aimed to determine whether 1) use of the 4Ms worksheet would help emergency clinicians understand older adult patients' goals of care and 2) use of the worksheet was feasible in the ED.

Methods: We conducted a qualitative, descriptive study among patients aged ≥60 years and emergency clinicians from January–June 2022. Patients were asked to fill out a 4Ms worksheet; following this, semi-structured interviews were conducted with patients and clinicians separately. We analysed data to create codes, which were divided into categories and sub-categories.

Results: A total of 20 older patients and 19 emergency clinicians were interviewed. We identified two categories based on our aims: understanding patient goals of care (sub-categories: clinician/ patient concordance; understanding underlying goals of care; underlying goals of care discrepancy) and use of 4Ms Worksheet (sub-categories: worksheet to discussion discrepancy; challenges using worksheet; challenge completing worksheet before discharge). Rates of concordance between patient and clinician on main concern/goal of care and underlying goals of care were 82.4% and 15.4%, respectively.

Conclusion: We found that most patients and emergency clinicians agreed on the main goal of care, although clinicians often failed to elicit patients' underlying goal(s) of care. Additionally, many patients preferred to have the interviewer fill out the worksheet for them. There was often discrepancy between what was written and what was discussed with the interviewer. More research is needed to determine the best way to integrate the 4Ms framework within emergency care. [West J Emerg Med. 2024;25(2)230–236.]

INTRODUCTION

Older adults will account for over 20% of the US population in the next decade, and they are more likely to have multiple comorbidities, take more medications, and use more healthcare resources than individuals in younger age groups.[1] The visit rate to emergency departments (ED) in the US in 2019 totaled 43 visits per 100 for individuals 65–74 years of age and 66 visits per 100 for individuals ≥75 years. The visit rate for those ≥75 was higher than all other age groups (ranging from 19–25 visits per 100

individuals) except for those under one year of age. Several studies have shown that there is a lack of recognition of risk factors (eg, polypharmacy, fall risk, delirium) for adverse outcomes among older adults in the ED.[2–4] Several assessment tools have been developed in the ED to evaluate risk factors (eg, identification of seniors at risk[5]), but there is no tool to effectively communicate the needs of older adults.[6–8]

The 4Ms framework of age-friendly health systems was created by the John A. Hartford Foundation in collaboration with the Institute for Healthcare Improvement, American Hospital Association, and Catholic Health Association. It incorporates four key elements: *what matters, medication, mentation*, and *mobility*.[9] These four elements were developed with current evidence-based practices with the intention of guiding clinician conversations with older adults. The 4Ms framework considers the common risk factors for adverse outcomes in older adult patients (eg, risk for delirium, potentially inappropriate medications, and challenges with mobility).

While there has been a focus on implementing the 4Ms framework in acute and ambulatory care settings, there have been few studies on its potential application in the ED.[10] The ED is one clinical setting in which it could be important to discuss the 4Ms so that all potential risk factors are identified and care is tailored to the needs of older patients. There is often a time constraint for the emergency clinician to engage in a lengthy conversation about what matters to the patient. ("What matters" entails discussing the specific details that matter to each patient on a deep level, including their goals and preferences for care, which can guide the care team and align care to what truly matters to the patient.) Use of the 4Ms framework could potentially prevent adverse outcomes for older adult patients receiving care in the ED by recognizing risk factors such as polypharmacy, fall risk, and delirium.

The 4Ms worksheet was developed by the team at Age-Friendly Care, PA, a Geriatric Workforce Enhancement Program at the Penn State Ross and Carole Nese College of Nursing. The worksheet is a patient-facing tool that allows individuals to identify what matters to them and what questions they may have about potential problems with mobility, mentation, and medications. The tool was developed to help facilitate conversations between patients and clinicians, but its use has not yet been evaluated in the ED (Appendix 1). We aimed to evaluate the potential usability of the 4Ms worksheet in the ED to facilitate conversations about what matters, medications, mention, and mobility between older patients and emergency clinicians, and to assess whether the 4Ms worksheet may support emergency clinicians' understanding of patients' goals of care, including barriers and facilitators to using the worksheet.

Population Health Research Capsule

What do we already know about this issue?
Older adults with multiple comorbidities face high risks post-discharge. The 4Ms framework—what matters, medication, mentation, and mobility—is used in various settings.

What was the research question?
Can the use of the 4Ms framework in the ED setting help clinicians understand older adult patients' goals of care, and is it feasible?

What was the major finding of the study?
Rates of concordance between patient and clinician on the main concern/goal of care and underlying goals of care were 82.4% and 15.4%, respectively.

How does this improve population health?
Integration of the 4Ms framework in emergency care could enhance understanding and alignment with older adults' underlying goals of care.

METHODS

Study Design

We conducted the study using a qualitative, descriptive approach involving semi-structured interviews with older adult patients (aged ≥60 years) and their emergency clinician from January–June 2022. This study is part of a larger study that examined patient goals reported through the 4Ms worksheet using the qualitative method.[11–13] In the present analysis we focused on usability of the worksheet by patients, as well as emergency clinicians' understanding of patients' goals of care.[11] The local institutional review board approved this study and determined it to be exempt. We adhered to the Consolidated Checklist for Reporting Qualitative Research (COREQ) guidelines. (Appendix 2).

Study Setting

This study took place in a single academic ED with Level I trauma accreditation and an annual census of approximately 60,000 patients. Clinicians practicing in this specific ED include attending physicians, residents, and advanced practice providers (APP). The ED has a three-year emergency medicine residency program and an 18-month fellowship for APPs; any EM resident or APP whom the patients saw would be enrolled in of one of these training

programs. The institution is currently a part of the age-friendly health systems movement.

4Ms Worksheet

The 4Ms worksheet was created by Age-Friendly Care, PA at the Penn State Ross and Carol Nese College of Nursing, which is a Center of Geriatric Nursing Excellence. The worksheet explains each category of the 4Ms framework—what matters, medications, mentation, and mobility— a program housed in the age-friendly healthcare system and provides space for the patient to write a short answer response about each.

Participants and Sampling

Participants were recruited for an interview if 1) they were aged ≥60 years; 2) they were currently receiving care in the ED; 3) their chief complaint was not related to altered mental status; 4) they were able to read and understand the 4Ms worksheet written in English, and 5) they had already been evaluated by a clinician in the ED. Patients who met eligibility criteria were approached by a member of the research team to provide study information. Consent was obtained from all participants before beginning the interview.

Data Collection

Two medical students, MM and MS—who were trained by the primary investigator SL and by DL who has extensive experience with qualitative research—conducted semi-structured interviews with patients and clinicians. The research team (SL, MS) developed an interview guide (Appendix 3). Interview responses were captured as handwritten notes instead of by digital recording due to cost. The research team collected patient age, gender, and type of clinician interviewed (staff physician, resident physician, or APP). Interviewers also took field notes, which contained the reason for the visit and contextual factors (symptom relief, diagnostic test, disposition, non-verbal aspects of the interview). The interviewer entered all data into REDCap, a secure electronic data capture tools hosted at The University of Iowa Hospitals and Clinics.[14] No compensation was provided for interviews.

Patient interviews took place in the room where the patient's ED evaluation took place. The emergency clinician was not present for the patient interview. First, the patient completed the 4Ms worksheet either independently or verbally to a member of the research team, followed by discussion. (Patients were not asked whether they had completed a 4Ms worksheet in prior healthcare encounters.) Discussion included patient goals for the current ED visit, questions about each category within the 4Ms framework, and how the patient felt their visit had gone overall. At the end of the interview, the interviewer offered the patient to keep the 4Ms worksheet for use as a reference in future healthcare encounters. Patient interviews lasted 30–60 minutes (including the time spent completing the 4Ms worksheet). After the patient interview was complete, the patient's clinician was interviewed about their perception of the patient's goals of care and how those goals were elicited during patient assessment. Clinician interviews occurred without the patient present and lasted 1–5 minutes.

Analysis

Interview data stored in REDCap was analyzed by research team members SL, MM, MS, and DL using content analysis.[15] Each interview was initially coded by two members (MS, MM), who received a brief training on qualitative content analysis. Two faculty investigators (SL and DL) reviewed these codes and made further recommendation before consensus was reached. The entire research team met to discuss coding; any discrepancies were resolved through group discussion. Identified codes were entered into a codebook (Appendix 4), which was maintained and updated throughout data analysis. Codes were grouped into categories and sub-categories to describe the data. Data collection and analysis followed an iterative process and occurred simultaneously, which allowed for revisions to the interview guide to address gaps in the data. Interviews continued until the research team jointly determined that no new information relevant to the research aims was emerging.

Rigor

Data was analyzed by a research team with a variety of backgrounds to reduce individual bias and improve credibility of the results.[16,17]

RESULTS

We approached 21 patients to conduct semi-structured interviews; one declined due to unknown reasons. In total we interviewed 20 patients and 19 clinicians during the six-month period. It should be noted that the reason for the small sample size in a six-month period was due to interviewers MM and MS also having medical school duties. All but one patient had a clinician to interview; the original clinician for that one patient was no longer in the ED, and the new clinician was unable to answer the questions, as the patient was being discharged. Nine attending physicians, eight residents, and one APP participated in the study (Table 1). The interview process for patient took about 30–60 minutes (median 45 minutes), including time to fill out the 4Ms worksheet, and 1–5 minutes (median 3 minutes) to interview emergency clinicians.

Patient and clinician interviews resulted in three themes on the topic of understanding patient goals of care: clinician/patient concordance; understanding underlying goals of care; and underlying goals of care discrepancy (summarized in Table 2). The 4Ms worksheet was used to facilitate

Table 1. Patient and emergency clinician demographic data.

Variable	*N*	Percent (%)
Patient age (years)		
60–70	8	40
70–80	9	45
80–90	2	10
90+	1	5
Patient gender		
Male	9	45
Female	11	55
Clinician role		
Attending physician	9	45
Resident	8	40
Advanced practice provider	1	5
Unknown	1	5

conversations about what matters, mentation, mobility, and medications, which support understanding of patients' goals of care, including barriers to and facilitators of its use (Appendix 4).

Understanding Patient Goals of Care

Clinician/patient concordance

In many cases, patients and clinicians arrived at concordant perceptions of the goals of care. This was indicated when patient and clinician agreed on the main concern and goals of care for the visit, such as in the following examples:

In interview 2, both the patient and clinician agreed that the main concern was addressing the patient's fever and coordinating care to address recurrent fevers related to chemotherapy; in interview 3, both the patient and clinician agreed that the goal of care was evaluation after fall and being able to continue living independently; in interview 4, both the patient and clinician agreed that the goal of care was addressing symptoms of constipation and abdominal pain; in interview 9, both the patient and clinician agreed that the main concern that brought the patient to the ED was chest pain; in interview 10, both the patient and clinician agreed that the goal of care was addressing symptoms of fatigue; and in interview 11, both the patient and clinician agreed that the goal of care was ruling out serious cardiac pathology. In this last case, both the patient and clinician identified a fear that the patient's chest pain may have pointed to serious cardiac pathology given the patient's history. The clinician elicited the foreboding feeling that the patient was having.

In interview 14, both the patient and clinician understood that the patient's chest pain was what mattered most. In interview 15, both the patient and clinician wanted to address abdominal pain. In interview 16, both the patient and clinician agreed that the main goal of care was pain management. In interview 17, the patient felt that they were treated well and when asked whether the clinician had addressed their concerns, answered, "Yeah, everyone was nice." However, for this patient, there was no clinician perspective to compare to. In interview 20, the patient reported that she was kept up to date (on her care) and felt that the ED clinician did "just fine" in addressing her goals of care, questions, and concerns.

Overall, 14 of 19 patients and clinicians agreed on the main concern or goals of care for the visit (Table 3). Further, we grouped these into symptom evaluation (Interviews 2, 4, 11); symptom management (Interview 16); symptom evaluation/management (Interview 3); generic agreement (Interviews 9, 10, 14); and miscellaneous (interviews 17, 20).

Table 2. Categories and sub-categories for understanding patient goals of care and utilization of the 4Ms worksheet.

Categories	
Understanding patient goals of care	Utilization of 4Ms worksheet
Clinician/patient concordance	Worksheet to discussion discrepancy
Understanding underlying goals of care	Challenges using the worksheet
Underlying goals of care discrepancy	Challenge completing the worksheet before discharge

Understanding Underlying Goals of Care

In some cases, the patient and clinician agreed on underlying goals of care for the patient. An underlying goal of care is defined as aspects of what matters to the patient in their daily life or health that affect their main concern and goal of care. Examples are as follows: In interview 2, both the patient and clinician suggested that a related goal of care was to coordinate with the team managing the patient's cancer to develop a care plan going forward that would address their recurrent fevers and chemotherapy issues; and in interview 3, both the patient and clinician agreed that an underlying goal of care was to be able to continue living independently. Overall, 2 of 19 patients and clinicians agreed on underlying goals of care (Table 3).

Underlying Goals of Care Discrepancy

Despite agreeing on main concerns and goals of care, patients and clinicians often did not agree on underlying goals of care. This was the case when interpretation of what matters for the patient and clinician was discrepant, as shown in these examples: In interview 5, the clinician mentioned that the main goal of care was pain relief, and that the patient would rather be at home and "soil himself" than be at the [deidentified] hospital. The patient's main goal of care was to work on physical therapy, gain strength, and get off some

Table 3. Clinician understanding of patient goals of care.

	Attending n = 10, (%) response = yes	Resident (MD/DO or APP) n = 8, (%) response = yes	APP n = 1, % response = yes	Concordance (%)
Patient perspective on whether clinician understood goals of care	4 (40)	5 (62.5)	NA	NA
Was the main concern addressed by clinician?	7 (70)	6 (75)	1 (100)	82.35
Was the underlying goal of care addressed by clinician?	2 (20)	0 (0)	0 (0)	15.38

APP, advanced practice provider.

medications. Thus, we identified themes of medication concerns and maintaining independence from this interview. In interview 4, the clinician identified improving symptoms as the main goal of care, but the patient identified the main goal as improving independence. Thus, we identified theme of medication concerns from this interview.

During the 19 clinician interviews, 17 were able to identify the main concern that brought the patient to the ED. Of these 17 clinicians, 14 (82.35%) mentioned a main concern or goal that matched with the patient's goal. Thirteen clinicians mentioned an underlying goal of care for the patient. Of these 13, only two clinicians (15.38%) mentioned an underlying goal of care that matched with the patient's underlying goals (Table 3). The responses on patient perspective, main concern, and underlying goals of care were similar between attending and resident physicians.

Utilization of the 4Ms Worksheet

Implementation of the 4Ms worksheet revealed multiple potential barriers to and facilitators of its use, including worksheet to discussion discrepancy, challenges using the worksheet, and challenge completing the worksheet before discharge (Table 2).

Worksheet to Discussion Discrepancy

In some cases, patients' answers to prompts on the 4Ms worksheet did not match information obtained through discussion with the research team, as shown in these examples: In interview 4, the patient answered "no" to medication concerns, but discussed many issues related to medications; in interview 3, the patient discussed information relevant to discharge/disposition and revealed opportunity to learn about medications that was not captured in the worksheet answers; and in interview 20, the patient wrote "no" to medication concerns, but had concerns about two of their medications. These examples could indicate that there was not enough space on the worksheet to provide the information, or that the patient did not care to fill out the worksheet in detail. A possibility also exists that the patient was reminded of more details through discussion that they did not think about before.

Challenges Using the Worksheet

Many patients preferred a verbal discussion about what mattered to them in their care as opposed to filling out the worksheet. Nine of 20 participants did not feel comfortable with filling out the 4Ms worksheet, and interviewers offered to fill it in for them. Some appeared to be uneasy completing the worksheet, as shown in these examples: Patient 2 began fidgeting with the worksheet and expressed discomfort with filling it out, stating that unease with worksheets extended back to being in school as a child; patient 5 could not read the questions, and the interviewer read them to the patient and also filled out the worksheet with their answers; patient 11 did not want to fill out the worksheet alone but was happy to allow the interviewer to do so; patient 19 had Parkinsonism and, therefore, was unable to write on the worksheet; the interviewer filled out the worksheet for this patient.

Challenge Completing the Worksheet Before Discharge

There were also logistical challenges with completing the 4Ms worksheet, including not having enough space on the worksheet to adequately answer the questions, as there are only so many lines available to write under each element. Limited time was another challenge, as shown in this example: Patient 17's interview was performed just before they were discharged, so it felt rushed as the patient was getting ready to leave. The interviewer and patient were also interrupted twice during the interview.

Overall, the use of the 4Ms worksheet required additional personnel to help interpret questions and fill out question items. Any downtime was used to finish this sentence, which provided opportunity to complete the worksheet.

DISCUSSION

We found that emergency clinicians have a good understanding of problem-oriented goals of care but not underlying goals. Further, the potential usability of 4Ms worksheet to facilitate the conversation between patients and emergency clinicians faces challenges. A successful implementation of the 4Ms framework in the ED is key in integrating emergency care into the age-friendly health system. Themes we identified highlight

the unique aspect of 4Ms and the worksheet to facilitate such care.

In terms of understanding patient goals of care, we identified clinician/patient concordance, understanding underlying goals of care, and underlying goals of care discrepancy. In most interviews, patients and clinicians agreed on a problem-oriented goal related to the patient's reason for presenting to the ED. However, we found that most emergency clinicians did not evoke the patient's underlying goals for the visit. The literature on using the 4Ms framework to elicit goals of care among older adults in the ED is limited. One study found that when discussing "what matters" to the patient, emergency clinicians and patients agreed that discharging home or reduction/resolving of symptoms was a high priority, but emergency clinicians often did not identify the patients' desire to return to prior functional ability.[18] Our study findings are similar in that many patients interviewed had underlying goals, but these goals were not described by the clinician.

In terms of barriers in using the 4Ms worksheet, we identified worksheet-to-discussion discrepancy, challenges using the worksheet, and challenges completing the worksheet before discharge. Nearly half of the patients did not feel comfortable filling out the worksheet and required the interviewer to assist them in doing so. This was due to a variety of reasons. In instances in which the patients did fill out the worksheet, there was often a discrepancy between what was written on the worksheet and what was discussed during the interview. In one instance the usage of the worksheet and discussion felt rushed due to the patient's impending discharge. In these cases, patients may not have fully described their goals, and interviewers may not have asked more in-depth questions about their goals.[10]

There is limited literature on the use of the 4Ms worksheet in the context of the ED. One paper suggested using a team approach to evaluating the 4Ms in elderly patients in the ED (eg, pharmacists should discuss medications, and social workers should discuss mobility). Another study used transitional care nurses in the ED to evaluate elderly patients for cognition and mobility and found that using such care nurses decreased admissions and readmissions to the hospital.[19,20] Our study is unique in that we used a worksheet based on the 4Ms framework and evaluated its feasibility for use in the ED. Given the amount of time that the discussions take, we suggest using a team approach or have a dedicated person to have 4Ms discussions with patients.

Strengths and Limitations

Strengths of our study include the in-depth discussion with patients, which allowed us to understand their goals and what matters to them. Another strength is that we had multiple members of the research team coding the same interviews; this allowed us to add more objective and diverse points of view. However, there were also several limitations to our study. The sample size was limited, and we were unable to recruit a sufficient number of APPs. Since we recruited these subjects during active clinical care, the time that physicians/APPs had for this interview was about 1-5 minutes, which may have caused bias. Patients were enrolled from a single center, limiting transferability to other health systems and geographic regions. The interviews were not recorded; so verbatim quotes were not possible in all cases, which may have caused recall bias. Also, we did not have access to demographic variables, again affecting transferability of findings. There was no quantitative measurement of discrepancy in the coding results.

Future Implications

Implications of use of the 4Ms worksheet for clinicians include increased time spent with patients and greater patient satisfaction, but also includes increased probability of falling behind in patient care. Implications of use of the 4Ms worksheet for patients include increased safety and needs being met, potential avoidance of hospital admission, and improved patient outcomes. It would be interesting to see whether early use of the 4Ms worksheet in the ED course with subsequent availability for ED clinicians allows greater concordance in the goals of care. The use of the 4Ms framework for emergency care is not fully developed, and the use of the worksheet can facilitate situation-specific care (eg, discharge planning).

CONCLUSION

We found that using the 4Ms framework as a guide for the care of older adult patients in the ED can help elicit underlying goals of care. We were able to answer whether patients' goals of care were congruent with what the emergency clinician believed the patients' goals were related to the presenting problem and with the patients' underlying goals. Our study also found that the use of the 4Ms worksheet in the ED needs more research on how to best incorporate it into the care of older adult patients, as many older adults may need additional assistance to fill it out. We suggest that the 4Ms worksheet can be used with older patients who present to the ED to guide conversations with clinicians. This study is preliminary, and requires a validation study to further test the worksheet's utility and acceptability in the ED.

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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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National Characteristics of Emergency Care for Children with Neurologic Complex Chronic Conditions

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Section Editor: Ronnie Waldrop, MD
Submission history: Submitted January 25, 2023; Revision received November 16, 2023; Accepted November 21, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.17834

Introduction: Most pediatric emergency care occurs in general emergency departments (GED), where less pediatric experience and lower pediatric emergency readiness may compromise care. Medically vulnerable pediatric patients, such as those with chronic, severe, neurologic conditions, are likely to be disproportionately affected by suboptimal care in GEDs; however, little is known about characteristics of their care in either the general or pediatric emergency setting. In this study our objective was to compare the frequency, characteristics, and outcomes of ED visits made by children with chronic neurologic diseases between general and pediatric EDs (PED).

Methods: We conducted a retrospective analysis of the 2011–2014 Nationwide Emergency Department Sample (NEDS) for ED visits made by patients 0–21 years with neurologic complex chronic conditions (neuro CCC). We compared patient, hospital, and ED visits characteristics between GEDs and PEDs using descriptive statistics. We assessed outcomes of admission, transfer, critical procedure performance, and mortality using multivariable logistic regression.

Results: There were 387,813 neuro CCC ED visits (0.3% of 0–21-year-old ED visits) in our sample. Care occurred predominantly in GEDs, and visits were associated with a high severity of illness (30.1% highest severity classification score). Compared to GED visits, PED neuro CCC visits were comprised of individuals who were younger, more likely to have comorbid conditions (32.9% vs 21%, $P < 0.001$), and technology assistance (65.4% vs. 45.9%) but underwent fewer procedures and had lower ED charges ($2,200 vs $1,520, $P < 0.001$). Visits to PEDs had lower adjusted odds of critical procedures (adjusted odds ratio [aOR] 0.74, 95% confidence interval [CI] 0.62–0.87), transfers (aOR 0.14, 95% CI 0.04–0.56), and mortality (aOR 0.38, 95% CI 0.19–0.75) compared to GEDs.

Conclusion: Care for children with neuro CCCs in a pediatric ED is associated with less resource utilization and lower rates of transfer and mortality. Identifying features of PED care for neuro CCCs could lead to lower costs and mortality for this population. [West J Emerg Med. 2024;25(2)237–245.]

INTRODUCTION

Approximately 30 million emergency department (ED) visits are made by children in the United States annually.[1] Previous studies have shown that most pediatric patients receive emergency care in general EDs (GED), where less pediatric experience and lower pediatric emergency readiness may compromise care.[2,3] Care in GEDs may be less likely to follow evidence-based guidelines for common pediatric conditions such as head trauma, croup, and asthma. In addition, GEDs may have higher rates of potentially avoidable transfers (given the likelihood of transfer when the patient did not present initially

to a specialty hospital) and higher mortality in critical illness.[4–6]

Children and young adults with chronic, severe neurologic conditions are a medically vulnerable population with poor functional status and high rates of comorbid disease and need for technology assistance (ie, gastrostomy tube or ventricular peritoneal shunts). These characteristics make this population at risk of frequent ED utilization, unique medical presentations, and high acuity of illness.[7–11] Prior studies have found children with neurologic disease account for up to 13% of inpatient pediatric admissions, and one third of inpatient pediatric healthcare costs.[7,8] Although GEDs provide most emergency care for children, emergency medicine (EM) trainees and GED clinicians have less experience and confidence in providing care to pediatric patients compared to treating adults.[12,13] Despite growing evidence that children with chronic neurologic conditions are at risk of frequent ED usage, there is limited data comparing the distribution, characteristics, and outcomes of emergency care for this specific population between GEDs and pediatric EDs (PED).

In this study we aimed to describe the national estimates of children and young adult patients with neurologic complex chronic conditions (neuro CCC) and compare the characteristics and outcomes of ED visits in GEDs and PEDs. We hypothesized that PED visits would be associated with lower rates of resource utilization, transfer, and mortality.

Population Health Research Capsule

What do we already know about this issue?
Children with chronic neurologic diseases are at risk for severe illness and poor outcomes in the emergency department.

What was the research question?
Does emergency care differ between general (GED) and pediatric EDs (PED) for children with chronic neurologic disease?

What was the major finding of the study?
Chronic neurological pediatric visits in PEDs had lower odds of mortality in the ED (aOR 0.4, 95% CI 0.2–0.8) compared to GEDs (0.04% vs 0.13%).

How does this improve population health?
Identifying features of pediatric ED care for children with chronic neurologic conditions could improve mortality in this high-risk population.

METHODS

Study Design and Data Source

We conducted a cross-sectional analysis to identify the frequency and characteristics of ED visits among patients aged 0–21 years with neuro CCCs between 2011–2014 in the Nationwide Emergency Department Sample (NEDS). The NEDS is part of the Healthcare Cost and Utilization Project database that is sponsored by the Agency for Healthcare Research and Quality. It is the largest all-payer, nationally representative ED database in the United States and contains a 20% stratified sample of hospital-based EDs. The sampling strategy deliberately encompasses between 945–955 hospital-based EDs in 24–34 states and approximately 120–137 million weighted visits to the ED annually.[14] Hospital-based EDs are stratified by US census region, trauma designation, urban-rural location, hospital ownership, and teaching status. Additionally, as no patient identifiers are available, individual patients cannot be tracked longitudinally, and encounters that originated in one facility and were transferred will have a separate encounter in the receiving facility. The unit of analysis is the ED visit. The study was submitted to the Seattle Children's Institutional Review Board (IRB) and was determined to be IRB exempt.

We included all ED visits made by patients 0–21 years of age with an International Classification of Diseases, 9th Rev (ICD-9) diagnosis consistent with a neuro CCC.[15] The classification of CCCs, originally developed by Feudnter and colleagues, is an organ-system based classification of complex diseases of childhood.[15] We excluded ED visits that were missing age, primary diagnosis. or the primary diagnosis was invalid.

Our primary predictor variable was the category of ED, either GED or PED. The NEDS does not specifically designate PEDs; thus, consistent with similar published reports, we designated PEDs as those where ≥75% of visits were children <18 years of age. All other EDs were categorized as GEDs.[3,5,16–18] Of note, while we defined PED based upon proportion of visits made by children <18 years, we included encounters in this study up to age 21, as patients with chronic medical conditions often continue to seek care in PEDs into young adulthood as they transition to adult care.[2,3] Patient-level predictors included the following: 1) demographics, insurance payer, median income quartile, and the urban-rural classification of the patient's area of residence; 2) neuro CCC diagnostic category; 3) number of non-neuro CCCs); 4) presence of technology assistance and CCC ICD-9 codes.[15] We identified specific technologies, including ventricular shunts, feeding tubes (gastrostomy, gastro-jejunostomy, and jejunostomy tubes) and tracheostomies, specifically using the corresponding

technology assistance codes.[15] Hospital-level predictors included teaching status of the ED, trauma center designation, and hospital region.

Our primary outcomes of interest were resource utilization, severity of illness presentation, disposition (admission and transfer), and mortality. Resource utilization was assessed through ED charges, frequency of procedures performed, and diagnostic imaging. As the NEDS provides only facility charges, and cost-to-charge ratios were not available for the years selected, we report total charges for the ED and inpatient stay. This approach is consistent with prior published studies.[19,20] We used total number of current procedural terminology (CPT) codes, rather than ICD-9 procedural codes, to assess procedure frequency as a significantly higher proportion of ED visits had CPT codes available. Diagnostic imaging (including radiograph, ultrasound, computed tomography (CT) or magnetic resonance imaging (MRI) and cross-sectional imaging (CT or MRI only) was reported based on the CPT and ICD-9 procedural codes associated with the ED visit.

We assessed the outcome of severity of clinical presentation using severity classification scores (SCS) and critical procedure performance.[2,21] The SCS is a Pediatric Emergency Care Applied Research Network consensus-derived diagnostic system that relies on the most severe ICD-9 diagnostic codes attached to each record to assign each ED visit a severity score. The severity score ranges from 1 (minimal resources used) to 5 (maximal resources used).[21] Critical procedures were defined as the presence of an ICD-9 code for endotracheal intubation, central line placement, and chest tube placement as previously described in the literature.[22,23] Mortality was categorized as (1) ED mortality and (2) visit mortality (death at any point during ED visit or hospitalization).

Statistical Analysis

We incorporated sampling weights to consider the significant survey design and sampling procedures of the NEDS. Descriptive statistics, including frequencies, proportions and sums as appropriate, were used to summarize patient and hospital characteristics. We made comparisons using chi-square or ANOVA test for categorical variables, and *t*-tests for continuous variables. Multivariable logistic regression was performed for five different ED outcome variables (admission, transfer, transfer or admission, mortality, and critical procedure performance). Predictor variables included in logistic regression were patient-level variables (demographics, number of CCCs, technology assistance, SCS score), and hospital-level predictors (trauma center designation, geographic location, PED vs GED). Results were reported as adjusted odds ratios (aOR) and 95% confidence intervals (CI).

RESULTS

Of the estimated 141 million weighted ED visits made by patients aged 0–21 years in the 2011-2014 NEDS, 387,987 (0.3%) had a neuro CCC diagnosis. Most neuro CCC ED visits occurred in GEDs (74.9%), and the remainder occurred in PEDs (25.1%). Neuro CCCs visits represented proportionately more of all 0–21-year-old PED visits compared to GED visits (1.0% vs 0.2%). The patient-level characteristics of neuro CCC ED visits are shown in Table 1. Younger patients (ages ≤9 years) represented proportionately more of PED than GED visits (63 vs 48%, $P < 0.01$). There was a predominance of males in both GED and PED visits (55.8% vs 55.9%). The primary payer for most GED and PED visits was Medicaid (56.1% vs 60.6%), and income quartile (not shown) was not significantly different between GEDs and PEDs.

There was a high rate of comorbid chronic conditions overall in children with neuro CCCs, with one in four ED visits associated with at least one non-neurologic CCC (93,075, 24%, Table 1). The medical complexity of neuro CCC visits was higher in PEDs compared to GEDs, with 32.9% of patients in PEDs with at least one additional CCC compared to 21% in GEDs. Technology assistance was more frequent in PED than GED encounters (65.5% vs 49.5%) and was comprised mostly of ventricular shunts (161,868, 41.7%), feeding tubes (56,568, 14.6%) and, less commonly, tracheostomies (17,653, 4.6%). Supplemental Table 1 demonstrates the frequency of subcategories of neuro CCCs and the most common categories of non-neuro CCCs.

Hospital characteristics are also shown in Table 1. Over 80% of PED visits were in metropolitan locations, teaching facilities, and Level I/II trauma centers, consistent with underlying differences between these two categories of EDs.[2,18] Regionally, PED visits were predominantly from the West, while GED visits were predominantly from the South. The Northeast region accounted for the lowest proportion of visits, 18.9% of neuro CCC ED visits overall and only 1.4% of PED visits (data not shown).

Characteristics of emergency visit care for neuro CCC ED visits are demonstrated in Table 1. Severe illness presentations were common; 30.1% of visits had a SCS 5 indicating critical illness. The PEDs had fewer SCS 5 presentations than GEDs, (26.4% vs 31.3% vs. $P = 0.002$), and more SCS 4 presentations than GEDs (55.8% vs. 47.5%, $P = < 0.001$). PEDs visits had fewer overall procedures performed (0 procedures performed in 34.9% PED vs13.4% in GEDs ($P = 0.048$) and less imaging (45.7% vs 24.4%, not significant). Endotracheal intubation was the most frequently performed critical procedure and occurred less frequently in PEDs compared to GEDs (5.7% vs 8.3%, $P = 0.003$).

Median ED charges were significantly lower in PEDs compared to GEDs ($P < 0.001$). Visits to PEDS, had higher proportion of admissions (55.1% vs 42.8%, $P < 0.001$) and

Table 1. Selected patient, hospital, and visit characteristics involving visits to general and pediatric emergency departments for neuromuscular complex chronic conditions.

N (%)	General ED (n = 290,641)	Pediatric ED (n = 97,346)	All ED visits (n = 387,987)	P value
Patient characteristics				
Age in years				
0–9	139,249 (47.9%)	61535 (63.2%)	200,706 (51.7%)	<0.001
10–17	79,886 (27.5%)	29,138 (29.9%)	109,024 (28.1%)	
18–21	71,505 (24.6%)	6,712 (6.9%)	78,257 (20.2%)	
Urbanicity				
Large metro	142,792 (49.1%)	72,560 (74.5%)	215,353 (55.5%)	0.18
Medium/small metro	100,482 (34.5%)	15,978 (16.4%)	116,460 (30.0%)	
Non-metro/unknown	47299 (16.3%)	8808 (9.0%)	56107 (14.5%)	
Primary payer				
Medicaid	162,965 (56.1%)	58,950 (60.6%)	221,916 (57.2%)	0.50
Private insurance	98780 (34.0%)	30,832 (31.7%)	129,612 (33.4%)	
Medicare/other	28,807 (9.9%)	7393 (7.6%)	11,868 (9.4%)	
Complexity				
>1 additional CCC	69,038 (21.0%)	32,037 (32.9%)	93,044 (24.0%)	<0.001
Technology assistance	143,788 (49.5%)	63,707 (65.45%)	207,495 (53.5%)	<0.001
Hospital characteristics				
Teaching hospital	195,506 (67.3%)	97,035 (99.7%)	292,542 (75.4%)	<0.001
Trauma center (I/II)	165,244 (56.9%)	90,905 (93.4%)	256,149 (66.2%)	<0.001
Large metro location	150,888 (51.9%)	80,818 (83.0%)	231,744 (59.7%)	0.015
Visit characteristics				
Disposition				
Admission	124,350 (42.8%)	53,659 (55.1%)	178,008 (45.9%)	<0.001
Transfer	27,392 (9.4%)	1,242 (1.3%)	28,633 (7.4%)	<0.001
Death in the ED	380 (0.13%)	47 (0.04%)	427 (0.11%)	0.003
Critical procedures[1]				
Endotracheal tube	20,059 (8.3%)	4,220 (5.7%)	24,278 (7.7%)	0.003
Central venous line	11,210 (4.6%)	3,873 (5.3%)	15,115 (4.8%) 1,763 (0.6%)	0.32
Chest tube	1,511 (0.6%)	255 (0.3%)	77,574 (20.0%)	0.004
Severity classification score				
<3	60,545 (20.8%)	17,030 (17.5%)	192,480 (49.6%)	0.007
4	138,084 (47.5%)	54,357 (55.8%)	116,823 (30.1%)	<0.001
5	91,060 (31.3%)	25,762 (26.4%)	$2,031 (1170–3743)	0.002
ED charges, median (IQR)	$2,200 (1237–3943)	$1,520 (873–2783)	$2,031 (1170–3743)	<0.001

[1]Critical procedures included both current procedural terminology (CPT) and International Classification of Diseases, 9th Rev (ICD-9) procedure codes. Visits with CPT/ICD-9 procedure codes listed, Total n = 367,108; general ED n = 241,401; pediatric ED n = 73,947. *ED*, emergency department; *CCC*, complex chronic conditions; *IQR*, interquartile range.

lower proportion of transfers (1.3% vs 9.4%, $P < 0.001$). In the combined outcome of admission or transfer, there were no significant differences between PEDs and GEDs (52.2% vs 56.4%, $P = 0.09$). Death in the ED was an infrequent outcome, representing only 0.11% of visits. However, ED mortality was lower for PED visits compared to GED visits (0.02% vs 0.11%, $P = 0.003$). Visit mortality (death at any point during ED or inpatient stay) was similarly lower for PED visits compared to GEDs (1.27% vs 2.39%, $P = 0.003$).

Table 2 summarizes results of our logistic regression models to explore the relationship between the category of ED and visit disposition and critical procedure performance. The PED visits had significantly lower adjusted odds of transfer compared to general EDs (aOR 0.14, 95% CI 0.04–0.56). Conversely, PEDs had a significantly higher adjusted odds of admission (aOR 1.52, 95% CI 1.19–1.96). Additional predictors in admission and transfer models included presence of non-neurologic CCCs, increased severity of illness, rural/fringe metropolitan residences, and in those whose insurance was self-pay. For the combined outcome of admission or transfer, there was no significant difference between PEDs and GEDs (aOR 1.07, 95% CI 0.86–1.33).

In the adjusted models of critical procedures (Table 3), PED visits had lower odds of critical procedures (aOR 0.74, CI 0.62–0.87) compared to GED visits. Overall, increased severity of illness was associated with a dramatically increased odds of critical procedures (aOR11.9, 95% CI 10.3–13.6). Non-neurologic CCCs were also associated with increased of critical procedures performance (aOR 1.51, 95% CI 1.42–1.59). The ED visits in which a patient had a tracheostomy had lower odds (aOR 0.48, 95% CI 0.38–0.59) of critical procedure as compared to those without a tracheostomy; other forms of technology assistance were not significantly different.

The logistic models for ED mortality and visit mortality are also shown in Table 3. Severity of illness scores were not included in the adjusted models of mortality, as there was collinearity with this variable and the outcome. The adjusted odds of ED mortality was significantly lower for PED visits (aOR 0.37, CI 0.19–0.73) compared to GED visits. Patients with ventriculorperitoneal shunts had a lower adjusted odds of mortality compared to those without. Similarly, in the model of overall visit mortality, PED visits had a lower odds of visit mortality compared to GEDs (aOR 0.62, $P < 0.001$). The presence of non-neurologic CCCs was predictive of increased odds of mortality, while all forms of technology assistance had lower adjusted odds of visit mortality.

DISCUSSION

In this national sample of ED visits, we estimate 387,000 annual ED visits were made by patients aged 0–21 years with neurologic complexity between 2011–2014. Neuro CCC patients had high rates of medical complexity and technology dependence, and often presented with severe illness to the ED. Most of the emergency care for this population occurred in GEDs, where visits had higher rates of diagnostic testing, critical procedures, and ED-associated charges. After adjustment for differences in demographics, comorbidities, and severity of illness presentation, GEDs had higher rates of transfer. However, there were no significant differences between GEDs and PEDs in a combined model of admission or transfer. Adjusted odds of critical procedure performance, ED mortality, and overall visit mortality were higher in GEDs compared to PEDs.

Table 2. Logistic models for outcome of admission, transfer, and the combined outcome of admission or transfer for emergency department visits for neurologic complex chronic conditions.

	Admission adjusted OR (95% CI)	Transfer adjusted OR (95% CI)	Admission or transfer adjusted OR (95% CI)
Age	1.01 (1.01–1.02)	0.94 (0.93–0.95)	0.99 (0.98–1.00)
Female gender	0.93 (0.89–0.97)	1.06 (1.00–1.13)	0.95 (0.92–0.99)
Insurance payer			
Private insurance	Referent	Referent	Referent
Medicaid	0.85 (0.78–0.93)	1.10 (0.99–1.23)	0.88 (0.82–0.95)
Medicare	0.88 (0.71–1.10)	0.84 (0.57–1.24)	0.86 (0.69–1.07)
Urbanicity			
Central metro	Referent	Referent	Referent
Small metro	0.74 (0.58–0.96)	2.33 (1.75–3.09)	0.96 (0.78–1.18)
Non-metro	0.79 (0.54–0.89)	2.98 (2.28–3.9)	1.01 (0.84- 1.21)
Additional non-neurologic CCCs	2.56 (2.31–2.86)	0.43 (0.38–0.49)	2.25 (2.05–2.47)
Feeding tube	1.30 (1.17–1.45)	0.82 (0.69–0.98)	1.23 (1.1–1.37)
Ventricular shunt	1.01 (0.89–1.14)	0.54 (0.46–0.63)	0.84 (0.76–0.93)
Tracheostomy	0.59 (0.48–0.71)	2.8 (2.11–3.70)	0.71 (0.6–0.85)
Severity classification score	2.52 (2.40–2.64)	1.9 (1.75–2.06)	3.0 (2.86–3.31)
Pediatric ED	1.52 (1.19–1.96)	0.14 (0.04–0.56)	1.07 (0.86–1.33)

OR, odds ratio; *CI*, confidence interval; *CCCs*, complex chronic conditions; *ED*, emergency department.

Table 3. Logistic models for the outcomes of critical procedure performance, death in the emergency department or death at any point in the visit (visit mortality).

	Critical procedure performance adjusted OR (95% CI)	ED mortality adjusted OR (95% CI)	Visit mortality adjusted OR (95% CI)
Age	1.0 (0.994–1.005)	0.97 (0.94–1.0)	1.03 (1.02 –1.04)
Female gender	0.81 (0.76–0.85)	0.63 (0.39–1.0)	0.76 (0.69–0.84)
Insurance payer			
Private insurance	Referent	Referent	Referent
Medicaid	1.03 (0.96–1.11)	1.04 (0.65–1.67)	0.66 (0.58–0.75)
Medicare	0.85 (0.62–1.15)	1.09 (0.15–8.24)	0.19 (0.09–0.36)
Urbanicity			
Central metro	Referent	Referent	Referent
Small metro	0.81 (0.70–0.94)	1.12 (0.54–2.31)	0.94 (0.74–1.12)
Non-metro	0.65 (0.56–0.75)	2.0 (0.89–4.54)	0.90 (0.72–1.12)
Non-neurologic CCCs	1.51 (1.42–1.59)	0.86 (0.55–1.33)	2.73 (2.54–2.94)
Feeding tube	0.92 (0.83–1.02)	1.34 (0.49–3.67)	0.23 (0.18–0.30)
Ventricular shunt	0.91 (0.81–1.02)	0.34 (0.18–0.64)	0.33 (0.28–0.40)
Tracheostomy	0.48 (0.38–0.59)	2.65 (0.77–9.17)	0.22 (0.15–0.31)
Severity classification score	11.81 (10.28–13.56)	N/A	N/A
Pediatric ED	0.74 (0.62–0.87)	0.38 (0.19–0.75)	0.62 (0.46–0.83)

OR, odds ratio; *CI*, confidence interval; *CCCs*, complex chronic conditions; *ED*, emergency department.

Prior research has demonstrated that children with complex chronic illnesses have a high risk of critical illness and poor outcomes during emergencies.[17,18,24,25] Our study adds to the literature by demonstrating that among a national sample of neuro CCC ED visits, an estimated 30% presented with critical severity of illness (SCS 5) and 7.7% required endotracheal intubation. In contrast, in a national sample of all-comer PED visits in the NEDS in which only 5% of patients had ≥1 complex chronic condition, only 0.5% of visits had a critical severity score of 5 and only 0.15% required intubation.[2] The comparatively much higher severity measures found in our study population further supports the high-acuity ED needs among children with neurologic complexity as compared to a general pediatric population.

Our work demonstrates that most emergency care for children with neuro CCCs occurs in GEDs rather than specialized pediatric centers, congruent with prior characterizations of emergency care for children with CCCs.[2] Prior research using nationally representative datasets has shown that PEDs may perform better across several quality-of-care metrics, including less diagnostic testing in asthma, fewer antibiotics for viral infections, and lower mortality in critical illnesses such as cardiac arrest and sepsis.[4,5,25] Our study expands upon this existing literature, by characterizing the disparities in characteristics of emergency care in GEDs for children with chronic neurologic diseases. These findings suggest there may be some specific benefits to PED care for certain high-risk, medically fragile populations, such as those with neurologic complexity.

Some of the differences we observed between GEDs and PEDs may be due to unmeasured influences of a pre-transfer evaluation and stabilization. As this dataset has no patient identifiers and does not allow for longitudinal assessment of patient care, we were unable to identify which ED visits were self-referred vs transferred from another ED. However, among the 28,633 transferred encounters in this study, 27,392 (95.7%) originated in a GED, and it is likely many of these encounters were transferred to a PED. Once these patients reached the receiving facility, they likely had reduced requirements for additional diagnostic testing or critical interventions, which could account for the comparatively lower ED costs and procedure frequency we observed in PED encounters. Additionally, other factors related to the transfer process may have influenced procedure rates in GEDs. For instance, referring emergency physicians might have chosen to intubate patients with a higher risk of respiratory decompensation before the transfer, potentially contributing to the relatively higher intubation frequency seen in GEDs. To gain a deeper understanding of the origins of the observed variations in ED costs and outcomes between GEDs and PEDs, future studies incorporating longitudinal patient data are needed.

It is worth noting that ED visits made by children with neuro CCCs had high rates of technology assistance overall, and in our logistic models patients with tracheostomy and ventricular shunts had lower odds of visit mortality. Although technology assistance in large population studies of all-comer pediatric patients has been identified as a risk factor for severe illness and mortality, in children with neurologic diseases there is evidence that technology assistance may be protective.[26,27] In a 2019 Canadian study of children with medical complexity, technology assistance was associated with lower odds of visit mortality in children with neurologic impairment and those with multiple CCCs.[8] Similarly, a 2015 analysis from Hong Kong found that in children with severe neurologic diseases, tracheostomy was associated with lower odds of mortality.[28] Additionally, inherent differences in the type of neurologic complexity between patients with and without these forms of technology assistance may help explain the observed differences in mortality.

We hypothesize the higher rates of transfer and lower rates of admission in GEDs are likely secondary to limited inpatient pediatric capabilities at these centers, thus necessitating transfer.[6,7,29] This hypothesis is supported by our finding that the combined outcome of admission and transfer in our logistic models showed no differences between GEDs and PEDs. There is increasing evidence that pediatric inpatient care is increasingly limited in community hospitals, resulting in increased regionalization of hospital pediatric care.[30] This is likely to be particularly true for children with neurologic complexity, who may require specialist consultation only available in pediatric centers.

These findings have important implications for the delivery of pediatric emergency care to medically vulnerable patients in the United States. Despite the increasing regionalization of inpatient pediatric care, emergency care for children is likely to continue to occur predominantly in GEDs given the geographic limitations in access to specialized pediatric emergency centers for many patients. Thus, ensuring adequate education and preparation for emergency conditions in complex pediatric patients in community and rural EDs is critical. Experience caring for critically ill, medically complex pediatric patients is lacking for many EM trainees and represents a target for ongoing educational efforts.[12,13]

Simulation interventions, such as those delivered by the IMPACTS network. are another possible intervention to help improve the care of this complex population by non-pediatric clinicians in community ED settings.[31] Pediatric emergency telemedicine may be another potential strategy to improve the quality of care received by complex pediatric patients in GEDs. Improvements in this technology, wider availability of telemedicine clinicians, and increasing acceptance of this format of care may ultimately address disparities in access to care by making specialized pediatric emergency physicians more available.[32–34]

LIMITATIONS

This study has several important limitations. First, we used data from 2011–2014, which may impact how translatable these findings are to the present. Increasing regionalization of care in the last 10 years may have impacted overall distribution of pediatric neuro CCC ED care between GEDs and PEDs and potentially an increased frequency of transfers. Increased efforts toward pediatric readiness in GEDs during this time frame could also have improved critical illness outcomes in some GEDs. Additionally, this work relies on large amounts of administrative data, which is susceptible to errors in data processing and variability in coding. We used ICD–9 codes to identify the population of neuro CCC visits, and the ICD–9 codes ascribed to an encounter only pertain to the currently recorded ED diagnoses and may not represent all pre-existing conditions. Thus, this work likely underestimates the true frequency of neuro CCC ED visits, particularly for lower acuity treat-and-release visits.[2]

Additionally, using the proportion of pediatric patients seen within an ED to determine PED designation has its own limitations. Specifically, if a PED and GED are financially linked (common in academic institutions that share the same campus) the visits from these two institutions will often be grouped as a single hospital in the NEDS. This results in some PEDs being grouped together with GEDs, using our categorization system. Given the collinearity of the outcome of mortality with SCS, we did not include this in our modeling, and thus differences in mortality between GEDs and PEDs may in part be due to unmeasured differences in severity of illness. Lastly, mortality was overall an infrequent outcome, and thus any broad interpretations of this finding should be taken with caution.

CONCLUSION

This study is the first in our knowledge to describe the national state of emergency care for children with neurologic complex chronic conditions in both pediatric and general EDs. Our findings demonstrate that most emergency care for children with neuro CCCs occurs in GEDs, and that GEDs had higher rates of procedures and charges, transfers, and mortality as compared to PEDs. As these patients are likely to continue to predominantly receive emergency care in GED settings, interventions to ensure appropriate training and preparation of general emergency physicians for children with neurologic complexity is needed. Additionally, further research efforts to explore the impact of pediatric emergency telemedicine support on improved quality of care for medically complex patients is needed.

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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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Pediatric Outcomes of Emergency Medical Services Non-Transport Before and During the COVID-19 Pandemic

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Submission history: Submitted July 24, 2023; Revision received November 22, 2023; Accepted November 27, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18408

Introduction: Pediatric patients account for 6–10% of emergency medical services (EMS) activations in the United States. Approximately 30% of these children are not transported to an emergency department (ED). Adult data in the literature reports higher hospitalization and complications following non-transport. Few studies discuss epidemiology and characteristics of pediatric non-transport; however, data on outcome is limited. Our primary aim was to determine outcomes of non-transported children within our urban EMS system before and during the COVID-19 pandemic. Our secondary objective was to explore reasons for non-transport.

Methods: This was a prospective, descriptive pilot study. We compared EMS data for September 2019 (pre-COVID-19) to September 2020 (pandemic). Included were children aged 0–17 years who activated EMS and did not receive transport to the primary hospital for the EMS capture area. We defined outcomes as repeat EMS activation, ED visits, and hospital admissions, all within 72 hours. Data was obtained via electronic capture. We used descriptive statistics to analyze our data, chi square for categorical data, stepwise logistic regression, and univariate logistic regression to test for association of covariates with non-transport.

Results: There were 1,089 pediatric EMS activations in September 2019 and 780 in September 2020. Non-transport occurred in 633 (58%) in September 2019 and 412 (53%) in September 2020. Emergency medical services was reactivated within 72 hours in the following: 9/633 (1.4%) in 2019; and 5/412 (1.2%) in 2020 ($P = 0.77$). Visits to the ED occurred in 57/633 (9%) in 2019 and 42/412 (10%) in 2020 ($P = 0.53$). Hospital admissions occurred in 10/633 (1.5%) in 2019 and 4/412 (0.97%) in 2020 ($P = 0.19$). One non-transported patient was admitted to the intensive care unit in September 2020 (<1%) and survived. Hispanic ethnicity, age >12 years, and fever were associated with repeat EMS activation. The most common reason for non-transport in both study periods was that the parent felt an ambulance was not necessary (47%).

Conclusion: In our system, non-transport of pediatric patients occurred in >50% of EMS activations with no significant adverse outcome. Age >12 years, fever, and Hispanic ethnicity were more common in repeated EMS activations. The most common reason for non-transport was parents feeling it was not necessary. Future studies are needed to develop reliable EMS guidelines for pediatric non-transport. [West J Emerg Med. 2024;25(2)246–253.]

INTRODUCTION

Pediatric patients historically account for up to 10% of emergency medical services (EMS) activations in the United States,[1] with more recent literature suggesting 6%.[2] A national EMS data review noted that 30% of pediatric patients are not transported to a medical facility for further evaluation and care.[2–6] The reasons for non-transport are broad, including factors such as parental refusal and type of complaint (ie, musculoskeletal trauma, respiratory illness). While data exists regarding rates of and factors related to pediatric EMS non-transport, outcomes are limited to a few studies. In the adult literature, non-transport was associated with a 16% hospitalization rate[7] and in some cases serious or fatal outcomes.[8] One pediatric study noted non-transported patients <3 years of age were 1.3 times more likely to have a subsequent emergency department (ED) visit,[9] while another reported a 10% hospitalization rate after pediatric non-transport for parental refusal.[10] During the COVID-19 pandemic, data suggests that EMS call volumes and non-transport rates changed, with a decline in overall EMS response volumes and an increase in the rate of non-transports.[11] Little is known about whether this impacted outcomes for children who were non-transported.

Our primary objective was to determine pediatric outcomes of non-transport within our large EMS system before and during the COVID-19 pandemic. Outcomes were defined as repeat EMS activation, in-person ED visits, and/or hospital admissions, all within 72 hours of initial EMS activation. We also aimed to describe demographic factors associated with subsequently needing medical attention after EMS non-transport. A secondary objective was to identify reasons for non-transport within our system both pre- and during the COVID-19 pandemic. We chose to compare pre- and during the pandemic to determine whether there was a change in utilization or in EMS clinicians'/parents' behavior during a pandemic to better prepare our systems for the future.

Population Health Research Capsule

What do we already know about this issue?
Up to 30% of pediatric EMS activations are not transported to an ED. Adult data reports adverse outcomes following non-transport; pediatric data is limited.

What was the research question?
We aimed to determine outcomes of non-transported children within our EMS system before and during COVID-19.

What was the major finding of the study?
There was no difference in outcomes pre/during COVID-19: EMS reactivation (1.3% of all patients) ($P = 0.77$); ED visits ($P = 0.53$); and admission ($P = 0.19$).

How does this improve population health?
Future studies are needed to develop reliable guidelines for pediatric non-transport, which could decrease burden on the medical system especially during pandemics.

MATERIALS AND METHODS

Study Setting

This was a prospective, descriptive pilot study at a large, urban, fire-based EMS system in the City of Dallas, Texas, with 59 stations and ~1,800 EMS responders serving a total population of 1.3 million, with approximately 25% of that population <18 years of age. The study was approved by the institutional review board.

Inclusion of Patients

We included children aged 0–17 years with EMS activation who did not receive EMS transport during the study period. We selected two one-month time periods, September 2019 (pre-COVID-19) and September 2020 (COVID-19 pandemic). During the study period, all non-transports of pediatric patients were, per protocol, required to have online medical control (OLMC) consultation and/or audio recording. Audio-recorded refusal was obtained via handheld tablet using a standardized script. Any EMS-initiated non-transports were not allowed in the system, and all non-transports were initiated by the parent or guardian.

Data Acquisition

We obtained and compared EMS data through comprehensive manual review of the prehospital electronic health record (EHR) from a daily automated report of the two periods. The EMS records were electronically matched using name and date of birth (DOB) for repeat EMS activation within 72 hours. At our pediatric hospital health system, which is the primary tertiary care children's hospital for the EMS capture area, we queried the EHR for ED visits and hospital admissions within 72 hours of EMS activation using the same name and DOB. If concerns arose for a name spelling error, we used DOB and address to confirm an identity match. Demographic data, chief/dispatch complaint, EMS vitals, non-transport volume, and non-transport reason were manually abstracted from our EMS electronic patient care database/automated report (by either the principal investigator PI or a single, trained research assistant [RA]). Race/ethnicity was EMS identified using a

drop-down menu in the electronic patient care record; the categories are per NEMSIS (National EMS Information System). Because prior versions of NEMSIS combined race and ethnicity there are not separate fields. In-person ED visits and hospital admissions (including inpatient observation and intensive care unit [ICU] admission) within 72 hours of EMS activation and final disposition (discharge vs death) were manually abstracted from the hospital health system EHR (by either the PI or a single trained RA). This included hospital presentations after refusal that came by repeat EMS activation and other means (eg, private vehicle).

Outcomes

We defined primary outcomes as repeat EMS activation, in-person ED visits, and/or hospital admissions, all within 72 hours of initial EMS activation. We used the 72-hour follow-up window based on other published papers in this area.[12–16] Pediatric EMS protocols did not change between these two study periods. The population was stratified by age group (similar to previously published studies[2,17,18]) and chief complaint to determine whether there was a higher proportion of non-transport based on age and the most common non-transport diagnosis. We classified EMS chief complaint/diagnosis into the following categories: fever; gastrointestinal; respiratory; trauma; neurological; pain; mental health; and other. Reason for parental refusal of transport was described (EMS documented).

Analysis

We analyzed categorical data using the chi-squared test. The Fisher exact test was used for smaller sample sizes (ie, hospital and ICU admission data). We used the *t*-test and Wilcoxon rank-sum test for EMS vital signs. Initial EMS vital signs of temperature, heart rate, respiratory rate and oxygen saturation were abstracted for each subject and defined as abnormal based on normal age-related ranges within the Pediatric Advanced Life Support guidelines.[19] We made correction for multiple testing and used only cases with complete data in the final analysis. Covariates for analysis were a priori based on previous literature. To identify covariates' association with the outcome we performed a stepwise logistic regression. However, the analysis identified only one covariate, and we used a univariate logistic regression to test for association of that covariate within non-transport outcomes. We did not calculate a predetermined sample size, as this was a pilot study. Results are presented as odds ratios with 95% confidence intervals (CI), taking *P*-values of <0.05 as significant. Statistical analyses were performed using SAS for Windows release 9.4 (SAS Institute, Inc., Cary, NC).

RESULTS

Annual pediatric EMS volumes were 12,663 (2019) and 10,429 (2020). There were 1,089 pediatric EMS activations in September 2019 vs 780 activations in September 2020 (Figure). Non-transport occurred in 633 (58%) activations in September 2019 vs 412 (53%) in September 2020 (Table 1). Per our EMS protocol, we obtained OLMC and/or audio recording in 84% of non-transports. Demographics are listed in Table 2.

Table 1. Volume of non-transported pediatric patients before (2019) and during (2020) the COVID-19 pandemic.

	Sept 2019	Sept 2020
EMS activations	1089	780
Non-transport (%)	633 (58)	412 (53)

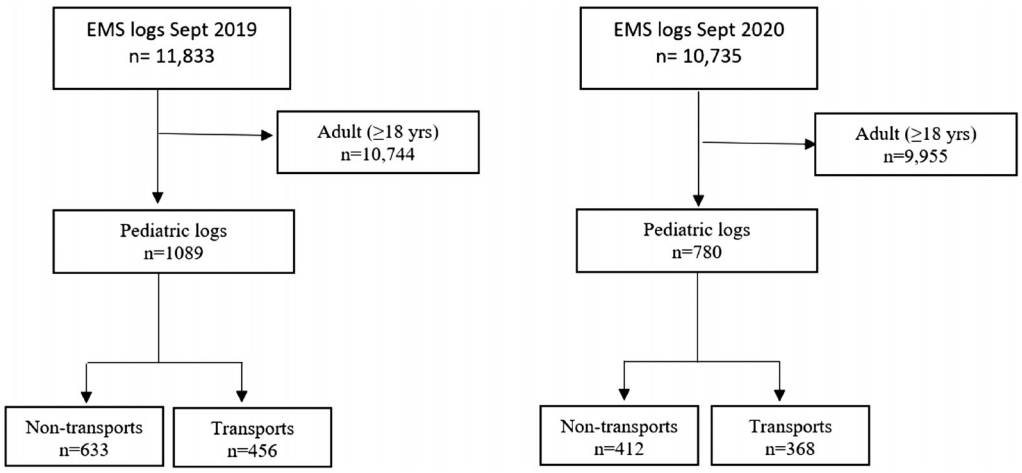

Figure. STROBE diagram illustrating patient inclusion.
EMS, emergency medical services.

Table 2. Demographics of non-transported pediatric patients before (2019) and during (2020) the COVID-19 pandemic.

	2019 (N = 633)	2020 (N = 412)	All (N = 1,045)	*P*-value
Patient Age (mos)	113 (38.0–182.0)	111.5 (33.4–181.5)		
Patient Age (yrs)				0.9
0–2	121 (19.2%)	76 (18.6%)	197 (19.0%)	
2–5	107 (17.0%)	63 (15.4%)	170 (16.4%)	
5–12	158 (25.1%)	105 (25.7%)	263 (25.3%)	
>=12	244 (38.7%)	164 (40.2%)	408 (39.3%)	
Gender				0.7
Female	312 (49.5%)	208 (50.6%)	520 (50.0%)	
Male	318 (50.5%)	203 (49.4%)	521 (50.0%)	
Race				0.7
Black or African American	337 (53.9%)	207 (50.9%)	544 (52.7%)	
White	63 (10.1%)	38 (9.3%)	101 (9.8%)	
Hispanic or Latino	205 (32.8%)	149 (36.9%)	354 (34.3%)	
Other	20 (3.2%)	13 (3.2%)	33 (3.2%)	

Patient age noted as mean with interquartile range.

Primary Outcomes

During September 2019 EMS was reactivated within 72 hours in 9/633 (1.4%) activations, ED visits occurred within 72 hours in 57/633 cases (9%), and hospital admissions occurred in 10/633 (1.5%). During September 2020, EMS was reactivated within 72 hours in 5/412 (1.2%) activations, ED visits occurred within 72 hours in 42/412 cases (10%), and hospital admissions occurred in 4/412 (1%). One non-transported patient was subsequently admitted to the ICU in September 2020 (<1%) and survived to discharge. There were no statistical differences in outcomes of non-transport pre- and during the pandemic (Table 3).

Secondary Outcomes

We further analyzed non-transport outcomes in September 2020 to determine whether there was a higher proportion of non-transport related to specific variables (gender, race/ethnicity, age, EMS diagnosis, and vital signs). Our percentage of missing variables ranged from 1–15%; however, in the analysis we used only cases with complete data. In those children who had repeat EMS activation within 72 hours, Hispanic ethnicity, age >12 years, and fever on EMS vitals were statistically significant factors for repeat activations. There was no difference in gender, EMS diagnosis, heart rate, respiratory rate, or oxygen saturation (Table 4). For those children with an EMS reactivation resulting in transport to the ED, a diagnosis of trauma, Hispanic ethnicity, age >12 years, and fever were significant (Table 5). Of those children with an ED visit within 72 hours of EMS non-transport, male gender was the only significant variable. There was no difference in race/ethnicity, age, diagnosis, or vital signs, including temperature (Table 6).

Race/Ethnicity

In our large, urban county in 2020, Black residents made up 22.8% of the total population[20] and accounted for approximately 53% of all pediatric EMS activations during our study month. Of all non-transported children in our study month 50% were Black. Hispanic/Latino accounted for 41% of the total population and 34% of all pediatric activations; 36% of pediatric non-transports were identified as Hispanic/Latino. In our urban county, 27% of the total

Table 3. Outcomes of non-transported pediatric patients before (2019) and during (2020) the COVID-19 pandemic.

Outcomes of non-transport (Within 72 hrs)	2019 (N = 633)	2020 (N = 412)	All (N = 1,045)	*P*-value
Repeat EMS activation	9 (1.4%)	5 (1.2%)	14 (1.3%)	0.8
Transport to ED on repeat activation	9 (1.4%)	4 (1.0%)	13 (1.2%)	0.5
ED visit	57 (9.0%)	42 (10.2%)	99 (9.5%)	0.5
Inpatient hospital admission	10 (1.6%)	4 (1%)	14 (1.3%)	0.2
ICU during hospital admission	0 (0.0)	1 (0.2)	1 (0.1)	0.4

Table 4. Non-transported outcome during the COVID-19 pandemic- repeat EMS activation.

Variable	Category	Odds Ratio	95% C.I. for Odds Ratio	*P*-value
Gender	Female			
	Male	1.310	(0.468, 3.668)	0.60
Race/Ethnicity	Black/African American			
	White	0.194	(0.011, 3.334)	0.25
	Hispanic	0.167	(0.031 ,0.909)	0.03
	Other	0.588	(0.033, 10.526)	0.71
Patient age (yrs)	0–2			
	2–5	0.225	(0.038, 1.320)	0.09
	5–12	0.341	(0.094, 1.234)	0.10
	>=12	0.219	(0.061, 0.790)	0.02
EMS chief complaint/diagnosis	Fever			
	Gastrointestinal	0.527	(0.073, 3.799)	0.52
	Mental Health	2.414	(0.293, 19.912)	0.41
	Neurological	0.288	(0.041, 2.043)	0.21
	Other	0.206	(0.052, 0.817)	0.02
	Pain	0.128	(0.006, 2.610)	0.18
	Respiratory	0.225	(0.043, 1.187)	0.07
	Trauma	0.108	(0.016, 0.758)	0.02
EMS vital signs				
	Temp	2.645	(1.007, 6.943)	0.04
	HR	1.007	(0.979, 1.036)	0.60
	RR	1.023	(0.991, 1.057)	0.16
	Sat	0.966	(0.920, 1.015)	0.17

Temp, temperature; *HR*, heart rate; *RR*, respiratory rate; *Sat*, oxygen saturation.

population identified as White and made up 10% percent of total pediatric activations. Of those non-transported children 9% were White.

Reasons for Non-transport

In the pre-pandemic period (September 2019), the reason for non-transport was filed for 354 (55%) of activations as follows: parent felt ambulance not necessary (47.7%); chief complaint resolved (24.9%); transport by private vehicle (20%); and other (3.1 %). In September 2020, the reason for non-transport was documented in 207 (49%) cases, with the most common reason being parent felt ambulance was not necessary (58%); followed by transport by private vehicle (22.2%); chief complaint resolved (15.5%); and other (4.8%).

DISCUSSION

We found our rates of pediatric non-transport (both pre-and during pandemic) to be higher than the previously reported 16.3%–30.1%.[2–6] Despite the higher rate of non-transport, our pediatric outcomes were favorable. The EMS reactivation and hospital admissions occurred in less than 1.5% of those children not transported to a healthcare facility. During our selected month in the pandemic, only one patient (<1%) required ICU care and survived to hospital discharge. Visits to the ED within 72 hours occurred in approximately 10% of children not transported; further study is needed to evaluate this subset of patients.

A recent published study from the United Kingdom showed a similar rate of pediatric EMS reactivation (2%) after ambulance non-transport. Subsequent ED visits were higher than in our findings (up to 24%), and hospital admissions were also higher (as high as 6% compared to our 1.5%). As in our study, no deaths occurred in pediatric non-transport.[16] Another study showed approximately 14% ED visits after non-transport, <1% hospital admission, and again no deaths.[21] A Scandinavian study reported 17.4% of non-transported children visited the ED, although this was within 96 hours compared to our 72-hour timeframe. Two patients were admitted to the ICU (compared to one in our study), and again no deaths occurred.[22]

All primary outcomes were not significantly different when compared to pre-pandemic data. Of note, we used the

Table 5. Non-transported outcome during the COVID-19 pandemic- transported to ED on repeat EMS activation.

Variable	Category	Odds Ratio	95% C.I. for Odds Ratio	*P*-value
Gender	Female			
	Male	1.645	(0.219, 1.899)	0.42
Race/Ethnicity	Black/African American			
	White	4.765	(0.276, 82.237)	0.28
	Hispanic	5.532	(1.009, 30.320)	0.04
	Other	1.573	(0.087, 28.284)	0.75
Patient age (yrs)	0–2			
	2–5	3.835	(0.639, 23.029)	0.14
	5–12	2.526	(0.678, 9.415)	0.16
	>=12	3.932	(1.058, 14.618)	0.04
EMS chief complaint/diagnosis	Fever			
	Gastrointestinal	1.897	(0.263, 13.667)	0.52
	Mental Health	0.414	(0.050, 3.417)	0.41
	Neurological	3.467	(0.0489, 24.553)	0.21
	Other	5.952	(1.419, 24.965)	0.01
	Pain	7.784	(0.383, 158.149)	0.18
	Respiratory	4.435	(0.842, 23.346)	0.07
	Trauma	9.223	(1.319, 64.478)	0.02
EMS vital signs				
	Temp	0.378	(0.144, 0.993)	0.04
	HR	1.001	(0.971, 1.032)	0.92
	RR	0.977	(0.947, 1.009)	0.16
	Sat	1.035	(0.985, 1.088)	0.17

Temp, temperature; *HR*, heart rate; *RR*, respiratory rate; *Sat*, oxygen saturation.

72-hour follow-up window based on other published papers in this area,[12–16] while acknowledging the balance between a longer window catching more cases but increasing the risk that those are not related to the index visit.

The majority of non-transported children were Black (50%); however, this was expected based on our demographics (the majority of all pediatric EMS activations during our study month were Black). Similarly, Hispanic/Latino children accounted for 34% of pediatric EMS activations and 36% of non-transports. This finding differs from prior studies that show a lower rate of non-transport for Black[3] and Hispanic[6] children. Our study is similar to a recent, large national study by Ward et al, which showed no association of race/ethnicity with non-transport.[2]

Although we found no association with race/ethnicity for non-transport, Hispanic children in our study were more likely to have repeat EMS activations within 72 hours. Age >12 years old and documented fever were also associated with repeat EMS activations. This age association with repeat activations may be due to a lower overall rate of non-transport in younger kids, both in our study and others[6] and the postulated lack of EMS responders' comfort level assessing young children.[14] We also found that chief complaint/diagnosis was not significantly related to EMS non-transport during the pandemic, although children with trauma were not surprisingly transported more often to the ED if EMS was reactivated within 72 hours. Interestingly, EMS vitals (except fever) did not seem to play a role in our primary outcomes.

In our study we observed no significant difference in the percentage or outcomes of pediatric non-transport during the COVID-19 pandemic compared to pre-pandemic. It is important to note that EMS protocols did not change between these two study periods. While many EMS agencies adopted more permissive "non-transport" policies in anticipation of higher EMS call volumes and 9-1-1 overuse for minor, flu-like illness symptoms, our system did not adopt any such policy; thus, it is a truer comparison.

Our reasons for non-transport are similar to those previously reported in the literature.[5–7,23] During the pandemic, there was approximately a 10% increase in "parents feel an ambulance is not necessary." It is unclear

Table 6. Non-transported outcome during the COVID-19 pandemic- ED visit within 72 hours.

Variable	Category	Odds Ratio	95% C.I. for Odds Ratio	*P*-value
Gender	Female			
	Male	1.595	(1.047, 2.430)	0.02
Race/Ethnicity	Black/African American			
	White	0.684	(0.292, 1.602)	0.38
	Hispanic	1.357	(0.879, 2.096)	0.16
	Other	0.459	(0.085, 2.481)	0.36
Patient age (yrs)	0–2			
	2–5	1.215	(0.604, 2.446)	0.58
	5–12	1.298	(0.695, 2.421)	0.41
	>=12	1.011	(0.556, 1.838)	0.97
EMS chief complaint/diagnosis	Fever			
	Gastrointestinal	0.919	(0.280, 3.018)	0.88
	Mental Health	1.939	(0.365, 10.301)	0.43
	Neurological	0.877	(0.313, 2.460)	0.80
	Other	0.589	(0.251, 1.380)	0.22
	Pain	0.545	(0.158, 1.885)	0.33
	Respiratory	0.654	(0.257, 1.665)	0.37
	Trauma	0.858	(0.355, 2.073)	0.73
EMS vital signs				
	Temp	0.983	(0.679, 1.424)	0.92
	HR	1.009	(0.998, 1.020)	0.10
	RR	1.004	(0.977, 1.032)	0.76
	Sat	0.982	(0.940, 1.027)	0.42

Temp, temperature; *HR*, heart rate; *RR*, respiratory rate; *Sat*, oxygen saturation.

whether this was directly related to the pandemic and fear of COVID-19 exposure or to missing data.

LIMITATIONS

There are certain limitations of this study. Although we are the primary children's hospital and urgent care within the jurisdiction served by the EMS system, there was the potential to miss repeat ED visits at a non-affiliated adult ED/urgent care. Future studies will include a phone call follow-up with the patient/family. We selected a single month, due to our high volumes, for this pilot study, assuming it would be representative of other months. Data was obtained through manual review of prehospital electronic patient care records obtained from an automated report, resulting in some occasional incomplete data. Hospital records (ED and inpatient) were matched using name and DOB, potentially missing subjects if there was an error in name spelling or provided DOB. If concerns arose for a mismatch, the provided address was used to confirm an identity, but this data was not always available. Furthermore, the EMS system's clinical practice guidelines (protocols) require consultation with online medical control for patients <18 years old and for specific conditions and vital sign parameters. In this study we did not examine the proportion of non-transported patients with online medical control actually contacted. It is not known whether this influenced the safety of non-transports. Lastly, reason for non-transport was missing in up to 50% of data, and the reason was as documented by the EMS clinician.

CONCLUSION

In our system, non-transport of pediatric patients occurred in over 50% of EMS activation with no significant adverse outcome. The most common reason for non-transport was parents feeling it was not necessary. Age >12 years, presence of fever, and Hispanic ethnicity were more common in repeated EMS activations. Chief complaint/diagnosis did not seem to play a role in repeat EMS activations or subsequent ED visits after non-transport. We observed no significant difference in the percentage or outcomes of pediatric non-transport during the COVID-19 pandemic compared to pre-pandemic.

Additional studies are needed to develop reliable EMS guidelines for pediatric non-transport.

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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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Development and Validation of a Scoring Rubric for Editorial Evaluation of Peer-review Quality: A Pilot Study

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Section Editor: Mark Langdorf, MD, MHPE
Submission history: Submitted August 16, 2023; Revision received December 1, 2023; Accepted December 7, 2023
Electronically published February 28, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18432

Introduction: Despite the importance of peer review to publications, there is no generally accepted approach for editorial evaluation of a peer review's value to a journal editor's decision-making. The graduate medical education editors of the *Western Journal of Emergency Medicine* Special Issue in Educational Research & Practice (Special Issue) developed and studied the holistic editor's scoring rubric (HESR) with the objective of assessing the quality of a review and an emphasis on the degree to which it informs a holistic appreciation for the submission under consideration.

Methods: Using peer-review guidelines from several journals, the Special Issue's editors formulated the rubric as descriptions of peer reviews of varying degree of quality from the ideal to the unacceptable. Once a review was assessed by each editor using the rubric, the score was submitted to a third party for blinding purposes. We compared the performance of the new rubric to a previously used semantic differential scale instrument. Kane's validity framework guided the evaluation of the new scoring rubric around three basic assumptions: improved distribution of scores; relative consistency rather than absolute inter-rater reliability across editors; and statistical evidence that editors valued peer reviews that contributed most to their decision-making.

Results: Ninety peer reviews were the subject of this study, all were assessed by two editors. Compared to the highly skewed distribution of the prior rating scale, the distribution of the new scoring rubric was bell shaped and demonstrated full use of the rubric scale. Absolute agreement between editors was low to moderate, while relative consistency between editor's rubric ratings was high. Finally, we showed that recommendations of higher rated peer reviews were more likely to concur with the editor's formal decision.

Conclusion: Early evidence regarding the HESR supports the use of this instrument in determining the quality of peer reviews as well as its relative importance in informing editorial decision-making. [West J Emerg Med. 2024;25(2)254–263.]

BACKGROUND

Peer review plays a critical role in the traditional paradigm of published scholarship. While peer review is the standard for assessing scholarly submission for publication, the most appropriate means by which to assess the quality of peer review remains unclear.[1–8] This issue is problematic for all the stakeholders of published scholarship. The development of a rigorous and valid tool for editors to assess the quality of peer reviews could help to enhance the peer-review process. This would improve editors' abilities to stratify the contributions of their reviewer pool, identifying reviewers who deserve outstanding recognition as well as those who could benefit from dedicated mentorship, and inform mechanisms to evaluate the downstream impact of interventions to improve the quality of peer reviews.

Efforts to assess peer-review quality have been challenging. Prior studies have been based primarily on the belief that review evaluation is an objective process.[9–12] Consequently, interventions have been aimed at achieving a high degree of absolute reliability in scoring between editors. The results have demonstrated a modest degree of inter-rater reliability.[9–12]

The inter-rater reliability of evaluations of performance by experts is confounded by idiosyncratic perceptions that are shaped by individual experiences, values, and priorities. Indeed, the preponderance of the literature argues that evaluation by experts is often subjective and nuanced.[2,4–6,8,10,13–17] Cole et al proposed that the potential divergent perspectives among peer reviewers are often the result of "*real and legitimate differences of opinion among experts about what good science is,*"[14] a concept supported by others.[15–17] Capturing the nuanced and potentially divergent perspectives of reviewers allows editors to develop a holistic understanding of the value of a manuscript.[15] This variability among editors' perspectives limits the degree of reliability that can be achieved in assessing individual reviews.

The Special Issue's editorial evaluation of reviews has traditionally depended upon a single, global five-point scale with anchors at the extremes (5 = high quality, 1 = low quality). A number of issues have been appreciated by the editors with this approach: 1) The website template only allowed for a single editor's evaluation of a review; 2) scores of 1 and 2 were seldom used; and 3) no guidance was provided for editors to determine how to score on the five-point scale, resulting in a lack of valid evaluation data on which to base decisions pertaining to the quality of reviews.

Our objective in this initiative was to develop and study a scoring rubric for editors to assess the quality of a review with an emphasis on the degree to which it informs a holistic appreciation for the submission under consideration. Herein we describe the development, refinement, and pilot-testing of this rubric. Additionally, our reporting was grounded within the validity evidence framework suggested by Kane to inform the interpretations of scores generated by this tool.[18]

METHODS

Holistic Editor's Scoring Rubric Development

This study involved graduate medical education (GME) submissions to the Special Issue and was determined to be exempt by the George Washington University Institutional Review Board.

There are several recurrent themes identified in the literature that appear important to developing an effective peer-review evaluation system. Such a system should be: 1) practical and simple to use[5,6,19,20]; 2) criterion referenced[4,5,20]; and 3) be able to capture differences in expert reviewers' perspectives.[14,16,21–23] To successfully operationalize an evaluation system, past works also suggest that rater training is necessary to ensure proper implementation.[3,10,13,20,24–28]

Prior to the production cycle for the 2020–2021 Special Issue the Council of Residency Directors in Emergency Medicine (CORD) guest editor and three associate editors discussed the need for an improved system for evaluating peer reviews. The use of a global five-point score has been shown to be practical in assessing reviews.[5,6] By adding anchors to each point on the five-point scale based on quality as the criteria reference, Landkroon et al provided early validity evidence supporting its use.[6] To define characteristics important to high-quality peer reviews in developing anchors for the current study's five-point global scale, the editors reviewed the mission and vision statements of CORD,[29] the literature relevant to peer-review scoring instruments and reviewer guidelines from four major medical journals.[30–33] Through an iterative process, the editors defined qualities of an ideal review as one that provides the following: 1)–insights that reflect both the value to readership and alignment with the current literature; 2)–consideration of the appropriateness of the study method(s) and relevant tenets of education scholarship; and 3)–feedback that provides mentorship to authors on how to improve their manuscript as well as their own skill set.

Through the same process, the editors determined that the anchors for the five-point scoring rubric should be based on these three provisions of a quality review as well as the degree to which the review informs the final evaluation of the submission under review (Figure 1). In other words, a review evaluation of five on this holistic editor's scoring rubric (HESR) provides all three provisions of a quality review and could stand alone as the final evaluation of that submission (Gold standard review).

Validity Assumptions

We used Kane's framework to gather validity evidence for use of this instrument, which involved testing

Gold Standard Reviews are those that provide:

1) Insightful review (detailed and global) that reflects upon how the work under consideration may be of value to the readership and informs the current literature.
2) Appropriateness of the study method(s) employed and a reflection of the relevant tenets of education scholarship.
3) Feedback that provides mentorship to authors on how to improve their manuscript and their own skill set.

5-Exceptional: A model review that reflects each of the tenets of the Gold Standard and could stand alone as a summary to the authors. Recommendations to the authors are appropriate, actionable and supportive with a basis in educational scholarship. The review provides an in-depth perspective which may include relevant citations, resources or specific suggestions for improving the manuscript and/or professional growth. An additional contributing factor includes instances where the reviewer makes an important observation or recommendation not previously considered by the editors.

4-Very Good: An excellent review that reflects the time, effort and expertise necessary to contribute substantially to the formal decision but falls short in one or more of the 3 key areas that define the "Gold Standard". For example, an excellent overall review that (1) misses 1-2 substantive points, (2) provides only cursory mention of educational scholarship concepts or (3) falls short of providing mentoring support when critiquing the authors work.

3-Good: The review meets the standard of an acceptable review. The analysis adds to the broader perspective in a measured way but is not as complete, organized, documented or is lacking adequate explanations for the authors. As a result, additional reviews are required to provide more extensive/actionable feedback to the authors.

2-Below Average: Though there may be some insights included the review provides a superficial evaluation of the submission. This may include lack of reasoning for the decisions rendered, comments are not actionable or there may be a general lack of critique for improvement. In essence, insights provided may reinforce other reviewers' comments but are not substantive enough to shape editorial decision-making pertaining to the manuscript. The majority of components of a "Gold Standard review" are missing.

1-Unacceptable: The review is sparse and may provide 1-2 insights but either (1) provides a decision without explanation (accept/reject, like/dislike, good/bad) (2) provide praise without critique (no substantive feedback for how to improve the manuscript) and concludes "accept as is" when revisions are needed or rejects with minimal justification, (3) lacks meaningful insights or (4) conclusions are based on faulty reasoning based on the literature, opinions of the **other reviewer(s) and the editor.** In short, the review provides little if any substantive critique that contributes to consensus decision making.

Figure 1. The holistic editor's scoring rubric used for evaluation of peer review. The initial version of this rubric can be appreciated as the unshaded content. Subsequent additions made based on a pilot of the 14 initial reviews are denoted by the shaded areas (See "Preliminary Calibration Exercise.")
CORD, Council of Residency Directors in Emergency Medicine.

assumptions about scoring, generalization, extrapolation, and implication.[18] Our first assumption involved the distribution of ratings or scores. In reviewing scores from the past few years with the traditional five-point scale, we observed limited use of the evaluation scale with skewing towards higher scores (>3); editors were hesitant to assign scores of 1 or 2 when appropriate. The wide variability of experience and expertise among the reviewers suggested that greater variability in scores should have been present. This skewed distribution could be attributed to a leniency bias, which is not uncommon in medical education evaluations.[23,34–37] Our logic followed that for the HESR to be a valid reflection of peer-review performance, the peer-review evaluation scores must reflect the full range of peer-review performance. If successfully developed and implemented, the HESR peer-review evaluation scores would have a distribution where all rating options were used.

Our second assumption involved inferences about scoring, namely that the assigned HESR score for a peer review would be an accurate representation of the editor's perspective of the quality and value of a peer review to editorial decision-making. If true at each score level, the associate and senior editors would be consistent with each other in applying the HESR for any given review.

Our third assumption had to do with implications that HESR scores would be used to inform the editorial decision-making process. In other words, highly rated reviews would have more value in decision-making, and as a result the reviewer's decision recommendation (i.e. accept, revise, reject) would more closely align with the editor's formal decision.

Study Setting and Participants

The Special Issue was established in 2014 as an annual publication of *WestJEM* dedicated to educational research practice.[38] Submissions related to GME were managed by a single guest editor and three associate editors. Peer reviewers for the Special Issue were recruited by the senior editor via the CORD and Clerkship Directors of Emergency Medicine listservs. The prerequisite for becoming a reviewer included recognition as an experienced educator and authorship of at least one scholarly educational study published in a peer-reviewed journal.

Once a manuscript was submitted via the *WestJEM* submission portal, screening editors either approved the manuscript for peer review or chose to "desk-reject" the manuscript without review. Manuscripts that passed the screening process were then assigned to two external peer reviewers. In an iterative process, reviewers concluded their reviews with a recommendation to the associate editor who in turn made a recommendation to the senior editor for a formal decision. At each step in this process the choice was to reject, revise, or accept the manuscript. In those instances where revisions were requested and submitted, the final decision was either to accept or reject for publication (Figure 2). Reviewer assignment was random without regard to defined expertise (eg, statistics, specific methodology, topic under consideration).

Through the first five editions of the Special Issue, peer reviews were "rated" by associate and senior editors using the methods and instrumentation adopted from the parent *WestJEM* editorial board: a closed, internal evaluation

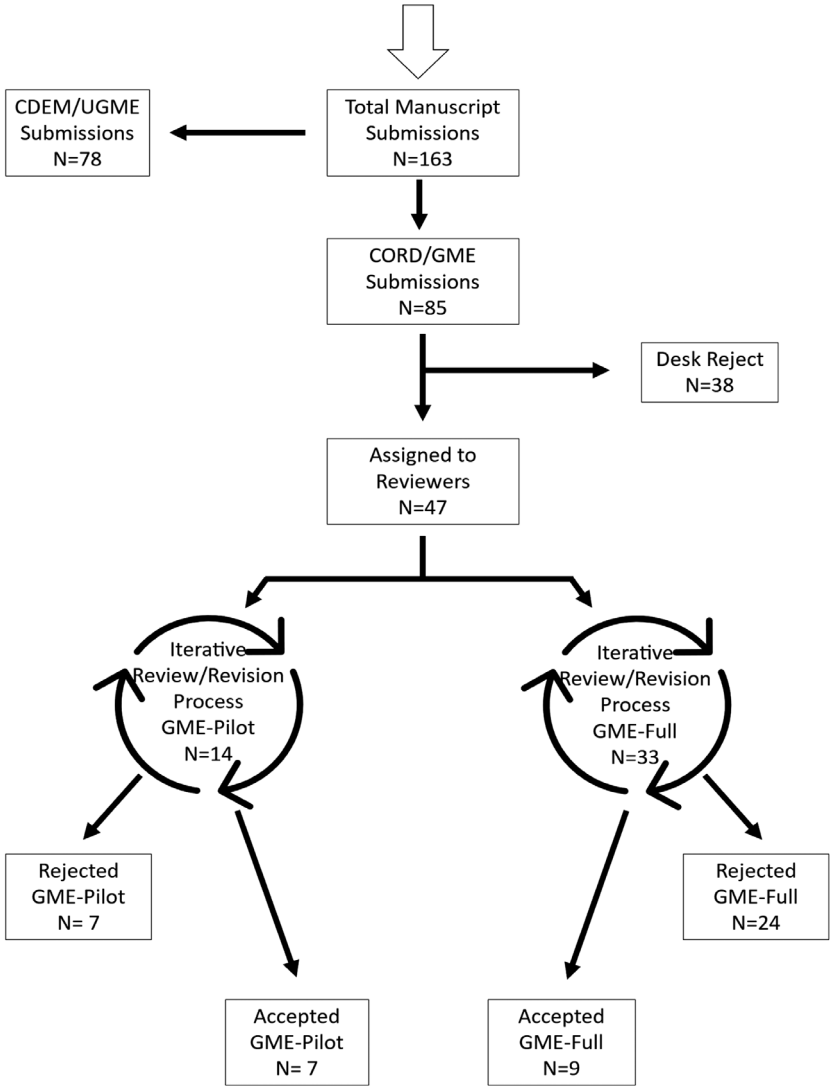

Figure 2. Flow chart showing the number of manuscripts submitted and processed during the 2020–21 submissions cycle for the *Western Journal of Emergency Medicine* Special Issue in Educational Research & Practice.
UGME, undergraduate medical education; *CDEM*, Clerkship Directors of Emergency Medicine; *GME*, graduate medical education; *CORD*, Council of Residency Directors in Emergency Medicine.

system that used a global five-point semantic differential scale with labels at the extremes: 5 = high quality and 1 = low.

Implementation of the Holistic Editor's Scoring Rubric

The HESR was piloted during production of the 2020–2021 Special Issue. Manuscripts reviewed by the four CORD editors of the Special Issue were included in the pilot. To minimize issues of recall and maintain consistency, the editors all agreed to reflect upon the HESR just prior to scoring each peer review. Subsequently, each peer review received an independent score from an associate editor and the senior editor. Blinding was accomplished by having each editor report their review score to a third party. The third party (AM), who was not involved in the formal review process, maintained the secured database that linked the editor's and associate editor's HESR ratings for each review.

Preliminary Calibration Exercise (Pilot)

The editors paused to review their experience with the original HESR after the first 14 peer reviews of manuscripts had been scored. Comparisons between scores assigned by the senior and associate editors raised questions and concerns about the clarity of the scoring rubric, which warranted another round of revisions. Changes were made based on iterative discussions and consensus to improve the clarity of the rubric options and ratings. In addition, adjective descriptors that characterized each option were added as follows: 5-Excellent, 4-Very good, 3-Good, 2-Below average, and 1-Unacceptable (Figure 1). During the implementation stage, the final HESR was used to score the remaining 32 GME submissions during the 2020-21 Special Issue production cycle.

Data Analysis

Assumption 1–Distribution of Evaluation Scores

Our first assumption was that a valid scoring mechanism of editorial evaluation of peer reviews should reflect the variability of quality and value of the reviews. The previous semantic differential rating system used by the Special Issue during a prior production cycle (2019–2020) did not reflect a high degree of variability in peer-review scores. In fact, the distribution of scores from this cycle appeared negatively skewed with scores clustered around "4" on the five-point semantic differential scale. Accordingly, one goal of the new HESR was for it to more accurately reflect the variability of the reviewer pool with regard to scholarly expertise through use of the entire evaluation scale. Using the "Explore" feature in IBM-SPSS version 28 (SPSS, Inc, Chicago, IL) to generate histograms, frequency distributions, and measures of variability, we compared three sets of peer-review scores: semantic differential ratings from the 2019–2020 Special Issue (baseline); the pilot CORD editor's evaluation of peer reviews; and the full implementation of CORD editor's evaluation of peer reviews using the revised HESR for the 2020–2021 edition.

Assumption 2–Inter-rater Reliability Between Evaluators of the Same Peer Reviews

Since the HESR provided clear criteria for five different levels of peer-review performance, we expected the HESR to generate reliable scores across editors. Accordingly, like Cicchetti, we compared inter-rater reliability among editors using the intraclass correlation coefficient (ICC).[39] To complement our reliability evaluation, we also used three measures of agreement between associate and senior editors' ratings of peer reviews for the CORD editorial team: percent of absolute and relative agreement, and the Spearman rho correlation for ordinal level data.[40] The percentage of identical ratings is a measure of absolute agreement between raters, while the percentage of ratings in close proximity of each other (+1) is an indicator of within-rater consistency. The Spearman rho correlation provides an indicator of the strength of the relationship between the ratings across the two types of raters.[41] We used the criteria from Schober et al. for interpreting the Spearman rho correlation (r of 0–0.10 = negligible; r of 0.10–0.39 = weak; r of 0.40–0.69 = moderate; r of 0.70–0.89 = strong, r of 0.90–1-very strong).[40]

The ICC model selected for this study is based on several assumptions. First, it is assumed that associate editors were randomly chosen from a larger pool and that the senior editor was fixed. Second, the design was not fully crossed, since not every review was rated by the same editors. Third, since one rating was the focus, rather than a series, the absolute agreement was thought to be the most appropriate ICC model. A final assumption was that since the ICC was being asked to represent the average of several coders, the "average measures" ICC was chosen. In summary, the ICC formula chosen for this study is a one-way random effects model reflecting absolute agreement and the unit of analysis related to average measures.[42] We applied guidance from Cicchetti for interpreting the resulting ICC reliability indices (ICC of <.4 = poor reliability; ICC of .40–.59 = fair reliability; ICC of .60–.74 = good reliability; ICC of .75–1.0 = excellent reliability).[39] Unfortunately, we were not able to perform comparable inter-rater reliability analyses for the prior Special Issue production cycle (2019–2020) due to the templated ability to provide only one editor's score per manuscript.

Assumption 3–Implications or the Statistical Relationship Between Peer-Review Rating and the Editorial Decision

The collective editors' evaluations of the peer review were assumed to be an indicator of its quality. If editors placed value on peer reviews due to their ability to inform the decision-making process, then higher quality peer reviews should have been more likely to agree with the editorial

decisions than lower quality peer reviews. In this analysis, the categories of yes/no refer to whether the reviewer's recommendation agreed with the formal manuscript decision. "Yes" designations were applied if the reviewer recommended the article be accepted, rejected or revised and the editorial decision made agreed with that recommendation. If the reviewer's recommendation did not agree with the editor's decision, this was categorized as a "No." This is known as a parallel line of validity evidence according to Kane.[18] We tested this hypothesis by averaging the senior and associate editors' peer-review ratings and then categorizing these average ratings into five categories: (1–1.5); (2–2.5); (3–3.5); (4–4.5); and (5). Next, using a chi-square test of association we tested the relationship between the summary rating category and the reviewer's agreement with the final decision (Did the reviewer's recommendation agree with the final decision, yes or no?). If true, the authors posited that the higher the ratings by the editors on the quality of the peer review, the more likely their recommendations for the manuscript submission would agree with the actual formal decision. We applied the criteria from Hahs-Vaughn et al for interpreting the associated effect sizes from the chi square test of association (small effects = <0.10, medium effects = 0.30; and large effects are >0.50).[43]

We also evaluated the relationship between the HESR score and the reviewer's agreement with the final decision using logistic regression analysis. For this analysis, we attempted to predict whether the reviewer recommendation would match the final editorial decision (yes or no) from the HESR scores assigned by each type of editor. Results of this test should provide a relative strength of the relationship between each type of editor's rating and the editorial decision.

RESULTS

The total number of manuscripts submitted for the 2021 Special Issue was 163. Of these, 85 were managed by the CORD editors. Thirty-eight submissions were desk-rejected by the editorial staff. Subsequently, 47 (55.3%) manuscripts were approved for peer review and 16 were published, for an acceptance rate of 18.8%. These 47 peer-reviewed manuscripts were the subject of this study, 14 during the pilot period and 33 during full implementation of the HESR (Figure 2).

Eighty-four peer reviewers reviewed an average of 1.84 manuscripts each (SD 1.34). About two-thirds of peer reviewers performed only one review (52/85; 61.2%), while an additional 34% (29/85) completed 2-4 reviews, and four individuals (4.8%) completed 5–7 reviews. The editors performed 91 evaluations of peer reviews, 27 at the pilot stage and 64 at the full implementation stage. The three associate editors performed 95 peer-review evaluations, 32 at the pilot stage and 63 at the full implementation stage (Table 1). There were 90 matched pairs of evaluations on the same peer review from both the senior and associate editor.

Distribution of Scores

During the prior production cycle (2019–2020), 163 peer reviews were rated using a five-point semantic differential scale. The distribution of editors' ratings of these reviews was shown to be negatively skewed (−0.371), which was caused by the underuse of the "1" rating and overuse of the "4" and "5" ratings (Figure 3). Contrasted with the semantic differential scale, the HESR distribution at both the pilot and full implementation stage had skewness closer to zero (0.005 and 0.078, respectively). The distribution during the pilot stage is considered a parallel distribution, since almost all response options were chosen equally (except for the "1" HESR rating). During the full implementation, negative skewness (0.078) almost disappeared as the distribution became more bell shaped, and kurtosis continued to suggest a distribution with symmetry (kurtosis = −0.967) (Figure 3).[44]

Table 1. Number and percentages of senior editor, associate editors, and reviewers involved in the production of the 2021 Special Issue by group. Included are the numbers of review evaluations performed and manuscripts processed by senior and associate editors and the numbers of peer reviewers and manuscripts they reviewed.

	CORD HESR Study						Total		
	Calibration-pilot			Implementation					
	Personnel	Review evals	Manuscripts	Personnel	Review evals	Manuscripts	Personnel	Review evals	Manuscripts
Senior editor	1	27	14	1	63	33	1	90	47
Associate editors	3	32	14	3	63	33	3	95	47
Reviewers*	32	N/A	14	69	N/A	33	84	N/A	47

*There were 84 total peer-reviewers who reviewed manuscripts during either the pilot or full implementation phase of this study. Fifteen of 32 reviewers participated only during the pilot while the other 17 contributed to reviewing at both stages of the project (pilot and full). Reviewers were not involved with using the Holistic Editor's Scoring Rubric to assess their own peer-reviews.
CORD, Council of Residency Directors in Emergency Medicine; *HESR*, holistic editor's scoring rubric; *evals*, evaluations.

	2020 Cycle Semantic-Diff Scale	Pilot-2021 Comp Editorial Rubric	Full-2021 Comp Editorial Rubric
N	163	73	137
Mean	3.64	3.32	2.91
Std Dev	1.05	1.20	1.26
Median	4.00	3.00	3.00
Skew	-.371	.005	.078
Kurtosis	-.681	-1.13	-.967
Normality	.215*	.165	.152*

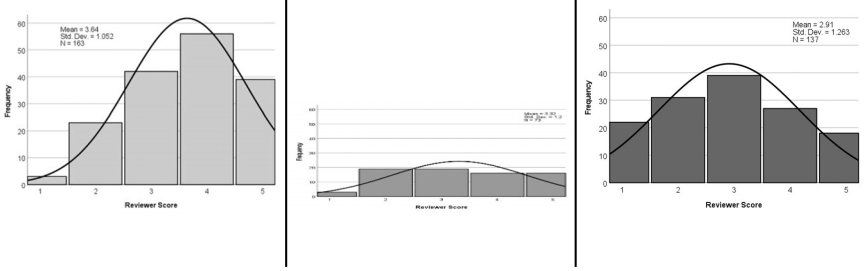

Figure 3. Comparison of the peer-review ratings distributions for two methods of editor evaluations across two Special Issue production cycles. The first method involved a 5-point semantic differential scale with labels only at the end points, which was used during the 2020 cycle. The second method involved the holistic editor's scoring rubric used by the CORD editors at the pilot and full implementation stages of the 2021 production cycle.
CORD, Council of Residency Directors in Emergency Medicine.
*Data significantly deviate from normal distribution ($P \leq 0.001$).

Table 2. Results of logistic regression using the outcome, whether the reviewer recommendation matched with the final decision (yes or no), regressed on the predictors: associate and senior editor's peer-review ratings.

Equation 1: Associate editor's score as predictor for review rec/final dec match [93]

							95% CI for EXP (B)		
	B	SE	Wald	df	Sig.	Exp(B)	Lower	Upper	% CC
Associate editor review score	.627	.184	11.571	1	<.001	1.871	1.304	2.685	67.7
Constant	−2.054	.631	10.587	1	.001	.128			

Equation 2: Senior editor score as predictor for reviewer rec/final dec match [N = 91]

							95% CI for EXP (B)		
	B	SE	Wald	df	Sig.	Exp(B)	Lower	Upper	% CC
Senior editor review score	.935	.247	14.350	1	<.001	2.548	1.57	4.133	63.7
Constant	−2.664	.721	13.633	1	<.001	.070			

Equation 3: Associate & senior editor scores as predictor for reviewer rec/final dec match [N = 90]

							95% CI for EXP (B)		
	B	SE	Wald	df	Sig.	Exp(B)	Lower	Upper	% CC
Associate editor review score	.137	.244	.314	1	.575	1.146	.711	1.849	66.7
Senior editor review score	.834	.313	7.084	1	.008	2.302	1.246	4.254	
Constant	−2.789	.765	13.300	1	<.001	.061			

Inter-rater Agreement

Ninety peer reviews were assessed with the HESR by both the senior editor and one of the three associate editors. The percentage of absolute agreement between the two types of editors' ratings of peer reviews was 37.8% (Table 2). Nearly half (47.8%) of ratings were in disagreement by only one

point. The associated Spearman rho correlation and r-squared for the ratings from the two types of assessors was 0.703 ($R^2 = 0.49$). A Spearman rho of this magnitude is interpreted as bordering between a moderate and strong positive correlation or statistical relationship.[40] Finally, the ICC between the associate and senior editors was 0.795. As interpreted by Cicchetti, an ICC of this magnitude is considered excellent in terms of clinical significance (between 0.75–1.00).[39]

Implication of HESR Scores as Associated with and Predictors of Manuscript Outcomes

The chi-square test of association for the relationship between average peer-review ratings and the peer reviewer's recommendation with the final manuscript decision was statistically significant (chi-square = 17.4, df = 4, $P < 0.01$, effect size = 0.44). The associated effect size of 0.44 is classified as a medium effect size according to Hahs-Vaughn et al who suggest that small effects are those ≤ 0.10, medium effects = 0.30, and large effects >0.50 (Table 3).[43]

Logistic Regression

For all logistic regression analyses, the tests for model coefficients were significant, suggesting that any one of the three formulas would improve our estimate of the probability that the peer-review recommendation matched the editorial decision. The Hosmer-Lemeshow tests were not significant, indicating that the models could be a good fit, and analyses of the scatter plots of predicted scores and residuals contributed to the conclusion that the analyses met the assumptions of normality and equal variance (statistics not shown).

Table 3. Reviewer summary rating grouped into 5 categories cross tabulated with whether the reviewer's recommendation agreed with manuscript final decision (expected values are in parentheses) with chi square test of association* between these two variables.

Reviewer summary rating*	N	Did reviewer's recommendation agree with final decision		
		Yes	No	Percent agreement
1.00	17	4 (8)	13 (9)	23.5
2.00	21	6 (10)	15 (11)	28.6
3.00	28	17 (14)	11 (14)	60.7
4.00	17	10 (8)	7 (9)	58.8
5.00	7	7 (3)	0 (4)	100
TOTAL	90	44 (44)	46 (46)	48.9
		$X^2 = 17.4$, df = 4, p = 0.006, es = 0.440		

*The minimum expected counts are 3.42. Cramer's phi effect sizes are interpreted as ≤ 0.10 = small; 0.30 = medium; and ≥ 0.50 = large effects.

Logistic regression analyses demonstrated that the associate editor's HESR ratings were a significant predictor of the manuscript outcome: a successful match between the reviewer's recommendation and the final decision for the manuscript. This was also true of the senior editor's HESR ratings. However, because the ratings of the associate editor and senior editor were so highly correlated with each other (Spearman rho correlation = 0.703), once combined into one logistic regression model, only the senior editor's ratings surfaced as a significant predictor.

Interpretation of the senior editor's HESR ratings as a predictor suggests that the ratings contributed to improving the correct classification of predicted vs observed outcomes from 51.6% with no predictor to 63.7%. The adjusted odds ratio Exp(B) = 2.548 (95% confidence interval [CI] 1.570–4.133] can be interpreted as follows: "For every one step increase in the senior editor's evaluation ratings, the risk of the outcome of a successful match between reviewer recommendation and the final decision increases by a factor of 2.548" (Table 2).

DISCUSSION

Using Kane's framework for validity evidence, this work tested three assumptions regarding the HESR as a novel means for editors to assess the quality of peer reviews of educational scholarship. The first assumption involved the distribution of editors' ratings of reviews, finding that the HESR demonstrated greater symmetry in scores compared to a prior instrument used during the 2019 cycle. We conclude that leniency bias was likely limited by the criteria-referencing basis of this intervention, which may have resulted from clearer behavioral anchors of the instrument itself,[5,6,13] improvements in rater training,[3,10,13,24–28] and/or more intentional quality control among editors during the review process. This change in behavior may also reflect the practicality of the HESR since it was clearly being used in editorial evaluation of reviews.

The second assumption made infers that the assigned peer-review scores based on the HESR are an accurate representation of the editors' perspective on quality and inform a holistic perspective on the submission. While the editors of the Special Issue had lower absolute agreement between the senior and associate editors (37.8%), they demonstrated excellent relative consistency reliability (ICC = 0.795) and correlations (Spearman rho = 0.703) between editors' scores. In other words, their evaluations, while not identical, were internally consistent. This finding related to reliability supports the hypothesis that the HESR captures the editorial perception of quality as well as the degree to which peer review informs a holistic understanding of a submissions value.

Finally, the third assumptions made has to do with the implication that scores are used to inform the editorial decision-making process. This is substantiated by the finding

that the ratings on the HESR corresponded to the reviewer's agreement with the manuscript's final disposition. The higher the peer-review evaluation of quality by HESR scoring, the higher the correlation between the reviewer disposition recommendation and the manuscript's formal outcome. Although this is to be expected, the fact that it holds true in this instance demonstrates that editors value and rate reviews higher when they contribute substantially to the editorial decision.[18]

LIMITATIONS AND FUTURE STUDIES

These findings should be interpreted in the context of several limitations. Traditionally, the Special Issue has not blinded its senior and associate editors to the identity of the reviewers. This raises the potential for bias if editors recognized peer reviewers' names, which could conceivably have impacted the ratings of more familiar peer reviewers. Second, the editors in this study had regular discussions regarding the use and interpretation of this scoring instrument. Given the centrality of rater training in the use of any evaluation instrument, future work will help to determine whether the performance of the HESR and lack of skewness in scoring persists beyond the editorial focus associated with this study.

Most importantly, this study is based on a single cycle of an annual specialty-related publication focused on health professions-education topics with a small number of editors and reviews. Future studies should focus on assessing additional validity evidence supporting the HESR's use as well as varying journal environments with larger numbers of editors and reviews. Our results are most likely to generalize to specialty-specific education journals whose approach is similar to that presented in this study. Our findings are less likely to generalize to journals that take an alternative approach such as those that bring together a diverse set of reviewers based on expertise (eg, methodology, psychometrics, content, etc) to assess specific components of the submission.

CONCLUSION

A holistic understanding of the value of a scholarly submission requires an iterative process informed by the expert perspective of reviewers that is often subjective and nuanced. The holistic editor's scoring rubric was developed as a practical approach to editorial evaluation of the quality of a review and the degree to which it informs the formal editorial decision. By studying a priori assumptions related to the development and use of the HESR. including distributions of evaluation scores, inter-rater reliability between evaluators of the same peer reviews and the statistical relationship between peer-review rating and the editorial decision, this study provides validity evidence supporting the use of the HESR. Future work should focus on further defining the value and limitations of the HESR.

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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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Novel Scoring Scale for Quality Assessment of Lung Ultrasound in the Emergency Department

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Section Editor: Ryan Gibbons, MD
Submission history: Submitted May 15, 2023; Revision received November 28, 2023; Accepted December 5, 2023
Electronically published February 28, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18225

Introduction: The use of a reliable scoring system for quality assessment (QA) is imperative to limit inconsistencies in measuring ultrasound acquisition skills. The current grading scale used for QA endorsed by the American College of Emergency Physicians (ACEP) is non-specific, applies irrespective of the type of study performed, and has not been rigorously validated. Our goal in this study was to determine whether a succinct, organ-specific grading scale designed for lung-specific QA would be more precise with better interobserver agreement.

Methods: This was a prospective validation study of an objective QA scale for lung ultrasound (LUS) in the emergency department. We identified the first 100 LUS performed in normal clinical practice in the year 2020. Four reviewers at an urban academic center who were either emergency ultrasound fellowship-trained or current fellows with at least six months of QA experience scored each study, resulting in a total of 400. The primary outcome was the level of agreement between the reviewers. Our secondary outcome was the variability of the scores given to the studies. For the agreement between reviewers, we computed the intraclass correlation coefficient (ICC) based on a two-way random-effect model with a single rater for each grading scale. We generated 10,000 bootstrapped ICCs to construct 95% confidence intervals (CI) for both grading systems. A two-sided one-sample *t*-test was used to determine whether there were differences in the bootstrapped ICCs between the two grading systems.

Results: The ICC between reviewers was 0.552 (95% CI 0.40–0.68) for the ACEP grading scale and 0.703 (95% CI 0.59–0.79) for the novel grading scale ($P < 0.001$), indicating significantly more interobserver agreement using the novel scale compared to the ACEP scale. The variance of scores was similar (0.93 and 0.92 for the novel and ACEP scales, respectively).

Conclusion: We found an increased interobserver agreement between reviewers when using the novel, organ-specific scale when compared with the ACEP grading scale. Increased consistency in feedback based on objective criteria directed to the specific, targeted organ provides an opportunity to enhance learner education and satisfaction with their ultrasound education. [West J Emerg Med. 2024;25(2)264–267.]

INTRODUCTION

Lung ultrasound (LUS) is frequently used in the emergency department (ED) to assess both medical and trauma patients.[1,2] Quality assessment (QA) of ultrasound images is one of the six required elements of diagnostic ultrasound per the American College of Emergency Physicians (ACEP) and is routinely performed to evaluate image quality, ensuring appropriate patient care, and enabling reviewers to assess user performance.[2] The use of a reliable scoring system for QA is imperative

to limit inconsistencies in measuring ultrasound acquisition skills.

The current QA grading scale endorsed by ACEP was developed from a consensus report of emergency ultrasound leaders to provide a systematic method to report and communicate ultrasound findings.[2] It is a non-specific scale that applies irrespective of the type of study performed and has not been rigorously validated. Similarly formatted organ-specific QA grading systems for cardiac and obstetric exams have been described but are not yet endorsed by ACEP and are not widely used.[2–5] Alternative LUS assessment tools have been developed; however, they are extensive and as such impractical for routine QA use or are focused on image acquisition skills and not tailored to anatomic feedback.[6,7] Our goal in this study was to determine whether a succinct, organ-specific grading scale designed for QA would be more precise with better interobserver agreement.

Population Health Research Capsule

What do we already know about this issue?
A reliable method of quality assessment (QA) of ultrasound images is imperative to assess user performance and limit inconsistencies in measuring ultrasound acquisition skills.

What was the research question?
Is there a QA scoring scale for lung ultrasound (LUS) that is more precise than the commonly used ACEP scoring scale?

What was the major finding of the study?
In the QA of LUS, a novel scoring scale showed significantly more interobserver agreement compared to the ACEP scale.

How does this improve population health?
A more individualized scoring scale for QA of LUS results in less grading variance and more objective feedback when compared to the ACEP scale.

METHODS

This was a prospective validation study of an objective QA scale for LUS. We developed a novel, lung-specific grading scale by a rigorous review of expert, published experience at an outside, unaffiliated institution (Scripps Mercy Hospital, San Diego, CA). This institution routinely performs lung imaging and has published an assessment tool for the evaluation of resident-performed bedside ultrasound B-line interpretation in thoracic ultrasound, as well as an analogous cardiac quality assessment scale.[3,7–13] In the expert review, the current available, organ-specific grading scale found in the literature was modified to the anatomy of the chest wall.[3,5] The gradations of the scale were empirically derived from the experience at this institution in addition to a rigorous review of the literature. [3,5,7–13] The use of four critical landmarks—rib shadows, pleural line, A/B lines, and technical flaws—were recognized as commonalities in all published images in LUS studies, including expert consensus.[14,15] We, therefore, divided these landmarks into a point scale that progressively defines the pattern of acquisition required to obtain an image (ie, bones first, pleural line, followed by artifacts). We described technical flaws as non-optimized depth/gain, distracting adjacent structures, inadequate axis, or hand movement. We deemed flaws to be major if they were present to a degree significant enough to decrease diagnostic capabilities, or if multiple flaws were present.

The scale was then validated at an urban academic tertiary care center in Richmond, Virginia. We identified the first 100 LUS studies completed as part of regular clinical practice in the ED by emergency physicians with two or more LUS videos performed in the year 2020. Dedicated thoracic ultrasound examinations are in general performed by resident physicians with attending oversight. Studies were obtained using Sonosite X Porte ultrasound machine (Fujifilm Sonosite, Bethell, WA) using either the C60XP 5-2-MHz curvilinear transducer, L25 13-6-MHz linear array transducer or the P19 5-1-MHz phased array probe. Four reviewers who were either emergency ultrasound fellowship-trained or current fellows with at least six months of QA experience scored each of the 100 studies resulting in a total of 400. Two blinded reviewers used the current ACEP grading scale,[2] and two used a novel lung-specific grading scale; there was one fellow and one ultrasound-trained physician in each group (Figure). The primary outcome was the level of agreement between the reviewers, indicating the reliability of the scoring system. Our secondary outcome was the variability of the scores given to the studies. For the agreement between reviewers, we computed the intraclass correlation coefficient (ICC) based on two-way random-effect model with a single rater for each grading scale. Ten thousand bootstrapped ICCs were generated to construct 95% confidence intervals (CI) for both grading systems. We used a two-sided one-sample *t*-test to determine whether there were differences in the bootstrapped ICCs between the two grading systems.

RESULTS

The first 100 LUS studies completed in the ED by emergency medicine residents (postgraduate year [PGY]-1,

Score	Novel- LUS scale	ACEP scale[2]
1	No recognizable features of ribs, pleural line, or A/B line artifacts	No recognizable structures
2	1 or 2 rib shadows seen with minimal identifiable pleural line (off axis)	Minimally recognizable structures but insufficient for diagnosis
3	1 or 2 rib shadows and pleural line seen, with major technical flaws	Minimal criteria met for diagnosis, recognizable structures but with some technical or other flaws
4	2 rib shadows seen, framing either A- or B-lines, but with minor technical flaws	Minimal criteria met for diagnosis; all structures imaged well
5	2 rib shadows seen, framing either A- or B-lines, with no technical flaws	Minimal criteria met for diagnosis; all structures imaged with excellent image quality

Figure. Comparison of the novel, lung ultrasound quality assessment scale with the traditional American College of Emergency Physicians scale.
ACEP, American College of Emergency Physicians; *LUS*, lung ultrasound.

42%; PGY-2, 14%; PGY-3, 22%) and ED faculty (22%) were reviewed by four blinded reviewers. Images were obtained using the linear probe (27%), curvilinear probe (32%), phased array probe (28%), or a combination of probes (13%). Studies had a median of six clips (IQR 4–9). The scores given using the ACEP scale and the novel scale are summarized in the Table. The ICC between reviewers was 0.552 (95% CI 0.4–0.68) for the ACEP grading scale and 0.703 (95% CI-0.59, 0.79) for the novel grading scale ($P < 0.001$), indicating significantly more interobserver agreement using the novel scale compared to the ACEP scale. The variance of scores was similar (0.93 and 0.92 for the novel and ACEP scales, respectively).

Table. Summary table of scoring systems.

Statistics	Novel	ACEP
N*	200	200
Min, max	1, 5	1, 5
Mean (SD)	3.70 (0.96)	3.32 (0.96)
Median	4	3
Q1, Q3	3, 4	3, 4
ICC (95% CI)	0.703 (0.59, 0.79)	0.552 (0.40, 0.68)
Variance	0.93	0.92
Variance ratio (Novel: ACEP)	1.01	

*N = number of scores given.
ACEP, American College of Emergency Physicians; *ICC*, intraclass correlation coefficient; *CI*, confidence interval.

DISCUSSION

The current ACEP grading scale used for QA was developed from a consensus report of emergency ultrasound leaders but has not been systematically validated.[2] The use of a reliable, validated scoring system for QA is imperative to limit inconsistencies and ensure objectivity in measuring ultrasound acquisition skill. The vague language used in the ACEP scale may contribute to variable interpretation by those assessing studies, leading to discrepancies in grading ultrasound skill. Inconsistent feedback may confuse the learner and hinder growth of technical skill. In our study, we found that there was an increased interobserver agreement between reviewers when using the novel, organ-specific scale when compared with the ACEP grading scale. Increased consistency in feedback, combined with directed feedback to the specific targeted organ, provides an opportunity to enhance learner education and satisfaction with their ultrasound education.

Organ-specific cardiac and obstetric QA grading systems have been described, although they have not yet been widely adopted in clinical practice.[3–5] This is thought to be due in part to the complexity of these scales and/or that they were validated outside the ED, limiting the external validity.[3,4,6,7] We sought to develop a scale that was concise, organ-specific, and applicable to the most common setting in which LUS is performed. To improve such vague language as "all structures imaged well," we found benefit in specifically stating the anatomic landmarks needed to maximize diagnostic imaging in each view. By emphasizing proper imaging technique before diagnostic interpretation, our assessment tool may improve errors in image grading and reduce learner feedback variability.

LIMITATIONS

Our study was limited by its evaluation of a QA experience at a single, academic tertiary-care center in which the validation took place. Patient demographics were not collected. The blinded reviewers all trained (or current trainees) at the same clinical ultrasound fellowship and, therefore, were taught to perform QA using the ACEP grading scale in a similar manner. Interestingly, this perhaps may have contributed to a higher agreement with the ACEP scale than if, alternatively, reviewers had trained at different institutions. Further, the scale itself was developed after an extensive review of the literature, customized into a feasible scale that is directly applicable to learner objectives. As such, this scale lacks the rigor of alternative methodological methods such as modified Delphi analysis. Importantly, this scale did not validate whether the score was related to the diagnosis or outcome, or whether it improved QA efficiency or educational feedback, but rather the degree of agreement. Additionally, our scale focuses on pathology related to the pleural line itself and does not include language to assess the ability to diagnose a pleural effusion. Finally, our study

involved reviewers with six months experience in QA and included a small (100) number of studies; consequently, our results may be understated. Further research is warranted to validate this novel scale, investigate learner satisfaction, and assess its impact on educational enhancement.

CONCLUSION

We found that a more individualized quality assessment scale of ultrasound imaging targeted to a specific organ—in this case the lung—results in less grading variance and more consistent, objective feedback. This finding may have implications on knowledge gained and learner satisfaction. Future studies are warranted prior to the adoption of this novel scale in clinical practice.

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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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Diagnostic Accuracy of a Handheld Ultrasound vs a Cart-based Model: A Randomized Clinical Trial

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Section Editor: Mark Langdorf, MD, MHPE
Submission history: Submitted January 1, 2023; Revision received November 16, 2023; Accepted November 22, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.17822

Introduction: Numerous studies have demonstrated the accuracy of point-of-care ultrasound (POCUS). Portable, handheld devices have expanded the clinical scope of POCUS at a fraction of the cost of traditional, cart-based models. There is a paucity of data assessing the diagnostic accuracy of portable devices. Our objective in this study was to compare the diagnostic accuracy of a portable device with a cart-based model.

Methods: This was an institutional review board-approved, observational, prospective, randomized clinical trial (NCT05196776) of a convenience sample of adult patients who presented to a university-based health system. Patients who required a cardiac, lung, renal, aorta, or biliary POCUS were randomized to a portable device or to a cart-based model. We hypothesized that the cart-based model would have a 90% diagnostic accuracy vs 70% for the handheld device. To detect a 20% difference, the sample size was calculated to be 98, with 49 patients randomized to each arm. We used standard 2x2 tables to calculate test characteristics with 95% confidence intervals (CI).

Results: A total of 110 patients were enrolled, with 56 patients randomized to the cart-based model and 54 to the handheld device. The sensitivity, specificity, and diagnostic accuracy of the cart-based vs handheld were 77.8% (40–97.2) vs 92.9% (66.1–99.8), 91.5% (79.6–97.6) vs 92.3% (79.1–98.4%), and 89.3% (78.1–96) vs 92.5% (81.8–97.9), respectively.

Conclusion: The diagnostic accuracy of a portable, handheld device is similar to that of a cart-based model. [West J Emerg Med. 2024;25(2)268–274.]

INTRODUCTION

Numerous studies have demonstrated the accuracy of point-of-care ultrasound (POCUS) to diagnosis pathology and to augment procedural guidance.[1–10] Portable, handheld devices have expanded the clinical scope of POCUS across diverse settings, including prehospital, resource-limited, and outpatient clinics.[11–13] The majority of existing literature has assessed the timeliness and image quality of handheld devices only.[13–15] To date, there is a paucity of data assessing the diagnostic accuracy of these portable devices.[16–24] To our knowledge, there are no randomized studies comparing the diagnostic accuracy of a portable, handheld device with a traditional cart-based model. Our primary objective in this study was to compare the diagnostic accuracy of these two diagnostic imaging modalities, specifically for cardiac, lung, biliary, renal and abdominal aorta imaging, Secondary analysis included assessment of image quality.

METHODS

Study Design

This was an institutional review board-approved, observational, prospective, randomized clinical trial (NCT05196776) with parallel assignment and an allocation ratio of 1:1. We followed the CONSORT guidelines and checklists for clinical trials. Butterfly Network, Inc. provided funding for this study.

Study Setting and Population

Between October 1–December 31, 2021 we included a convenience sample of patients ≥18 years old, who presented to one of three clinically distinct emergency departments (ED) affiliated with an urban, Level I, university-based health system with >200,000 adult and pediatric visits annually, and who required a cardiac, lung, biliary, renal, or abdominal aorta POCUS based on the discretion of the emergency attending physician (EP). Study investigators enrolled patients capable of providing written informed consent. Our department credentials all EPs in the core POCUS applications as defined by the American College of Emergency Physicians (ACEP).[25] All English- and Spanish-speaking patients requiring a POCUS evaluation were eligible for enrollment. We excluded patients unable to consent.

Population Health Research Capsule

What do we already know about this issue?
Point-of-care ultrasound (POCUS) enhances our ability to safely, efficiently, and accurately diagnose and manage our patients.

What was the research question?
Does a handheld POCUS device have similar diagnostic accuracy as a traditional, cart-based model?

What was the major finding of the study?
A handheld POCUS device has similar diagnostic accuracy as a traditional, cart-based model (sensitivity 77.8% vs. 92.9%, specificity 91.5% vs. 92.3% and accuracy 89.3% vs. 92.5%).

How does this improve population health?
Given the similar diagnostic accuracies, handheld devices broaden the availability of POCUS and enhance patient care in resource-limited settings.

Study Protocol

We used permuted-block randomization with an allocation ratio of 1:1. Allocation concealment included sequentially numbered, opaque, sealed envelopes. Upon enrollment, blinded study investigators selected an envelope containing study materials and pre-randomized selection into the handheld device (HH) or cart-based model (CB) using Research Randomizer version 4.0 (www.randomizer.org).[26] Patients, who required a cardiac, lung, renal, aorta, or biliary POCUS, were randomized to a portable device, the Butterfly iQ (Butterfly Network, Inc, Guilford, CT) transducer connected to a fifth generation Apple iPad Mini (Apple Inc, Cupertino, CA), or to a cart-based model, the GE Venue Go or GE Logiq E (GE HealthCare, Wauwatosa, WI). (Refer to Image.) We studied the five most commonly performed POCUS scans in our department.

Using the phased array transducer (2–5 mHz) for cardiac imaging or the curvilinear transducer (1-mHz) for the lung, renal, aortic, and biliary scans, postgraduate year 1–3 emergency medicine (EM) residents performed each POCUS prior to advanced imaging. Performing physicians used the

Image. Handheld Butterfly iQ device and cart-based GE Venue Go model demonstrating parasternal long axis view.

corresponding settings for the HH device. An attending EP, credentialed in the core ACEP POCUS applications, reviewed each study concurrently. Study investigators blinded all residents performing the scans and the attending EPs reviewing them to the study objective and its funding.

A cardiologist-interpreted echocardiogram, performed within 24 hours of presentation to the ED, served as the reference standard for cardiac images. For biliary tract images, the reference standard was a radiology-interpreted ultrasound performed during the ED visit. For lung, renal and aortic scans, the reference standard was computed tomography images (when available and performed during the ED visit), or POCUS quality assurance (QA) review by two ultrasound fellowship-trained physicians (when no CT was available). If there was disagreement, a third ultrasound fellowship-trained physician provided an interpretation. The cardiologist, radiologist, and the ultrasound fellowship-trained EPs were blinded to the real-time POCUS reads. However, the EPs performing QA knew about the study and its funding.

Prior to starting their internship, our EM residents participate in an introductory five-hour Introduction to POCUS course taught by our emergency ultrasound faculty. Additionally, each resident completes a three-week emergency ultrasound rotation during their internship in accordance with Accreditation Council for Graduate Medical Education (ACGME) and ACEP guidelines.[24,27] Residents received no additional training prior to their study participation. Nonetheless, each participant completed more than 25 of each scan prior to participating in the study to achieve competency per ACEP and AGME guidelines.[24,27]

Measurements

Prior to study commencement, we defined the following diagnostic endpoints: ejection fraction (EF) (good >50%, moderate 30–50%, poor <30%) and the presence or absence of the following: gallstones; hydronephrosis (mild, moderate, or severe); abdominal aortic aneurysm (>3 centimeters), and B-lines (≥3 in a single lung field or a single, confluent B-line occupying >1/3 of the intercostal window).[28] The presence of B-lines indicates an interstitial process, whether localized or diffuse, reflects its etiology. We compared this to interstitial findings on CT (if available) of the corresponding lobe. We did not compare additional measurements (ie, gallbladder wall thickness, or assess M-mode or Doppler findings). The study included B-mode findings only. Using the electronic health record (Epic Systems Corp, Verona, WI), we performed chart abstraction on all patients to obtain results of cardiology-interpreted echocardiograms and radiology-interpreted ultrasound and CT studies.

Diagnostic accuracy of each imaging modality compared to the aforementioned gold standards served as the primary endpoint. Image quality served as the secondary endpoint. Three ultrasound fellowship-trained physicians used a previously validated Likert scale to assess image quality.[29] A score of 1 indicated unable to interpret, and a score of 7 specified superior imaging quality.

Statistical Analysis

Prior studies assessing POCUS performed using traditional CB technology have demonstrated the following sensitivities for respective pathologies: EF (89%); cholelithiasis (94%); abdominal aortic aneurysms (97%); B-lines (92%); and hydronephrosis (75%), providing an average sensitivity of 90%.[28,30–37] Given the lack of pre-existing data comparing the modalities, we hypothesized that the HH device would have an overall sensitivity of 70%. We postulated that the HH would be inferior given the smaller screen size, novel technology to generate sonographic images, and limited clinician experience with the device. Based on a power of 80% and an alpha of 0.05, we calculated a sample size of 98, with 49 patients randomized to each arm, to detect a 20% difference. We report continuous and categorical data as medians with interquartile ranges (IQR) or proportions with 95% confidence intervals (CI), and we used standard 2×2 tables to calculate test characteristics with 95% CIs using MedCalc version 19.1.6 (MedCalc Software Ltd, Ostend, Belgium). Intraclass correlation coefficient assessed inter-rater reliability between blinded expert reviewers, and we used the *t*-test to compare median Likert scores.

RESULTS

We enrolled 110 patients with 56 patients randomized to the CB model and 54 to the HH device (Figure 1). Authors excluded one HH patient given there were no sonographic images available to review. Table 1 illustrates the similarity of patient characteristics and the number of each POCUS type across both cohorts (Table 1). Table 2 portrays test characteristics for each diagnostic modality, while

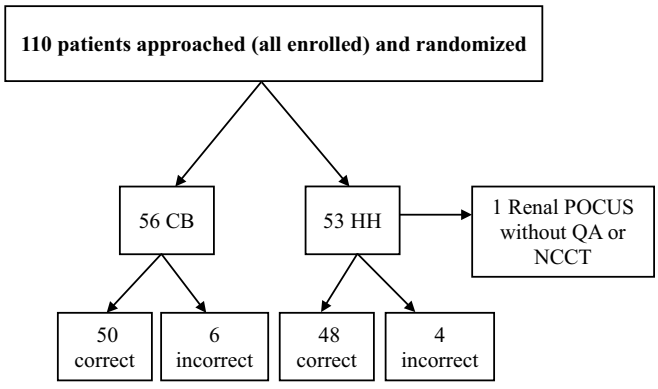

Figure 1. Patient flow chart.
CB, cart-based ultrasound model; *HH*, handheld device; *POCUS*, point-of-care ultrasound; *QA*, quality assurance review; *NCCT*, non-contrast computed tomography of the abdomen and pelvis.

Table 1. Patient characteristics.

Characteristic	Cart-based model (n = 56)	Handheld device (n = 53)
Age, median (IQR), years	57 (18–90)	60 (18–89)
Gender, N (%)		
Female	60.7	51
Male	39.3	49
Body mass index, median (IQR)	30 (22–64.9)	27.9 (15–42.2)
Point-of-care ultrasound scans	Aorta (9)	Aorta (4)
	Cardiac (11)	Cardiac (17)
	Gallbladder (10)	Gallbladder (14)
	Lung (11)	Lung (7)
	Renal (15)	Renal (11)

IQR, interquartile range.

Table 2. Test characteristics.

	Cart-based model (n = 56; 95% CI)	Handheld device (n = 53; 95% CI)
Sensitivity	77.8 (40–97.2)	92.9 (66.1–99.8)
Specificity	91.5 (79.6–97.6)	92.3 (79.1–98.4)
Positive likelihood ratio	9.2 (3.4–24.9)	12.1 (4.0–36.2)
Negative likelihood ratio	0.2 (0.1–0.8)	0.1 (0–0.5)
Disease prevalence	0.2	0.3
Positive predictive value	63.6 (39.2–82.6)	81.3 (59.1–92.9)
Negative predictive value	95.6 (86.3–98.7)	97.3 (84.5–99.5)
Accuracy	89.3 (78.1–96)	92.5 (79.3–96.9)

CI, confidence interval.

Tables 3 and 4 depict the diagnostic criterion reference used and the diagnostic inaccuracies, respectively.

Overall, there were 10 incorrect diagnoses, four for the HH device and six for the CB model. Table 4 highlights the diagnostic inaccuracies by scan type, diagnostic modality, and criterion reference. The HH correctly identified the following: six instances of cholelithiasis; one case of mild and one of moderate hydronephrosis; four individuals with pulmonary edema; and one patient with a moderate EF. The CB modality correctly identified the following: two instances of cholelithiasis; one case of severe hydronephrosis; two individuals with pulmonary edema; and two patients with poor EFs. The median Likert score for CB was 5, and 4 for the HH. Intraclass correlation coefficients for the HH and CB were 0.5 (95% CI 0.2–0.7) and 0.8 (95% CI 0.7–0.8), respectively.

DISCUSSION

To the best of our knowledge, ours is the first published randomized trial comparing a portable HH device with a traditional CB model in ED patients. Given the lack of pre-existing data, we hypothesized that the traditional CB model would be superior with respect to diagnostic accuracy and image quality. Handheld devices are still novel and have not been adopted broadly, limiting clinician experience. Moreover, novel technology to generate sonographic images, compared to the traditional piezoelectric crystals, may affect image quality as well. Similarly, we assumed screen resolution and size would limit image quality and, subsequently, accuracy. However, a small pilot study by Magee et al demonstrated similar results between HH and CB devices when interpretating pre-recorded videos assessing for free fluid in the right upper quadrant.[13]

We chose five basic POCUS examinations that our EPs have considerable experience performing with appropriate diagnostic accuracy. Our EPs currently have less experience with other POCUS indications, such as regional anesthesia and fracture assessment. Moreover, we did not have access to a HH endocavitary transducer to assess for pregnancy-related issues. These areas are ripe for future research.

Table 3. Diagnostic criterion reference used for comparison.

	Cart-based model (n = 56)		Handheld device (n = 53)	
	QA	Echo	QA	Echo
Cardiac (n = 27)	5	6	8	8
	QA	RUQ US	QA	RUQ US
Biliary (n = 24)	10	0	10	4
	QA	CT	QA	CT
Lung (n = 18)	11	0	5	2
Renal (n = 27)	13	2	9	3
Aorta (n = 13)	6	3	0	4

QA, quality assurance review; *Echo*, cardiology-performed and interpreted echocardiography; *RUQ US*, radiology- performed and interpreted right upper quadrant ultrasound; *CT*, computed tomography of the chest or abdomen and pelvis with or without contrast.

Overall, we found no significant difference in sensitivity or specificity between CB and HH ultrasound images. However, this limited our sample size for each modality.

Although the study types and indications varied, the idea of diagnostic accuracy should apply to all POCUS studies. It is probably expected that when the diagnosis was the objective presence or absence of a finding, (ie, gallstones) there were no misdiagnoses.[29,30] However, when the diagnosis was more subjective (ie, estimating EF or the degree of hydronephrosis) there were more inaccuracies across both modalities. This is consistent with previous studies showing more overlap of good and moderate EFs and between poor and moderate.[31] In our study, there was a tendency to overestimate the presence or degree of hydronephrosis, which is likely confirmational bias in the setting of a presumed nephrolithiasis diagnoses.

As expected, the CB device had better overall image quality than the HH. However, this did not affect diagnostic accuracy, as our results suggest that it is similar between HH and CB modalities in an academic EM residency. Superior image quality may detect more subtle pathology, such as signs of cholecystitis.[32] Each diagnostic modality serves a clinical role. This data can be extrapolated to the broader EM community with the increasing prevalence of ultrasound competency in practicing EPs and availability of portable devices. Furthermore, it supports the utility of HH devices in resource-limited settings, outpatient clinics, and inpatient locations with limited access to traditional sonographic machines, not to mention pandemic settings where disinfection is paramount.[2]

LIMITATIONS

This study suffers from the limitations of an observational design with convenience sampling at a single health system resulting in a selection bias as well as a smaller sample size, which limits the level of precision to exclude a type II error. Using the discretion of the attending EP to determine whether a patient needed a specific POCUS examination created a selection bias as well. We did not define specific indications to perform one of the aforementioned POCUS scans. Moreover, we hypothesized the diagnostic accuracy of the HH device given the lack of pre-existing data. This limits the validity of our power analysis.

Butterfly Network, Inc. funded the study, which may have introduced bias. However, physicians performing the ultrasounds were unaware of this funding. Furthermore, physicians performing the ultrasound had significantly more experience using the CB model compared to the HH device, which may have introduced bias in favor of the traditional modality. Furthermore, we did not account for the

Table 4. Diagnostic inaccuracies by imaging modality.

	Cart-based model (n = 6)	Handheld device (n = 4)
Cardiac (n = 5)	2 interpreted as normal EF, read as moderate during QA	1 interpreted as normal EF, read as moderate during QA 1 interpreted as moderate EF, read as normal during QA 1 interpreted as poor EF, read as normal on echo
Biliary (n = 0)	0	0
Lung (n = 0)	0	0
Renal (n = 4)	2 interpreted as mild hydronephrosis, read as normal during QA 1 interpreted as moderate hydronephrosis, read as normal during QA 1 interpreted as moderate hydronephrosis, read as normal on NCCT	1 interpreted as mild hydronephrosis, read as normal on NCCT
Aorta (n = 0)	0	0

EF, ejection fraction; *QA*, quality assurance review; *Echo*, cardiology performed and interpreted echocardiography; *RUQ US*, radiology performed- and interpreted right upper quadrant ultrasound; *NCCT*, non-contrast computed tomography of the abdomen and pelvis; *CB*, cart-based model; *HH*, handheld device.

experience level of the residents performing the ultrasound, which could have impacted quality and accuracy. Presumably, senior residents had more proficiency.

We did not compare additional types of HH devices. Therefore, it is unclear whether our data is applicable to other devices using different technology. Specifically, the Butterfly iQ device uses chip technology compared to traditional piezoelectric crystals. This may impact image quality and diagnostic accuracy. Presumably, the HH frequencies settings for each study reflect those of the traditional CB modalities. However, we did not account for software features, screen size, or resolution in our study. Future studies need to validate our findings across the array of HH devices and emerging technology. Furthermore, we limited our study to only five of the ACGME core ultrasound competencies. Therefore, additional studies are needed to validate our findings to broader POCUS applications, including various settings such as M-mode and Doppler.

Using the subjective interpretation of ultrasound fellowship-trained faculty as the criterion reference when other standard diagnostics imaging modalities were not done limits the validity of the results and causes a misclassification bias. Specifically, we did not account for the potential for inferior technology. For example, if the HH or CB model provides inferior imaging, not only may the performing physician miss pathology, but the EPs conducting QA may overlook it as well. This false negative may not be missed by a radiology-performed and interpreted ultrasound. Moreover, reviewers were not blinded to the image source, HH vs CB, given that each modality uses unique storage means. Nonetheless, quality assurance review is common practice in academic EDs with an ultrasound division, and confirmatory studies are typically unnecessary.

Additionally, using cardiologist-obtained echocardiograms as a reference standard introduces the potential for treatment effects between when the POCUS images were obtained and when the cardiology images were obtained. While each patient received a cardiology echocardiogram within 24 hours of the ED visit to limit such effects, this is nonetheless a limitation to our study. Finally, our ED is not representative of the broader EM community. We have an active ultrasound division with numerous faculty and fellows. All EPs are credentialed in POCUS. In our department, residents are the treating clinicians, who typically have more POCUS experience compared to most practicing EPs. Furthermore, our department has regular access to and experience with portable devices.

CONCLUSION

The diagnostic accuracy of a portable, handheld ultrasound device is similar to the accuracy of a traditional, cart-based model when performing cardiac, lung, biliary, renal, or abdominal aorta studies. Future larger, multicenter studies are required to validate these findings.

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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. This study was funded by Butterfly Network, Inc. The company had no role in conduction of the study, the method of reporting or decision to publish the study.

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Space Ultrasound: A Proposal for Competency-based Ultrasound Training for In-flight Space Medicine

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Section Editor: Mark Langdorf, MD, MHPE
Submission history: Submitted August 8, 2023; Revision received November 7, 2023; Accepted December 6, 2023
Electronically published February 13, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18422

Space travel has transformed in the past several years. Given the burgeoning market for space tourism, in-flight medical emergencies are likely to be expected. Ultrasound is one of the few diagnostic and therapeutic modalities available for astronauts in space. However, while point-of-care ultrasound (POCUS) is available, there is no current standard of training for astronaut preparation. We suggest an organized and structured methodology by which astronauts should best prepare for space with the medical equipment available on board. As technology continues to evolve, the assistance of other artificial intelligence and augmented reality systems are likely to facilitate training and dynamic real-time needs during space emergencies.

Summary: As space tourism continues to evolve, an organized methodology for POCUS use is advised to best prepare astronauts for space. [West J Emerg Med. 2024;25(2)275–281.]

BACKGROUND

Over the last decade, impressive technological advances surrounding space travel have made space tourism a reality for the not-too-distant future. As commercial industry increasingly lays down a stake in this nascent market, prior barriers to private-passenger space travel, such as cost and accessibility, are rapidly falling.[1,2] Proposed opportunities for private passengers range from long-haul global travel through space, to brief orbit, to prolonged stay with hotel accommodations.[3] As of late 2021, less than a handful of the nearly 600 individuals who have gone to space were civilian passengers.[4] Despite small numbers currently, it is projected that by 2030 both space tourism and long-haul travel by space will capture nearly $20 billion of the larger space economy.[4]

Professional astronauts are often screened for baseline health conditions that could lead to in-flight medical emergencies and potentially jeopardize personnel safety or the mission.[5] Therefore, true in-flight medical emergencies to date have been rare. However, with the greater diversity of traveler anatomy, physiology, and medical history, which will inevitably result from expansion of private-passenger space travel, a significant increase in in-flight medical emergencies is expected.[1,2,5] For longer duration missions, it is projected that at least one medical emergency will occur per crew of six travelers.[5] Unlike for medical emergencies during air travel, emergency landings and real-time conversations with ground control are not reliable options in space.[6,7] Additionally, as more flights depart it will be increasingly unlikely that a trained medical doctor will be available or present on each flight. In fact, SpaceX just recently launched an all-civilian mission crew with only a trained physician assistant.[8] Thus, with the expansion of the private space flight industry, innovative medical protocols and approaches must be developed.[9]

OBJECTIVES

Point-of-care Ultrasound Training for Space Medicine

Current Training Standards

Prior to current space travel, flight crews are required to train for anticipated mechanical, mission, and engineering challenges.[3] Medical care is the responsibility of the crew medical officer (CMO) who typically has limited prior medical knowledge.[10] The CMO training involves 40–80 hours of hands-on training with remediation and continuing virtual trainings as needed.[10] Some of this preparatory training includes rudimentary medical education (phlebotomy, vital sign measurement, tonopen use, panoptic use, and ultrasound)[11] designed in anticipation of coordinated care with Mission Control for telehealth interpretations.[11] This often consists of "just-in-time" diagnostic algorithms to facilitate ultrasound interpretation with the aid of live telehealth guidance.[10] Flight surgeons are frequently and regularly on console at Flight Control Room 1-Mission Control and actively participate in medical monitoring and guidance.

Point-of-care ultrasound (POCUS) images can be downloaded in real time for evaluation, and by using a private medical conference channel loop, only the ultrasound operator (trained and under non-disclosure agreement), the physician, and the patient/subject are involved. Even the mission's flight director would not have access. Inherently, telemedicine has been a part of the International Space Station (ISS) since it launched. As longer space duration missions and interplanetary travel progress, time lapses of 40 minutes or longer are anticipated for ground crew virtual contact.[6,7,12,13] These communication delays could lead to severe medical consequences for missions with flight crew trained according to the current standard of care.[6,7,12]

Because of its portability, low-cost, and radiation-free, real-time imaging for an impressive array of medical conditions, POCUS has a demonstrated utility in space medicine, In cases where ultrasound training is currently provided, a maximum of 2-3 hours is allotted throughout the entire pre-flight training curriculum.[11,14] This Advanced Diagnostic Ultrasound in Microgravity (ADUM) educational program is used on the ISS where "cue cards" are used to rapidly guide non-expert users to perform ultrasounds on patients, with more than 90% accuracy after just minutes of training.[14] While "cue cards" can be used, ADUM has found that non-medical operators can obtain quality data with the right amount of training and direction.[14] For this reason, an on-board proficiency enhancement has also been created both in English and Russian.[14] The combination of this several-hour training course with the "remote expert guidance" (available by Mission Control) is the most effective means by which in-flight ultrasound guidance is currently conducted with attention to limitations of ultrasound in space (gel use, device battery life, etc).[14]

In contrast, true mastery of POCUS for healthcare professionals typically requires years of practice during medical residency and often an additional year of dedicated training through an ultrasound fellowship. While mastery of POCUS at the same level of a medical professional is not realistic for most flight surgeon training, introducing POCUS to crew members and a flight surgeon's repertoire through a structured and systematic curriculum has the potential to yield significant benefit to both private passengers and potentially the entirety of the mission. Additionally, in longer duration flight missions when emergency decisions need to be made using ADUM's proposed telecommunication and ultrasound video transmission, time and video delays have real and significant limitations for astronaut care and outcomes.

CURRICULAR DESIGN

Proposed Point-of-care Ultrasound Training Solutions

Prior data on POCUS education suggests that even novice POCUS learners can retain the basics of image acquisition and interpretation with a minimum amount of focused training.[14–18] Core competency in scanning each organ system can be achieved with a two-hour session of combined didactics and hands-on scanning.[19–22] Thus, as a consortium of medical doctors and experts, we propose a structured, competency-based POCUS curriculum for commercial space travel that includes well-defined aims targeting image acquisition and interpretation for the most common organ systems involved in in-flight medical emergencies (Figure 1A). Astronauts trained for space should be considered technicians in these scenarios, with physicians supplementing the real-time diagnoses and treatments.

The seven most high-yield procedure or organ-based systems are identified with an advised 1–2 hours training per topic. Realistically, a one-day course of about 6–8 hours would be sufficient to satisfy a foundation for competency. However, as pre-mission astronaut preparation time is busy and filled with requirements, these preparatory courses can be adjusted and elongated as tolerated by individual mission schedules and needs. This structured format would ensure consistent and homogenous training for all astronauts anticipated in space. Each aspect of the mission is rehearsed, and each astronaut (and back-up astronaut) is also cross-trained for activities outside their primary mission designation scope, in the event of astronaut drop-out. Training would be mission-specific and expected to be intensive and start about three years before launch. Real-time updates can be made if mission requirements change at any point within the three years to launch, so that the most up-to-date equipment and procedures are used prior to launch.

Core competency is an appropriate goal for most flight surgeons in training and should include the basic skills needed for POCUS image acquisition and a proficient level

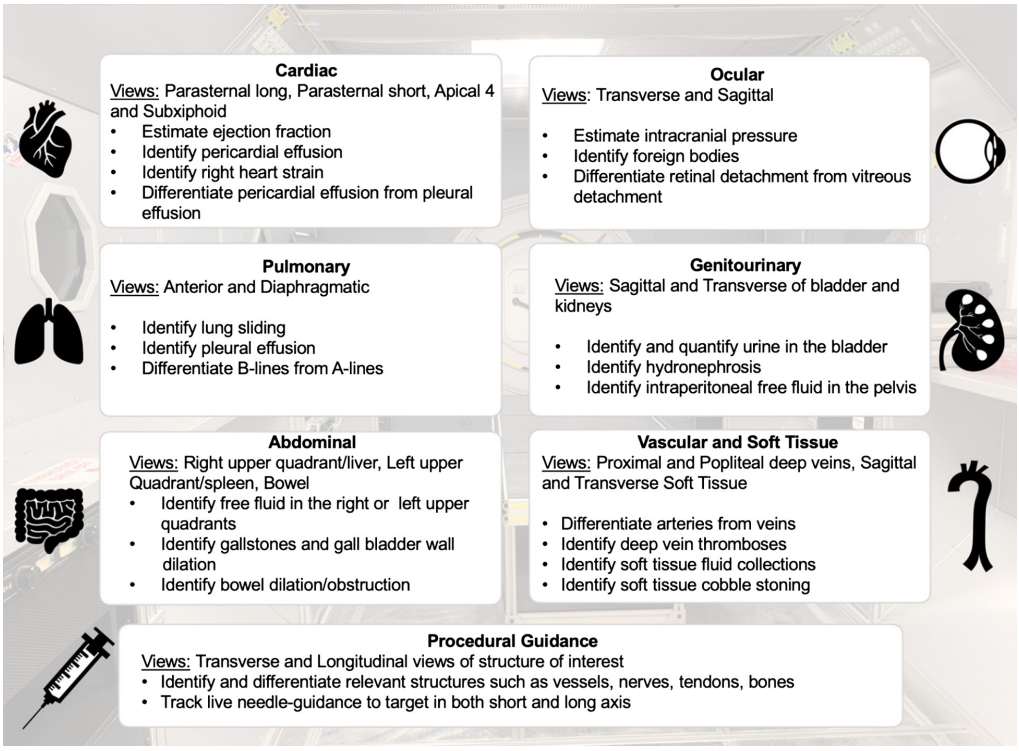

Figure 1A. Core point-of-care ultrasound competencies in a structured ultrasound training program.

of independent interpretation. Although far from mastery level, core competency allows for an appropriate balance of limited input of training time required. The skills of POCUS acquisition and interpretation can always be supplemented with adjuvant tools such as live telehealth with ground control, or (artificial reality/artificial intelligence [AI]) tools during live missions (Figure 1B). For travel at lower altitudes of orbit, lower tiered competency coupled with available telehealth guidance may be sufficient.[23–25] For long-haul or deeper space travel, however, completing the entire

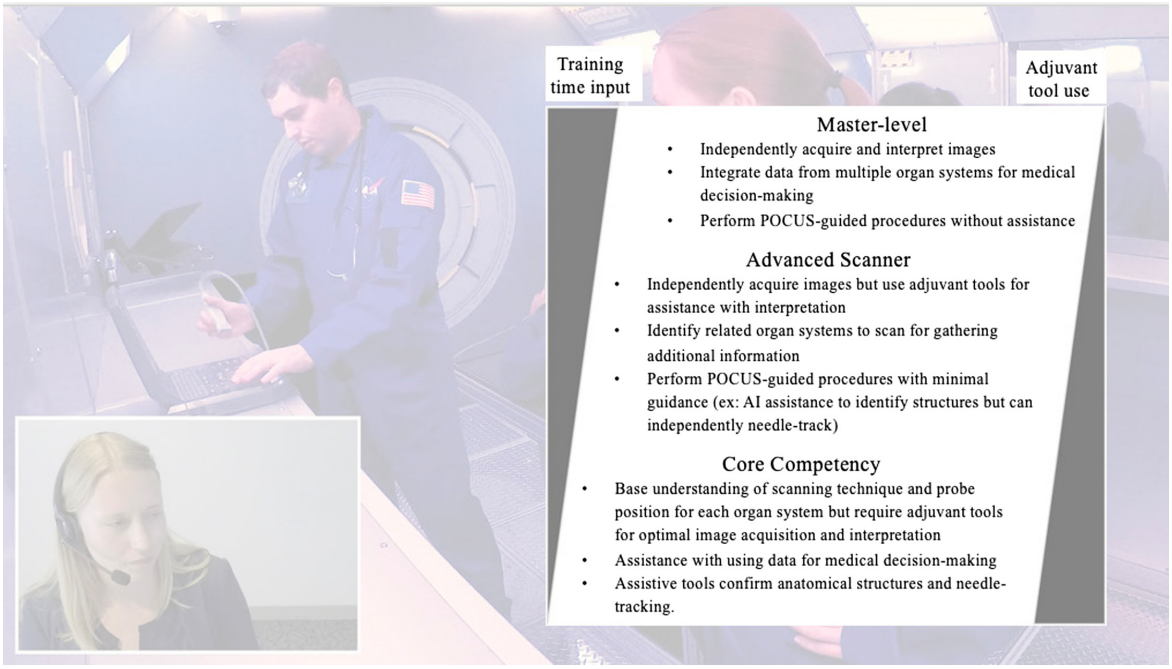

Figure 1B. Suggested tiered competency-based ultrasound training. Images from the STRATUS Space Simulation training.

Table 1. Medical emergencies with respective incidences in space and related utility of point-of-care ultrasound.

Physiological system	Medical events	Incidence in space (% reported)	Pathophysiology	Ultrasound indication/ POCUS finding
Ocular and sensory organs	• Ocular foreign body • Increased intracranial pressure • Disequilibrium	Up to 42%[32]	Foreign bodies from exposures within the space capsule or orbit	• Identify ocular foreign bodies • Measure optic nerve sheath diameter • Measure optic nerve sheath diameter
Cardiac	Arrhythmias	0.2–9.55%	Shifting fluids and dynamic changes in gravitational movements can cause compensatory changes in both pulmonary and cardiac volumes and potentially provoking cardiac arrhythmias and cardiac irritability[33,34]	Transthoracic echo for arrhythmias, wall motion abnormalities, or cardiac standstill
	Pulmonary embolism	***	Lack of gravity and venous stasis in space can promote thrombotic events	Transthoracic echo for right ventricular strain
Pulmonary	• Pneumothorax • Respiratory infections	7.6–64%[35]	Barotrauma	Confirm lung sliding
			Dysregulation of the immune system with possible concurrent viral reactivation[36]	Identify pulmonary B-lines or consolidations
Vascular	Venous thromboembolism	***[37,38]	Lack of gravity and venous stasis in space can promote thrombotic events[31]	Identify deep vein thromboses
Gastrointestinal	Bowel obstruction and constipation	***[39]	Constipation is common in space but symptoms can mimic bowel obstruction	Abdominal POCUS for bowel obstruction
Genitourinary	• Acute urinary retention • Renal stones	~1.20%[32]	Often multifactorial, pharmacologic, loss of gravitational forces, and demanding schedules with limited access to voiding are considered contributors to urinary retention[40]	Measure post-void bladder volume
		0–5%	Bone loss and muscle wasting can lead to increased calcium excretion that can precipitate renal stones[41]	Identify hydronephrosis
Dermatological	Soft tissue infections	8–10%[32]	In a gravity-less environment, bacteria and other pathologic flora can potentially linger longer on the skin's surface	Confirm abscess vs cellulitis
Traumatic injuries	• Intra-abdominal bleeding • Fractures • Joint injuries • Soft tissue injuries	11–26%[32]	Trauma[27]	• eFAST for intraperitoneal free fluid • Identify bony abnormalities • Identify joint effusions • Identify hematomas, etc

***Indicates described reports of pathophysiology in space without disclosed numerical values in space or with little to no episodes in space. Terrestrial incidences are often used for risk stratification modeling.
POCUS, point-of-care ultrasound; *eFAST*, extended focused assessment with sonography for trauma.

curriculum, perhaps with progression to advanced-level training, is highly recommended. For any level of training, learning can be consolidated by remediation and spaced repetition of training through augmented reality and recorded lectures.

IMPACT AND EFFECTIVENESS

Point-of-care Ultrasound and Space Medicine

While POCUS has been used by the National and Aeronautics Space Administration (NASA) as the primary form of imaging aboard the ISS since 1982, original devices

offered only rudimentary imaging capabilities.[12,27–29] Today POCUS devices are capable of advanced imaging with multiple frequencies and modalities for both diagnostic and therapeutic applications.[30] Many POCUS devices are now hand-held, which offers a unique advantage over alternative imaging modalities in settings where weight and volume restrictions are critical, such as in space travel.[6–8] Consequently, POCUS represents an ideal imaging modality for the growing space medicine industry.[8]

Previously described medical emergencies in space span nearly all organ systems and reflect the unique physiological stress placed on the human body by microgravity and other natural risks in space such as dehydration (Table 1).[5,9,31] Similarly, there are scenarios in zero gravity, such as scanning for free fluid for trauma (as in cases with focused assessment with sonography for trauma exams) or for pleural edema (pneumonia or other infectious or cardiac conditions), that have alternative interpretations given the gravity-less conditions. On Earth, blood or fluid would pool in certain areas of the body (the bladder recess or inferior aspects of the lungs), but in zero gravity, there is no proclivity for pooling in any one specific area; hence, a complete and thorough exam is important to train for. As demonstrated in Table 1, POCUS has a potential role in assessing medical conditions associated with nearly every organ system in space travel including cardiac, pulmonary, genitourinary, and ocular complaints. Although expansive, this list does not address the array of potential POCUS-guided critical procedures. Anticipated in-flight procedures include the following: establishing vascular access; regional anesthesia for acute pain control (or rare but life-saving procedures); and pericardiocentesis and needle decompression for tension pneumothorax. Additionally, there are many other important implications for the preparation of POCUS use in space and adjustments that must be made and trained for in zero-gravity conditions. For example, ultrasound gel is not used in space, in part because water is equally as effective and because duplicate use of items is critical for the cost and weight restrictions imposed for each launch.

CONCLUSION

Future of Point-of-care Ultrasound in Space Medicine

While there are a variety of ultrasound applications not described here, the identified organ systems listed were chosen based on frequency of emergencies and the anticipation of in-flight medical needs.[42] While these recommendations have yet to be tested and applied for space medicine practices, based on similar POCUS education models, skill retention is likely to be high among astronauts.[11,23] Spaced repetition and remediation will help consolidate skills and can be instrumental in maintaining fluency long term.[23,26] Alternative learning modalities such as virtual reality and mixed in-person training modules can assist with skill retention in real time when live tele-consults are unavailable. Similarly, AI algorithms have the potential to offer automated image interpretation and clinical-decision assistance without the need for live tele-support.

Implementing a structured POCUS curriculum has the potential to make tangible changes to in-flight healthcare and emergency procedures, which will be crucial as the space flight industry continues to evolve. To maximize the utility of this diagnostic and therapeutic device, we propose that POCUS education should be a prerequisite of training for space flight for both near-future and future missions and can be achieved through a structured curriculum to make the most efficient use of astronaut training and time.[11,29,43,44] While time allocation is an exceptionally valuable resource in astronaut training and education, integrating POCUS education into the mandatory space-flight training curriculum will likely pay off in dividends for future passengers and missions.

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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. Drs. Emily Frisch, Andrew Goldsmith, and Nicole Duggan all have received consulting or advising fees from Centaur Labs. Dr. Chanel Fischetti was formerly employed by Centaur Labs and owns equity in the company. She also is a consultant for Philips Ultrasound and LevelEx. Select authors (Drs. Dias, Savage, Loesche and Mormann) have received funding from, are currently employed by, or receive related funding/grant support from NASA or SpaceX.

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Ultrasound Performed by Emergency Physicians for Deep Vein Thrombosis: A Systematic Review

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Section Editors: Jason Fields, MD, and Patrick Maher, MD, MS
Submission history: Submitted May 17, 2023; Revision received October 24, 2023; Accepted November 22, 2023
Electronically published February 9, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18125

Introduction: Point-of-care ultrasound (POCUS) performed by emergency physicians (EP) has emerged as an effective alternative to radiology department ultrasounds for the diagnosis of lower extremity deep vein thrombosis (DVT). Systematic reviews suggested good sensitivity and specificity overall for EP-performed POCUS for DVT diagnosis, yet high levels of heterogeneity were reported.

Methods: In this systematic review and meta-analysis, we aimed to provide the most up-to-date estimates of the accuracy of EP-performed POCUS for diagnosis of DVT and to explore potential correlations with test performance. We performed systematic searches in MEDLINE and Embase for original, primary data articles from January 2012–June 2021 comparing the efficacy of POCUS performed by EPs to the local standard. Quality Assessment of Diagnostic Accuracy Studies-2 for individual articles are reported. We obtained summary measures of sensitivity, specificity, and their corresponding 95% confidence intervals (CI) using bivariate mixed-effects regression models. We performed meta-regression, subgroup, and sensitivity analyses as planned in the protocol CRD42021268799 submitted to PROSPERO.

Results: Fifteen publications fit the inclusion criteria, totaling 2,511 examinations. Pooled sensitivity and specificity were 90% (95% CI 82%–95%) and 95% (CI 91%–97%), respectively. Subgroup analyses by EP experience found significantly better accuracy for exams performed by EP specialists (93%, CI 88%–97%) vs trainees (77%, CI 60%–94%). Specificity for EP specialists (97%, CI 94%–99%) was higher than for trainees (87%, CI 76%–99%, $P = 0.01$). Three-point compression ultrasound (CUS) was more sensitive than two-point CUS but was only statistically significant when limited to EP specialists (92% vs 88%, $P = 0.07$, and 95% vs 88%, $P = 0.02$, respectively).

Conclusion: Point-of-care ultrasound performed by emergency physicians is sensitive and specific for the diagnosis of suspected DVT when performed by trained attending EPs. Three-point compression ultrasound examination may be more sensitive than two-point CUS. [West J Emerg Med. 2024;25(2)282–290.]

INTRODUCTION

Lower extremity deep venous thrombosis (DVT) is an acute medical condition that, if not urgently diagnosed and treated, can result in severe morbidity and mortality. Left untreated, the associated one-month mortality of acute DVT is 10–15%.[1] Postphlebitic syndrome is seen in 23–67% of patients after resolution of the initial thrombosis.[2] Further, DVT is a common problem representing up to 2% of diagnoses made in the emergency department (ED),[3,4] making it a compelling "can't-miss" urgent diagnosis. Compression ultrasonography (CUS) has become a widespread tool that makes the evaluation of DVT rapid and precise. Compression ultrasonography is recognized by the American College of Emergency Physicians and the American College of Radiologists as the standard of care for the diagnosis of DVT, supplanting older techniques.[5] In addition to radiology department-performed CUS, point-of-care ultrasound (POCUS) performed in the ED has emerged as an effective diagnostic modality.[6]

The region of interest for most ED-based DVT POCUS protocols extends from the common femoral vein to the popliteal vein. Most DVT POCUS protocols include CUS of the common femoral vein, popliteal vein, and possibly the femoral vein.[7] These are referred to as two-point or three-point CUS, respectively, depending on the number of sites interrogated. The clinical significance of isolated venous thrombosis of the calf is controversial; however, non-urgent outpatient surveillance is an accepted treatment.[8] Finally, while isolated thrombosis of the iliac vein is a potentially life-threatening condition, it is rare and difficult to detect with existing sonographic techniques.[9] Thus, distal DVT and isolated iliac vein thrombosis are not addressed in this review.

While ED-performed POCUS is accepted by emergency physicians (EP) and radiologists for the diagnosis of DVT, there exists substantial variability in the diagnostic accuracy of POCUS.[7] Factors that may affect diagnostic accuracy include the experience and ability of the ultrasound operator, the number of anatomical sites of the lower extremity scanned,[10] whether augmentation techniques are used (such as Doppler) and image interpretation (such as vessel identification and partial compressibility).[11,12]

Studies and reviews comparing the accuracy of ED-performed POCUS for the diagnosis of DVT to a radiology department-performed ultrasound span more than 20 years. Earlier studies were small, more likely based in the United States, and complicated by heterogeneous methods and results.[13] Currently, to our knowledge, there exist no guidelines or best practices for ED-based DVT POCUS. With the last systematic review published almost a decade ago, we performed an updated systematic review to explore the diagnostic accuracy of ED-based POCUS compared to radiology department-performed ultrasound. We also explored factors affecting the diagnostic accuracy for the diagnosis of DVT through subgroup analysis and meta-regression of recent studies.

METHODS

In this systematic review we aimed to assess the accuracy of bedside venous ultrasonography as performed by EPs when compared to those performed by the radiology department for the diagnosis of DVT of lower extremities in adult patients. The protocol for this review was accepted and registered on the International Prospective Register of Systematic Reviews (PROSPERO) under the number CRD42021268799.

Search Strategy

We conducted a literature search in MEDLINE (via Ovid MEDLINE) and Embase (via Elsevier) for relevant, original studies published from January 2012–June 2021 to update from the latest published systematic review on the topic.[13] The detailed list of search terms used is listed in the Appendix (supplemental material). We consulted with domain experts for unpublished studies and conducted a manual search of published literature from the references listed on the included articles. The language was restricted to English.

Study Selection

Eligible studies were original, primary data, collected using cross-sectional and longitudinal study designs (cohort or randomized controlled trials), that included adult patients (age >18 years) presenting to the ED for which DVT was listed as a differential diagnosis and for which, as part of the diagnostic workup, an ultrasonographic exam was performed by an EP and an ultrasound was performed by the radiology department. A contrast venogram (angiography) was an acceptable alternative to a radiology department-performed ultrasound. We used the systematic review management tool, Covidence, for the screening of titles/abstracts and quality assessment of studies. At least two investigators (DH and MV or OH and MV) independently reviewed the titles and abstracts of the studies for eligibility.

Discrepancies in the eligibility decision were resolved by a third investigator (RL) after reviewing the full article. Reasons for exclusion were recorded. We excluded review articles, editorials or letters, expert opinions, comments, and animal experiments. Lastly, we excluded articles for which no information was available on the total number of true positives, true negatives, false positives, or false negatives.

Data Extraction

At least two reviewers independently extracted data on the selected studies (DH and MV, or OM and MV). Collected information included the following: country where the study was performed; the type of US exam used for the index test

(two-point or three-point); clinical experience (attending and/or trainee) and description of the formal training of physicians performing the index test; whether the original study had performed risk stratification of participants prior to the use of the index test; numbers of true positives, true negatives, false positives, and false negatives, sensitivity and specificity as reported; and corresponding measures of precision (confidence intervals [CI]). To assess potential biases in individual studies, we used the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2) checklist. Disagreements were resolved by consensus, or by a third reviewer.

Statistical Analyses

Summary measures of sensitivity, specificity, and their corresponding 95% CIs were obtained using bivariate mixed-effects regression models. We estimated I^2 statistic assessing for study heterogeneity. In addition, inconsistencies were further explored through visual inspection of forest plots (for overlapping of sensitivity and specificity point estimates and corresponding 95% CI) and by subgroup analyses. Subgroup analyses, defined a priori, included stratification by the type of US study performed (two-point CUS vs three-point CUS); experience of physicians performing the index POCUS (completed specialty EM training or specialist/attending vs EM trainee or resident status); prevalence of DVT; sample size; risk of bias; and outlier status. We performed all analyses with STATA v16 (StataCorp LLC, College Station, TX).[14]

RESULTS

We identified 230 studies in EMBASE and Medline that fit our search strategy (Figure 1). After removing duplicates, titles, and abstracts, we retrieved 38 studies for further evaluation based on inclusion criteria and abstract review. Fifteen publications[15–29] remained after full text review with reasons for exclusion listed in Figure 1. Fourteen were full-length articles with one manuscript reporting two trials. One additional study reporting sufficient data for inclusion in the analysis was published as an abstract. In two instances, we obtained additional study characteristics via direct author correspondence.

Characteristics of Studies

Studies varied greatly in geographic locations; three studies were done in the United States and Canada, two in Australia, and three in Iran, among other locations (Table 1). The number of diagnostic tests compared ranged from 56–385. Most studies reported data per patient, with two studies that reported results by limb.[15,18] Prevalence of DVT in the samples varied from 10%–79%.[16,19,27] About 50% of the studies used two-point ultrasound, and 50% used three-point. One publication tested both two-point and three-point US to the reference standard.[22] Most studies used the locally

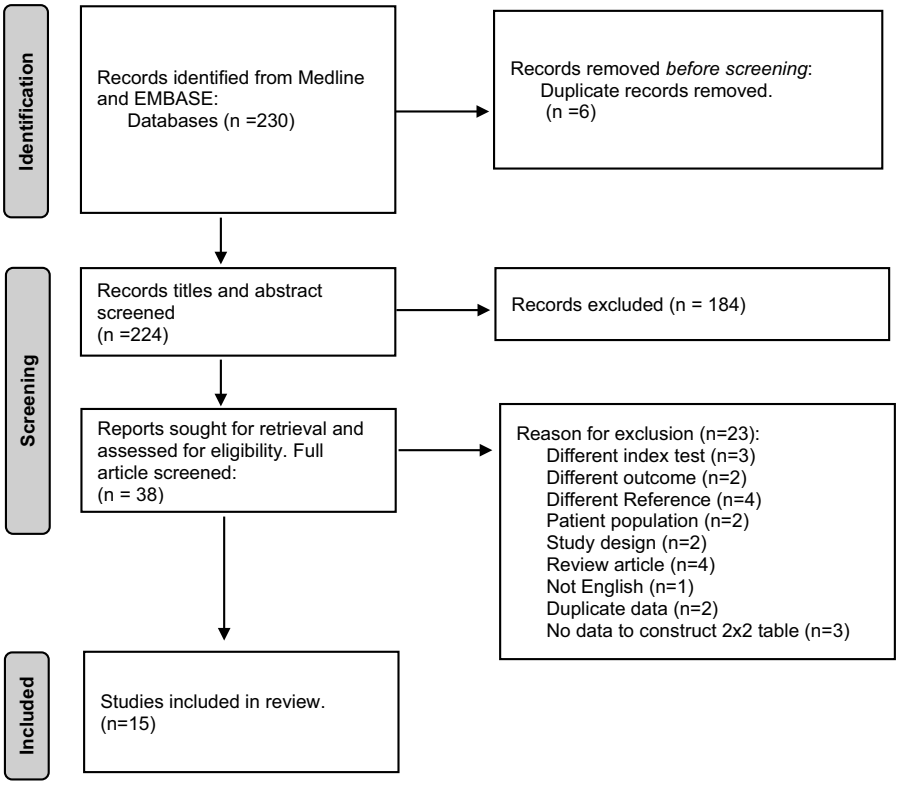

Figure 1. PRISMA flow diagram of the search and selection process for studies included in the meta-analysis.

Table 1. Characteristics of studies selected for data abstraction.

Author, year	Patient's country	Number of tests*	DVT prevalence %	Index test	Reference	Experience of physician performing the index test
Torres-Macho, 2012	Spain	76*	34	Two-point US	US done by radiologist	Attending
Abbasi, 2012	Iran	81	79	Three-point US (with Doppler)	Duplex US done by a 2nd-year radiology postgrad	EM resident
Crowhurst, 2013	Australia	178*	13	Three-point US	Duplex US done by radiologist (Doppler used if obese patient)	Attending
Poley, 2014	Canada	227	12	Two-point US	LC US done by radiologist or medical record review at 6 months in those who had no comprehensive LCUS	Attending + EM resident
Zitek, 2016	United States	385*	10	Two-point US	US done by radiologist	EM resident
Kim, 2016	United States	296	19	Three-point US (with Doppler)	LC US done by radiologist	Attending + EM resident
Pedraza-Garcia, 2017	Spain	109	54	Three-point US	US done by radiologist (with Doppler)	Attending
Zuker-Herman, 2018	Israel	195	26	Two- and three-point US	Duplex US done by radiologist	Attending + EM resident
Pujol, 2018	France	56	20	Two-point US	Duplex ultrasound done by a vascular certified practitioner.	Attending
Dehbozorgi, 2019	Iran	240	44	Three-point US	Duplex US done by radiologist	Attending + EM resident
Basaure, 2019	Chile	101	17	Three-point US	US done by radiologist with Doppler	Attending + EM resident
Jahanian, 2019	Iran	72	38	Three-point US (with Doppler)	US done by radiologist with Doppler	EM resident
Howland, 2019	Australia	100	10	Three-point US	Unclear	Attending
Elsenga, 2020	Netherlands	138	21	Two-point US (with Doppler)	rCUS done by radiologist	Attending + EM resident
Canakci, 2020	Turkey	266	26	Two-point US	US done by radiologist or venography	EM resident

Diagnostic assessment could be done per patients or per limb (*mark studies done per limb).
DVT, deep vein thrombosis; *US*, ultrasound; *ED*, emergency department; *LCUS*, limited compression ultrasound; *rCUS*, regional compression ultrasound; *EM*, emergency medicine.

available radiology department-performed DVT US as the reference standard. Lastly, pre-intervention training requirements for the EP operators varied greatly between studies, ranging from brief didactics to multi-day practical courses. Pre-existing experience was categorized as either completion of an emergency medicine (EM) postgraduate training program or by trainee status.

Primary Outcomes

Both the study-specific and pooled sensitivities, specificities, and respective 95% CIs are shown in Figure 2. Compared to the reference standard, the pooled sensitivity and specificity of the EP-performed US for diagnosis of DVT of the lower limb was 90% (95%, CI 82%–95%) and 95% (95%, CI 91%–97%), respectively. I^2 and Q-test statistics suggested significant heterogeneity between studies (Figure 2). The pooled positive and negative likelihood ratio for the same comparisons were, respectively, 19.1 (95%, CI 10.2–35.8) and 0.10 (95%, CI 0.06–0.19) (data not shown).

Subgroup Analyses and Meta-Regression

We performed exploratory meta-regression analyses with only one explanatory variable added to the model, considering the limited number of studies included. We assessed presence of bias, two-point vs three-point CUS, prior experience of the EP, prevalence of DVT reported (less than or greater than 30%), and sample size. The experience of the EP and increased prevalence of DVT in the sample were found to be significantly associated with improved sensitivity and specificity (meta-regression joint model $P = 0.01$ and

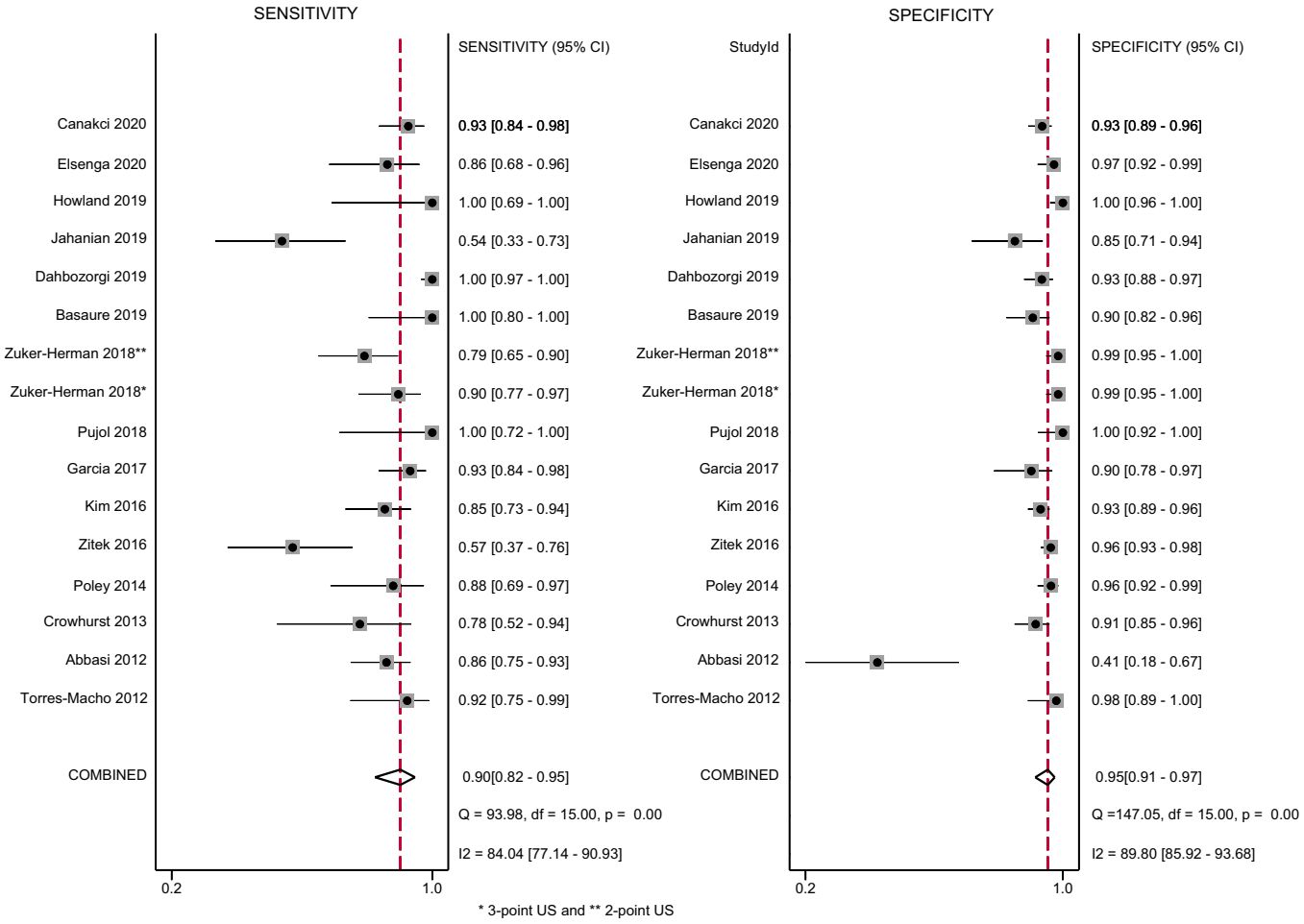

Figure 2. Forest plots of sensitivity and specificity of ultrasound performed by emergency physician for the diagnosis of lower extremities deep vein thrombosis (DVT).

0.05, respectively) (Figure 3). Trainee sensitivity was 77% vs 93% within the attending group. Specificity was 87% and 97%, respectively. The sensitivity of two-point and three-point CUS were 88% and 92%, respectively. When assessing for accuracy this was a non-statistically significant improvement ($P = 0.07$).

Heterogeneity was substantially reduced with respect to the pooled sensitivity and specificity for the studies including only specialist EPs. Given these findings, we performed further subgroup analysis on specialist EP-performed studies. Two-point CUS studies performed by specialist EPs had a pooled sensitivity of 88% compared to the 95% found for three-point CUS also performed by specialist EPs ($P = 0.02$). Specificity of US performed by EP specialist was not different when comparing two- to three-points US.

Quality Assessment

Based on the QUADAS-2 tool for assessment of the quality of the individual studies, there were concerns regarding the risk of bias (Figure 4). The aggregate risk of bias identified that 40% of studies were considered high or unclear risk of bias of patient selection due to the use of convenience, non-consecutive sampling. Concerns regarding high or unclear risk of biases related to the index test, the reference standard, blinding, or the flow and timing (of the index procedure relative to the reference test) were found in fewer than 30% of the studies included (Figure 4A). The rating of each individual study regarding the QUADAS-2 biases assessed is shown in Supplemental Table 1.

Sensitivity Analyses

We performed sensitivity analyses excluding studies[16,19,24–27] that were outliers based on model fitting and outliers' assessment. Pooled accuracy for the remaining 11 results was slightly lower, and heterogeneity reduced substantially (sensitivity 89%, 95% CI 85%–92%, and $I^2 = 27.8$; specificity 96%, 95%, CI 93%–97%, $I^2 = 60.3$). Lastly, analyses restricted to studies for which the risk of bias was considered low for all domains yielded similar pooled sensitivity and specificity (data not shown).

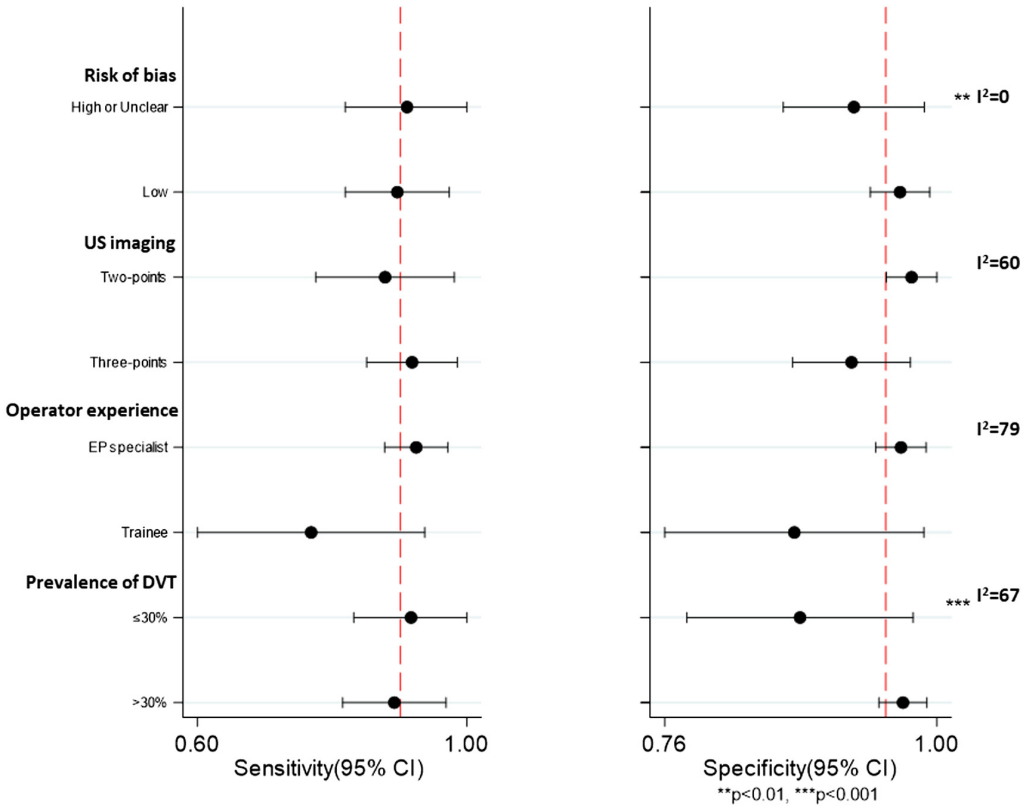

Figure 3. Subgroup analyses for sensitivity and specificity according to selected study characteristics. I^2 to assess heterogeneity and meta-regression *P*-values for differences in the accuracy within subgroups. The dotted line represents reference values obtained in the pooled sensitivity and specificity of all studies.
US, ultrasound; *EP*, emergency physician; *DVT*, deep vein thrombosis; *CI*, confidence interval.

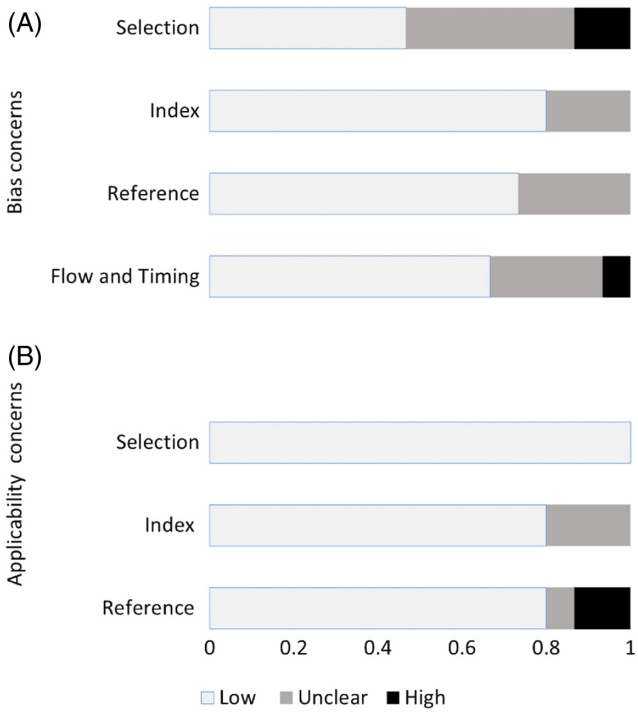

Figure 4. Aggregate assessment of individual study quality according to QUADAS-2 tool.

Updated Search

We performed a new literature search in late 2022. Only one new relevant study of 100 patients had been published since June 2021.[30] An exploratory analysis adding this study to the pool of 16 studies previously assessed showed no differences in the pooled results reported.

DISCUSSION

The diagnosis of DVT in the ED evolved from cumbersome tests performed outside the ED, such as impedance plethysmography and venography, to easily implemented POCUS that is mainstay training of current EM curriculum in the United States and some other countries.[31,32] Despite widespread use of POCUS, concerns persist regarding the accuracy of tests done in widely disparate EDs. An earlier quantitative systematic review of studies performed in the US yielded sensitivities greater than 95%.[33] However, as more diverse studies were published, a subsequent review demonstrated a more moderate pooled sensitivity close to 90%.[13] Both reviews demonstrated very high specificity. Unfortunately, to date all meta-analyses addressing this topic have been plagued by high levels of heterogeneity, a problem identified in a recent review by Lee.[12] No model has been proposed to reduce heterogeneity.

To our knowledge this is the first systematic review with a focus to maximize performance of ED-based DVT POCUS with recommendations on operator and technique. We identified trends explaining study variability as well as key biases within the literature. In this meta-analysis, using the most recent studies on the use of POCUS in EDs from multiple countries, we demonstrated a pooled sensitivity and specificity of 90% and 95%, respectively. These results are somewhat similar to prior systematic reviews on ED-based DVT POCUS. However, clinically significant variation in operator and scanning protocol existed in the subgroups examined.

General operator level of training (trainee/resident vs attending/fellow/specialist status) was an important predictor of performance with 77% sensitivity noted in the trainee group vs 93% in the specialist group. Specificity in these groups was 87% and 97%, respectively. This is in sharp contrast with training provided as part of the included studies. A quantitative analysis of training immediately pre-intervention was not possible due to lack of detailed information. With what has been reported, its effect on accuracy appears to be far less than general level of training/specialization. Completion of formal EM training pathway appears to have a strong effect on POCUS DVT US performance.

This review spans 10 nations from 2012-2022, representing different approaches to EM and ultrasound training and is, therefore, broadly applicable to contemporary practice. While specialty training is often country-specific,[34–36] most of these countries now include dedicated POCUS training as a mandatory requirement for EM specialist qualification with subspecialist US certification available as well. Ultrasound technique across all included countries tended to be similar, with a reliance on CUS of the proximal leg veins, in accordance with internationally published guidelines on the diagnosis of DVT.[32]

Another unsettled question for the EM application of POCUS for the diagnosis of DVT is whether three-point US is superior compared to the commonly implemented two-point examination. A 2018 radiologist consensus report recommends three-point rather than two-point CUS as a base requirement for diagnosis of DVT because three-point CUS detects isolated femoral vein thromboses that would otherwise be missed in 5%–8% of those with lower extremity DVT.[7] The study by Adhikari et al,[10] analyzing three years of radiology-performed CUS in the ED also found that three-point CUS detected an additional 6% of lower extremity DVT isolated to the femoral vein, without involvement of the common femoral vein or popliteal vein. Lastly, the study of Tabbut et al found a similar rate of isolated thrombi from a mix of POCUS and radiology-performed studies.[37]

One of this review's studies explored the sensitivity of two vs three-point US exams performed by trainees and specialists as a *within-patient* analysis. The sensitivity for the diagnosis of DVT increased by 7% by including the third site. These results are intuitive even in cases of non-isolated femoral vein thrombi. Scanning multiple sites reduces the probability of false negative scans as just a single positive finding is a requirement for diagnosis. Our pooled analysis of two-point vs three-point scanning yielded a 5% higher point estimate of sensitivity for the more comprehensive scan without loss in specificity, which is congruent with prior literature. The difference was not statistically significant with a P-value of 0.07. When limited to only specialist-performed exams, the difference was statistically significant ($P = 0.02$).

We found large reductions in heterogeneity in multiple subgroups when looking at studies of attending physician-performed POCUS. These include specialty trained EP-performed two-point and three-point scans and studies without high levels of bias. This implies a higher degree of confidence in the consistency of the intervention's performance in qualified hands. Subgroup analyses with prevalence below or above 30% yielded increased specificity for studies with prevalence above 30%. However, a 30% prevalence of DVT in the ED is unusually high and unexpected. Differences in patient inclusion criteria (Wells scoring and/or D-dimer) may have contributed to this effect. The potential effect of high prevalence of DVT on the diagnostic accuracy studies is yet to be confirmed.

LIMITATIONS

This meta-analysis has some limitations. First, because only 15 studies were identified, more complex analyses could not be performed. Furthermore, most studies contained elements of bias, especially related to patient selection; recruitment often occurred as a convenience sample, presumably selected by the ultrasound operator/clinician. Additionally, three studies included inconclusive results.[18,20,28] We followed best practices and made the decision to classify inconclusive cases as all positive or all negative depending on the clinical context.[38] Based on the study design reported by the authors, we categorized the inconclusive results as negative. A sensitivity analysis was conducted, and the limited number of inconclusive results are unlikely to affect the pooled results hereby reported.

Another limitation relates to the inability to better characterize the level of experience of the US operator due to limited detailed information on operator training (Supplemental Table 2). Lastly, restricting publications from 2012 to the present limited the number of studies and the power to assess potential subgroup differences. However, since 2012 formalized training in POCUS has been adopted as part of specialist training in most countries included in this review. Thus, we believe that this review's results are more generalizable to the broad EM population.

CONCLUSION

This meta-analysis of studies reported since 2012 demonstrated excellent performance of EM specialist-performed three-point point-of-care ultrasound for the diagnosis of deep vein thrombosis. Both the pooled sensitivity and specificity were 95%. We recommend that POCUS-trained attending EPs perform a three-point examination in the ED to effectively and accurately diagnose DVT. Future general studies on ED-based DVT POCUS are unlikely to modify these findings given the numerous existing studies of at least moderate quality. Future studies of rigorous methodology further addressing certain subgroups are recommended.

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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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User Experience of Access to Sexual Assault Nurse Examiner and Emergency Contraception in Emergency Departments in the United States: A National Survey

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Section Editor: Laura Walker, MD
Submission history: Submitted July 19, 2023; Revision received November 28, 2023; Accepted December 5, 2023
Electronically published February 28, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18405

Background: Despite the prevalence of sexual assault presentations to emergency departments (ED) in the United States, current access to sexual assault nurse examiners (SANE) and emergency contraception (EC) in EDs is unknown.

Methods: In this study we employed a "secret shopper," cross-sectional telephonic survey. A team attempted phone contact with a representative sample of EDs and asked respondents about the availability of SANEs and EC in their ED. Reported availability was correlated with variables including region, urban/rural status, hospital size, faith affiliation, academic affiliation, and existence of legislative requirements to offer EC.

Results: Over a two-month period in 2019, 1,046 calls to hospitals were attempted and 960 were completed (91.7% response rate). Of the 4,360 eligible hospitals listed in a federal database, 960 (22.0%) were contacted. Access to SANEs and EC were reported to be available in 48.9% (95% confidence interval [CI] 45.5–52.0) and 42.5% (95% CI 39.4–45.7) of hospitals, respectively. Access to EC was positively correlated with SANE availability. The EDs reporting SANE and EC availability were more likely to be large, rural, and affiliated with an academic institution. Those reporting access to EC were more likely to be in the Northeast and in states with legislative requirements to offer EC.

Conclusion: Our results suggest that perceived access to sexual assault services and emergency contraception in EDs in the United States remains poor with regional and legislative disparities. Results suggest disparities in perceived access to EC and SANE in the ED, which have implications for improving ED practices regarding care of sexual assault victims. [West J Emerg Med. 2024;25(2)291–300.]

Keywords: *emergency contraception; sexual assault nurse examiner; sexual assault.*

INTRODUCTION

The emergency department (ED) is an important point of entry for victims of rape, trafficking, and other forms of sexual and domestic violence. In the United States, sexual assault presentations to EDS increased by 1,533% from 2006 to 2019.[1] The current state of access to high-quality emergency sexual assault care in the US is unclear.

Sexual assault care in EDs in the US includes the need for forensic evidence collection. A directed approach to provide this specialized care is through the use of sexual assault nurse (or forensic) examiners (SANE)[2]; SANEs are registered nurses or clinicians who have completed a didactic and clinical curriculum approved by the International Association of Forensic Nurses or other certifying body.[3] They perform forensic sexual assault exams and evidence collection while meeting the medical, psychological, and educational needs of individuals requiring services.[4] Studies have demonstrated that SANEs provide more "humanizing" care than non-SANE emergency practitioners from the patient perspective,[5] more comprehensive and consistent medical services,[4] and more thorough forensic examinations to improve the criminal justice response to sexual assault.[6] Currently, there are over 450 SANE programs in the US, approximately 75% of which are affiliated with an ED.[3,4] However, no federal regulations dictate who can provide sexual assault care or oversee the quality of care for sexual assault victims, and requirements vary by state.[7] The state of national access to sexual assault care, including the knowledge of frontline health clinicians about accessibility, is unclear. Despite the effectiveness of SANE-led care,[4] significant disparities in access are believed to persist.[7,8]

In addition to SANE accessibility, emergency contraception (EC) is an important componenent of care after sexual assault, just as it is an important component of reproductive healthcare. Endorsed by leading medical organizations, EC is considered a safe and effective means of preventing pregnancy, including in cases of sexual violence.[9,10] Provision of EC is important in the care of survivors of abuse or domestic violence.[11] Access to EC in the ED is important both as a component of appropriate care for sexual assault and as a service for low-income individuals because cost remains a barrier for them. Indeed, the Affordable Care Act requires most private insurers and state Medicaid programs to cover prescription contraception but not EC.[12] In 2017, the national average price for trade-name, one-dose levonorgestrel was $49.48 and generic one-dose levonorgestrel was $38.74.[13] In addition to financial barriers, only 4.9% of pharmacies are open 24 hours per day/seven days per week.[14] Other potential barriers to patient access include refusal to dispense by pharmacists, misinformation due to personal religious beliefs, lack of clinician exposure, and social stigma.[15]

Population Health Research Capsule

What do we already know about this issue?
In 2005 an estimated 16% of emergency departments (EDs) in the US provided unrestricted access to emergency contraception (EC). Shifting legislation may have impacted access.

What was the research question?
What factors affect the user experience of seeking EC and sexual assault nurse examiner (SANE) care in US EDs?

What was the major finding of the study?
Access to SANE and EC were reported to be available in 48.9 (95% CI 45.5–52.0) and 42.5% (95% CI 39.4–45.7) of hospitals, respectively.

How does this improve population health?
Access to SANE care and EC in US EDs is low and with clear disparities. Results have implications for improving ED policies regarding care of sexual assault victims.

A 2005 study using a "mystery client" survey found that only an estimated 16% of EDs in the US provide access to EC without restriction.[16] However, there is reason to believe that access to EC in the ED has changed. The above study was performed prior to notable expansions in EC choices and access in the US. In 2006, the US Food and Drug Administration approved the over-the-counter sale of levonorgestrel to those ≥18 years of age, and then in 2013 expanded access to those ≥15 years.[17] New hormonal options have also become available.[18] Further, since 2005 14 states and the District of Columbia have required EDs to dispense EC to sexual assault victims upon request.[19] Current penalties include fines or suspension or revocation of hospital licensure[20]; however, the absence of strong enforcement mechanisms has correlated with decreased compliance rates.[21] One 2019 review of literature on EC provision in EDs in the US found that 60% had a policy on EC, 75% officially provided EC counseling, 44% officially offered EC, and 62% officially had EC available to dispense on site.[22] It is unknown how these statistic correlate with practice.

Most studies have examined access to SANE services and EC in the ED from the perspective of hospital personnel,

based on institutional policy, or prior to changes in EC legislation. The studies included only ideal cases rather than real-world conditions; those that used a "mystery client" approach showed lower rates of access.[16,22] Thus, studies conducted from the perspective of the patient or sexual assault victim are needed to define national access and ascertain potential discrepancies between predicted (ie, reported or previously published) and observed rates of access to SANE services and EC in the ED.

Given the recent rise in presentations of sexual assault in the US[1] and the role of the ED as a pivotal and time-sensitive point of access in cases of sexual violence, we sought to evaluate SANE and EC availability in EDs in the US from the perspective of a patient seeking to know the availability of care over the phone. Our survey addresses user experience, providing a pragmatic example of patient experiences when attempting to access sexual assault services and EC through the ED; this study also examines differences in perceived availability of these services on the basis of geographic and institutional factors.

MATERIALS AND METHODS

We sought to update the 2005 telephone-based, "secret shopper" study of hospitals across the US to investigate patient access to sexual assault care using the availability of SANE services and EC as a proxy for access to comprehensive services from the perspective of a prospective patient. To assess accessibility and perceived availability, we used the report of frontline healthcare workers likely to be the first point of contact for patients in the ED as the source of information regarding available services. We also sought to determine whether geographic and institutional factors were associated with reported access. Moreover, given the influence of graduate medical education programs on institutional resources, we sought to determine whether teaching status improved access. Our study included a demographic evaluation based on size, rural vs urban setting, teaching status, and faith-based status of hospitals.

We obtained a list of EDs in the US from a publicly available database of the Centers for Medicare & Medicaid Services (CMS) in March 2019. This database consisted of 4,806 hospitals. Exclusion criteria included federal institutions, children's hospitals, tribal hospitals, hospitals without EDs, and hospitals located in US territories. Of the remaining eligible 4,360 hospitals, 25% were randomly selected and stratified by region (Northeast, South, West, and Midwest; see Table S1 for the list of states per region) and by teaching status. We aimed to survey greater than 20% of eligible hospitals with 21% representation of teaching institutions, which was the proportion of teaching institutions in the overall cohort. Hospitals were classified as teaching hospitals on the basis of their registration with the CMS. Each regional sample was checked to ensure representation of hospitals classified as having teaching status. In general, for every three non-teaching institutions, one teaching institution existed in the analysis within each region.

For the analysis, hospitals were classified by region and state as small (<100 beds), mid-sized (100–200 beds), or large (>200); as urban (population ≥50,000) or rural (population <50,000); as academic or non-academic; as faith- or non-faith-based; and by the presence of a state legislative requirement to offer EC to sexual assault victims. A team of five women investigators simulating potential patients called publicly available ED phone numbers for each hospital between June–September 2019, seeking EC as described by Harrison et al.[16] Callers contacted the ED seeking medical advice and asked about EC and SANE access. The respondent would either provide the response or transfer the call to a more knowledgeable member of the medical staff including advanced practice providers and physicians.

Callers received structured training with standardized scripts, which were then calibrated through a series of simulated calls. In addition, 5% of calls were screened for fidelity and to ensure standardization by completing a series of observed call encounters. The phone numbers of the callers were concealed, and the time of the day and day of the week was recorded; calls took place during normal business hours (ie, 9 AM-5 PM). Callers first asked about access to EC and then asked if it was available in the case of sexual assault. They then asked whether a SANE was available. This script was modeled on the protocol of the most recent survey of EC access.[16] Following the first 5% of calls, the script was revised and standardized for increased fidelity in data collection. Revisions included minor changes in wording and order of questions.

Primary outcomes were reported access to SANEs and EC in the ED. A SANE was considered available if the respondent reported that a SANE was on site or could be on site within six hours. A SANE was considered not available if respondents were told there were no SANEs available within six hours. We defined EC access as full, conditional, or no access. Full access included hospitals that reported that they had available EC with no restriction. Conditional access was defined as hospitals that reported that they provided EC only in the circumstance of sexual assault; and no access was defined as hospitals that reported an absence of EC provision under any conditions or if the caller was referred to an outpatient pharmacy for access. Secondary outcomes included type of EC options available, alternative methods of obtaining EC, access to referral to alternative healthcare systems, and access to sexual assault resources. As we sought to pragmatically imitate the experience of a prospective patient calling the ED, callers did not ask for the qualifications of respondents, nor did they ask to be transferred to a physician or nurse, although they took such transfers if they were offered. They recorded the first definitive response they received from any staff member.

We managed all study data in Research Electronic Data Capture v 9.11, hosted at the University of Florida. Statistical analyses were performed using SAS v 9.4 (SAS Institute, Inc, Cary, NC). We initially used descriptive statistics, including means, medians, frequencies, and proportions, to examine survey response representation, variable distribution, and missingness where appropriate. We calculated exact confidence intervals (CI) using the Clopper–Pearson method. Unadjusted and adjusted logistic regression models were used to evaluate the relationship between hospital characteristics and outcomes. We performed an unconditional hierarchical logistic regression model, where EDs were nested in respective states, to assess the predicted probability of an ED providing EC for each state. Each state was added as a random effect.

This study received approval for exemption from the University of Florida Institutional Review Board prior to initiation.

RESULTS

Between July 2–September 5, 2019, callers attempted to call 1,046 hospitals and completed 960 calls (91.7% response rate). Eighty-six of the calls (8.2%) failed due to the following reasons: failure to contact (25, 2.3%); refusal to answer questions (13, 1.2%); hospital closure (20, 1.9%); no ED (7, 0.6%), or another unclassified reason (21, 2%). The Figure illustrates the flow of hospital inclusion or exclusion through the study. Table 1 presents the characteristics of the 960 hospitals that were successfully surveyed. (See Table S2 for the breakdown of number of hospitals by state.) Sexual assault nurse examiners were reported to be available in 48.9% of the 960 hospitals surveyed (Table 2).

After adjusting for covariates, the following factors were independent predictors of SANE access: region; EC access; size of hospital; academic status; and urban status (Table 3). See unadjusted comparisions in Table S2). Region was associated with reported SANE access, with hospitals in the Northeast being 4.00 times more likely (95% CI 2.38–7.14), 2.78 times more likel (95% CI 1.59–4.76), and 2.00 times more likely (95% CI 1.19,–3.33) to have SANE access than hospitals in the South, West, and Midwest, respectively (Table 3). Reported EC access in cases of sexual assault was also associated with SANE presence, with employees at these hospitals 3.94 times more likely (95% CI 2.66–5.83) to report

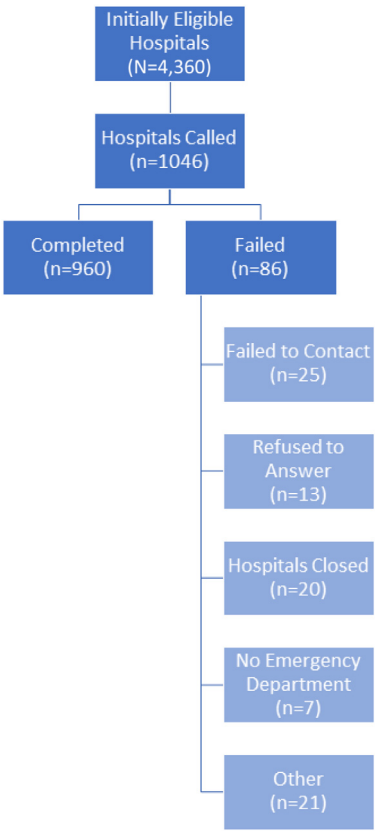

Figure. Standards for Reporting of Diagnostic Accuracy diagram reporting flow of participants through the study.

Table 1. Hospital characteristics of study sample.

Hospital characteristics	Total (N = 960)	95% CI
Region – n (%)		
Northeast	122 (12.7)	10.7–15.0
Midwest	284 (29.6)	26.7–32.6
South	369 (38.4)	35.4–41.6
West	185 (19.3)	16.8–21.9
Urban–rural status – n (%)		
Urban area	319 (33.2)	30.3–36.3
Rural area	641 (66.8)	63.7–69.8
Size of hospital – n (%)		
Small	469 (48.9)	45.7–52.1
Medium	203 (21.2)	18.6–23.9
Large	288 (30.0)	27.1–33.0
Number of beds – mean ± sd	170.5 ± 206.3	157.4–183.5
Faith-based status – n (%)		
Faith based	173 (18.0)	15.6–20.6
Non-faith based	787 (82.0)	79.4–84.4
Hospital type – n (%)		
Academic	237 (24.7)	22.0–27.5
Non-academic	723 (75.3)	72.5–78.0
State requirement if SA – n (%)		
In-state requiring dispense	284 (29.6)	26.7–32.6
Not required to dispense	612 (63.8)	60.6–66.8
No state law (Ohio and Pennsylvania)	64 (6.7)	5.2–8.4

CI, confidence interval; *SA*, sexual assault.

Table 2. Emercency contraception survey response by hospital sample.

Survey responses (N = 960)	Frequency (%)	95% CI
EC Access		
Full access*	215 (22.4)	19.8–25.2
No access	551 (57.4)	54.2–60.5
Conditional access**	193 (20.1)	17.6–22.8
Contraception options (if available, n = 408)		
Levonorgestrel (Plan B)	196 (48.0)	43.1–53.0
Ulipristal (Ella)	6 (1.5)	0.5–3.2
IUD	0 (0.0)	0.0–0.0
Don't know	216 (52.9)	48.0–57.9
Method of obtaining EC (if available, n = 408)		
Physician decision	256 (62.7)	57.9–67.5
Pregnancy test	12 (2.9)	1.5–5.1
Pelvic exam	26 (6.4)	4.2–9.2
Don't know	87 (21.3)	17.4–25.6
Other	62 (15.2)	11.9–19.1
Access to referrals (if EC not available, n = 551)		
Yes	341 (61.9)	57.7–66.0
No	207 (37.6)	33.5–41.8
Access to sexual assault resources		
Yes	653 (68.0)	65.0–71.0
No	281 (29.3)	26.4–32.3
Don't know	23 (2.4)	1.5–3.6
Access to SANEs		
Yes	468 (48.9)	45.5–52.0
No	458 (47.8)	44.5–50.9
Don't know	32 (3.3)	2.3–4.7

*Full access values are hospitals that answered yes to having EC when initially asked.
**Conditional access values are hospitals that responded no to having EC available initially, but yes when sexual assault was reported.
CI, confidence interval; *EC*, emergency contraception; *IUD*, intrauterine device; *SANE*, sexual assault nurse examiner.

having SANEs when compared to those at hospitals without reported EC access (Table 3).

Mid-sized and large hospitals were 2.96 (95% CI 1.72–5.11) and 2.43 (95% CI 1.63–3.61) times more likely, respectively, to report having SANE access than small hospitals. Prior to adjusting for covariates, it appeared as though urban hospitals were more likely to report having SANE access (1.39 times more likely, Table 3). In the adjusted model, however, rural hospitals were 1.48 times more likely (95% CI 1.00–2.20) to report having SANEs, illustrating a reversal of the association with hospital size acting as the qualitative confounder (Table 3). Faith-based and non-faith-based hospitals reported having SANEs available at similar rates of 51.7% and 48.2%, respectively (Table 3). Academic hospitals were 2.18 times per likely (95% CI 1.42–3.34) to report having SANE access than non-academic hospitals (Table 3).

Of the 960 hospitals included, 551 (57.4%) reported no access to EC. Of the 408 (42.5%) reporting EC access, 215 (22.4%) had full access, and 193 (20.1%) had conditional access (Table 2). Of the 551 hospitals with no access, 341 (61.9%) had a referral system to obtain EC. Of the 408 hospitals with reported EC access, 196 (48.0%) prescribed levonorgestrel, six (1.5%) prescribed ulipristal acetate, and 216 (52.9%) of respondents did not know the available options. No hospitals reported the copper intrauterine device (IUD) as an option. The majority of respondents told callers that EDs leave EC provision to the discretion of the physician (62.7%), 2.9% require a pregnancy test, and 6.4% require a pelvic examination (Table 2). Nationally, the predicted probability of a respondent reporting that their hospital did not provide any EC in the ED was 55.2% (Table S3).

Massachusetts, Oregon, New Jersey, New York, Washington, and Wisconsin had a significantly greater predicted probability of reported EC access in EDs than the national average, while Florida, California, Kansas, Louisiana, Texas, and Nebraska had a significantly lower chance of having EC than the national average (Table S3). The presence of a state requirement to prescribe EC for sexual assault victims was the second strongest predictor of EC access (following region), at 2.27 times more likely (95% CI 1.59–3.22). Additionally, rural hospitals were 1.65 times more likely (95% CI 1.11–2.44) than urban hospitals to have any EC access, and academic hospitals were 1.58 times more likely (95% CI 1.05–2.39) t than non-academic hospitals to have any EC access (Table 4; see unadjusted comparisions in Table S4).

After adjusting for covariates, reported EC access was associated with hospital region, urban status, academic status, and state requirement in cases of sexual assault (Table 4). After excluding hospitals with reported conditional access in cases of sexual assault, faith-based status became an additional independent predictor, while the association between academic status and EC access was no longer significant (Table 5).

DISCUSSION

Globally, rates of sexual assault, gender-based violence, and human trafficking for sexual exploitation remain high, and access to appropriate care following a sexual assault remains marked by sharp disparities.[23–25] Similarly, our study suggests that there is inconsistent access to SANEs and

Table 3. Unadjusted and adjusted odds ratios of access to a sexual assault nurse examiner by hospital characteristics (available vs not available).

Hospital characteristics	Unadjusted model OR (95% CI)	Adjusted model OR (95% CI)
Region		
Northeast	Ref	Ref
Midwest	0.43 (0.27–0.69)	0.50 (0.30–0.84)
South	0.26 (0.16–0.40)	0.25 (0.14–0.42)
West	0.35 (0.21–0.57)	0.36 (0.21–0.63)
Urban–rural status		
Urban area	Ref	Ref
Rural area	0.72 (0.55–0.95)	1.48 (1.00–2.20)
Size of hospital		
Small	Ref	Ref
Medium	2.26 (1.61–3.19)	2.96 (1.72–5.11)
Large	2.76 (2.03–3.76)	2.43 (1.63–3.61)
Number of beds (per 250 increase)	1.49 (1.24–1.80)	0.91 (0.70–1.18)
Faith-based status		
Non-faith based	Ref	Ref
Faith based	1.16 (0.83–1.63)	1.01 (0.70–1.46)
Hospital Type		
Non-academic	Ref	Ref
Academic	2.87 (2.08–3.96)	2.18 (1.42–3.34)
State requirement if SA		
In-state requiring dispense	Ref	Ref
Not required to dispense	0.65 (0.49–0.87)	0.95 (0.66–1.38)
No state law (Ohio and Pennsylvania)	1.42 (0.81–2.52)	0.81 (0.42–1.53)
EC access		
No access	Ref	Ref
Full access*	2.87 (2.05–4.00)	2.33 (1.62–3.34)
Conditional access**	4.82 (3.33–6.97)	3.94 (2.66–5.83)

OR, odds ratio; *CI*, confidence interval; *SA*, sexual assault; *EC*, emergency conception.

EC in EDs across the US. While this study does not establish the distribution of absolute access, our methodology provides a pragmatic depiction of the patient experience when attempting to access sexual-assault services and EC through an ED. This picture reflects stark disparities in access as well as overall low levels of access to SANEs and EC nationally. Our findings highlight the difference between policy and practice, which may be influenced by bias, lack of knowledge of policy by clinicians, and other factors.

Roughly half of the EDs surveyed reported that they could not provide SANEs for sexual assault victims on site within six hours, and responders in the South were twice as likely not to know whether there was a SANE available. This finding is in contrast to other studies conducted in the Southeastern US that relied on clinician and administrator surveys, which found that access to SANE and EC was consistent with the standard of care.[26] It is, therefore, unclear whether this regional difference represents true availability or a gap in the education of frontline emergency clinicians in the southern US.

Larger academic institutions were more likely to have a SANE available, possibly because for those institutions it was less of a financial burden. The cost to develop a SANE program can be up to $40,000.[27] According to the International Association of Forensic Nursing (IAFN), only 1,200 IAFN-certified SANEs for adults and adolescents are available internationally.[28] As a result, disparities in access are likely, and although the reasons are not well studied, they likely include a number of variables such as high costs, limited training opportunities, and a lack of supportive

Table 4. Unadjusted and adjusted odds ratios of emergency contraception access by hospital characteristics (any access* vs no access).

Hospital characteristics	Unadjusted models OR (95% CI)	Adjusted model OR (95% CI)
Region		
Northeast	Ref	Ref
Midwest	0.31 (0.20–0.50)	0.39 (0.24–0.65)
South	0.16 (0.10–0.26)	0.25 (0.15–0.43)
West	0.32 (0.20–0.53)	0.33 (0.19–0.57)
Urban–rural status		
Urban area	Ref	Ref
Rural area	1.05 (0.80–1.37)	1.65 (1.11–2.44)
Size of hospital		
Small	Ref	Ref
Medium	1.31 (0.94–1.84)	1.35 (0.91–2.00)
Large	1.59 (1.81–2.15)	1.60 (0.93–2.73)
Number of beds (per 250 increase)	1.18 (1.01–1.39)	1.07 (0.83–1.38)
Faith-based status		
Non-faith based	Ref	Ref
Faith based	0.91 (0.65–1.28)	0.90 (0.62–1.30)
Hospital type		
Non-academic	Ref	Ref
Academic	1.67 (1.25–2.25)	1.58 (1.05–2.39)
State requirement if SA		
In-state requiring dispense	Ref	Ref
Not required to dispense	0.33 (0.25–0.45)	0.44 (0.31–0.63)
No state law (Ohio and Pennsylvania)	0.93 (0.54–1.62)	0.55 (0.30–1.02)

Any access* includes hospitals with full access** or conditional access***.
Full access** values are hospitals that answered yes to having emergency contraception available when initially asked.
Conditional access*** values are hospitals that responded no to having EC available initially, but yes when sexual assault was reported.
OR, odds ratio; *CI*, confidence interval; *SA*, sexual assault.

resources, particularly in already underserved areas.[29] Our results, in combination with the increase in the number of sexual assault patients being seen in the ED,[1] highlight the need for hospitals to be prepared with properly trained staff to treat this patient population. One possible solution to the cost of SANE services for individual hospitals is to regionalize resources.

In the unadjusted model, rural hospitals appeared less likely to have SANEs available; however, once adjusted for hospital size, rural hospitals were more likely to report having a SANE. This is contrary to previous research in Pennsylvania, Washington, and Oregon, which demonstrated that programs in rural areas were lacking in SANEs and facilities, resulting in urban programs absorbing patients from underserved areas,[7,8] This may be a result of the availability of sexual assault resources outside the ED in urban areas, or of the centralization of SANEs at a single hospital in an urban center. If the results of this study represent access to SANEs, rather than a lack of knowledge among frontline healthcare practitioners, there is a strong disparity in SANE access for sexual assault patients based on region and hospital size. This disparity may affect the quality of counseling and forensic evidence collection based on the location of the hospital, which could have legal ramifications for victims as hospitals in different locations may not equally facilitate the collection of high-quality evidence in cases of sexual assault.

Only 22.4% of ED frontline healthcare practitioners reported that they provide EC without restriction; furthermore, an additional 20.1% reported that they provided EC only in cases of sexual assault. Our results align with those reported by Harrison et al in 2005, with a minority (31.5%) of surveyed EDs found to provide EC.[16] The poor access to EC found in this study may in part reflect increased access to alternative resources, such as over-the-counter EC at pharmacies or women's specialty clinics. The low rate of access reported by ED personnel may also be due to lack of knowledge of hospital policies regarding EC among frontline

Table 5. Unadjusted and adjusted odds ratios of full emergency contraception access by hospital characteristics (full access* vs no access).

Hospital characteristics	Unadjusted models OR (95% CI)	Adjusted model OR (95% CI)
Region		
Northeast	Ref	Ref
Midwest	0.22 (0.13–0.37)	0.32 (0.18–0.59)
South	0.14 (0.08–0.23)	0.23 (0.12–0.45)
West	0.30 (0.18–0.54)	0.33 (0.18–0.63)
Urban–rural status		
Urban area	Ref	Ref
Rural area	1.14 (0.81–1.60)	1.74 (1.05–2.87)
Size of hospital		
Small	Ref	Ref
Medium	1.34 (0.75–1.72)	1.11 (0.67–1.82)
Large	1.42 (0.99–2.04)	1.28 (0.67–2.46)
Number of beds (per 250 increase)	1.16 (0.97–1.39)	1.16 (0.86–1.55)
Faith-based status		
Non-faith based	Ref	Ref
Faith based	0.45 (0.27–0.75)	0.44 (0.25–0.76)
Hospital type		
Non-academic	Ref	Ref
Academic	1.61 (1.12–2.30)	1.67 (0.99–2.82)
State requirement if SA		
In-state requiring dispense	Ref	Ref
Not required to dispense	0.32 (0.22–0.45)	0.42 (0.27–0.67)
No state law (Ohio and Pennsylvania)	0.93 (0.54–1.62)	0.54 (0.25–1.14)

Full access* values are hospitals that answered yes to having emergency contraception when initially asked.
OR, odds ratio; *CI*, confidence interval; *SA*, sexual assault.

ED staff, especially about costs and barriers associated with these alternative resources.[27] Similar to what Harrison et al reported, respondents in our study frequently provided incorrect or misguided comments regarding EC. Several respondents referred to EC as an "abortion pill," possibly mifepristone, or a hysterectomy during the phone call. According to the ED non-physician practitioners surveyed, 63% of EC provision was based on individual physician discretion, which is not required in many states.

Studies have demonstrated that less than 50% of victims of sexual assault seek medical attention. While the reasons are multifactorial, it is clear that victims experience serious psychosocial and emotional stress that may contribute to a reluctance to be subject to additional scrutiny, loss of privacy, or invasive examinations.[30] In our survey, many reported that EC was dispensed only following a physician assessment, which would include a pelvic examination. Many respondents in our study stated that their ED did not take sexual assault cases and that the patient would need to be transferred to another facility or seek guidance from law enforcement.

Few respondents provided the specific brand of EC available, and none offered the copper IUD as an option. Many respondents commonly referred patients to private pharmacies for EC, a problematic practice given coverage of costs and potential logistical difficulties and delays. Importantly, the referral of those seeking EC to private pharmacies limits access to consultation on sexually transmitted disease, behavioral health, or the opportunity to report to law enforcement in the case of victims of sexual assault, domestic violence, or trafficking. These findings underscore the need for increased training for healthcare practitioners responsible for triage and response to inquiries.

In states with legislation requiring access to EC in cases of sexual assault, EDs were more than twice as likely to report that EC was available without restriction, demonstrating that such legislation may have an impact. With current enforcement mechanisms in place for only 13 states, there is room for expansion of legislation to cover the remaining states.

Perhaps unexpectedly, EC was more likely to be available in rural hospitals after adjusting for covariates. Rural

hospitals often serve as critical access points for remote or underserved communities. Non-faith-based hospitals were more than twice as likely to report providing EC than faith-based hospitals, consistent with a previous study in which non-Catholic hospitals were more likely to provide EC than Catholic hospitals.[21] This finding may be based on local institutional policies limiting access among faith-based institutions.

There is a need for improved education on sexual assault care, as well as an increase in SANE access among hospitals. Hospitals should consider building SANE resources into ED protocols. Hospital administrators can collaborate with local rape crisis centers or apply for federal grants or funding to defray the cost of training and supplies.

LIMITATIONS

The primary limitation of this study was the inconsistency in knowledge of protocols related to this topic and willingness to provide accurate information over the telephone. It is plausible that callers would have received different information had the encounter been in person. However, a phone protocol was specifically chosen as a pragmatic approach used by a potential member of the community seeking services.

The specific inquiry regarding sexual assault rather than the initial request for EC may have influenced the respondent's response regarding resources and access. Respondents in this study may have been more motivated to find an answer to questions when the topic of sexual assault was introduced. For example, some respondents who stated EC was not available changed their response upon the callers' disclosure that there had been a sexual assault. When respondents endorsed SANE access, callers did not record on-site availability, nor the hours when access was available. Call timing was varied randomly between 9 AM–5 PM but was not standardized. In addition, as many sexual assaults present outside normal working hours, it is possible that the availability could be even lower during off-hours.

CONCLUSION

Access to emergency contraception and sexual assault nurse examiners in EDs remains limited with disparities in access across the nation. Variable accessibility depending on the geographic location of the hospital or the legislative status of the state suggests that those seeking these resources might receive substandard quality of healthcare depending on the institution where they have chosen to seek care. Given the importance of EC and sexual assault services, emergency physicians may find it worthwhile to examine their hospitals' existing protocols regarding dispensing prescriptions of these medications and availability of SANEs. Hospitals should consider providing training for all ED staff, especially those who first interact with patients, to prevent misinformation about patient access to EC or SANEs.

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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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Factors Associated with Overutilization of Computed Tomography Cervical Spine Imaging

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Section Editor: Mark Langdorf, MD, MHPE
Submission history: Submitted November 12, 2023; Revision received November 12, 2023; Accepted December 8, 2023
Electronically published February 28, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18570

Dear Editor:

We are writing to provide some comments on the scientific paper recently published in your journal titled "Factors Associated with Overutilization of Computed Tomography of the Cervical Spine."[1]

Firstly, we commend the authors for putting together a relevant and well-done multicenter study that both revalidates the NEXUS criteria and offers insight into the overutilization of computed tomography (CT) for traumatic injuries. However, we do have some concerns about the methodology used. Having a single reviewer collecting chart data on NEXUS criteria—criteria that we know include the subjective component of a distracting injury or deficit not attributable to pain—introduces the possibility of bias; it would, therefore, be beneficial to see congruence of chart analysis between different reviewers. It is also recognizable that there were timing constraints related to feasibility, thus allowing for only one person to review each chart for the presence of NEXUS criteria. The process involved combing through more than 800 individual records that included physician documentation, imaging, lab studies, and nursing notes. This added significantly to the workload of the single reviewer, which could have impacted the overall accuracy of the data collected. Additionally, it was unclear whether the reviewer was blind to the result of the CT when reviewing the chart, opening up further opportunities for bias.

Secondly, the short time frame in this case linked to skiing/winter sports-related injuries may provide only a partial picture, limiting the applicability of results. Imagine the study had been conducted for longer than two months outside the winter season. Would there be additional variables regarding the mechanism of injury associated with the overutilization of CT imaging not otherwise uncovered in their initial review? Additionally, the baseline characteristics for the presenting mechanism of injury included falls, which constituted approximately 75% of the total number. Further characterization of the mechanism of injury may also have been beneficial—fall from standing vs from a height, or motor vehicle collision with airbag deployment vs without—could all reveal associations of injury that would cause physicians to bypass the NEXUS criteria altogether.

Future studies should look to investigate whether a physician-in-triage structure is associated with increased CT overutilization. We are seeing more protocols being implemented in emergency medicine, including within the triage process, and it would, therefore, be interesting to see how this alternate workflow would affect results.

Overall, we found the authors' study to be extremely informative, and we appreciate their contribution to the ever evolving and highly challenging field of emergency medicine.

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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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Reply to "Factors Associated with Overutilization of Computed Tomography Cervical Spine Imaging"

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Section Editor: Mark Langdorf, MD, MHPE
Submission history: Submitted December 5, 2023; Revision received December 5, 2023; Accepted December 8, 2023
Electronically published February 28, 2024
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.18614

November 29, 2023
Dear Editor:

We appreciate the feedback and commentary on our recently published study. First, we would like to acknowledge the limitations of having a single reviewer performing all chart reviews. To mitigate potential bias, we created objective binary definitions for each NEXUS criterion. For example, we explicitly defined distracting injuries to include only radiographic findings of long bone fractures or multiple rib fractures, or any injuries that were described explicitly as "distracting" in the clinical documentation. Similarly, all documented neurological deficits were assumed to fulfill this criterion unless the clinical documentation explicitly ascribed the deficit to pain. While these definitions are more explicit and objective than the original NEXUS criteria, we felt this modification was necessary due to the retrospective nature of our study, as our methodology inherently prohibited us from prospectively asking clinicians whether an injury was distracting, for example. Furthermore, we felt that our definitions were aligned as closely as possible to the original criteria and, therefore, provided an accurate estimation of overutilization. Ideally, future studies on the topic should use multiple reviewers and prospectively collect data on the subjective criteria.

Secondly, we agree that a more granular analysis of mechanisms of injury could reveal additional associations with overutilization. In our analysis, none of the mechanisms of injury were significantly associated with CT overutilization, and seasonal mechanisms accounted for a very small percentage. Our categorization of mechanism was intentionally broad, as we sought to identify potentially meaningful targets for future interventions aimed at reducing overutilization. While it is possible that a subset of mechanisms within a given category could be statistically significant, this would require further investigation, and it is not clear whether those findings would yield clinically important targets for intervention.

Lastly, and most importantly, we would like to emphasize the letter writer's point about flow and triage processes that may affect overutilization of CT resources. Because none of the sites included in this study use a clinician-in-triage process, we were unable to directly assess this association from our dataset. However, strategies to improve emergency department (ED) throughput (eg, clinician-in-triage staffing models, direct-to-CT protocols, nurse-initiated orders) have proliferated across the country in recent years, despite these strategies having uncertain impacts on resource overutilization. As we develop and implement novel flow and triage processes, it is paramount that we consider the secondary effects on healthcare costs, radiation exposure, incidental findings, and hospital resources. At a time when ED crowding and boarding have reached crisis levels, effective resource utilization is essential for operational success.

Thank you.

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