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This special issue will highlight the proceedings from the 2019 SAEM annual meeting* relevant to education and training. In addition to the standard manuscript types, conceptually-based white papers—submitted by SAEM academy, committee, and interest group members that share cutting edge ideas and concepts unique to their areas of expertise—with an emphasis on education and training in emergency medicine—will be accepted.

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Conceptually based papers for this special issue of AEM E&T will seek to develop a fuller understanding of emergency medicine education and training by building on existing knowledge. A conceptual model explains facts of events in a way that increases understanding. This should be more than a basic introduction to a topic. The structure of a conceptual paper includes:

1. Introduction of the topic and review of previously published work
2. Methodology used to develop manuscript and how writing group was identified committee objective, task force work, etc.
3. Unique treatment, analysis, or critique of the current state of knowledge on the topic
4. Implications for education and training in emergency medicine.
5. References

Manuscripts can be no longer than 5000 words excluding abstract. Conceptually based papers must contain two tables and no more than five. Manuscripts should include a minimum of five references. See section entitled “Original Contributions and Brief Contributions” in the AEM E&T Author Instructions, for specific guidelines for tables, figures and references.

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CME Information: A Multifaceted Intervention Improves Prescribing for Acute Respiratory Infection for Adults and Children in Emergency Department and Urgent Care Settings

CME Editor: Corey Heitz, MD

Authors: Kabir Yadav, MDCM, MS, MSHS, Daniella Meeker, PhD, Rakesh D. Mistry, MD, MS, Jason N. Doctor, PhD, Katherine E. Fleming-Dutra, MD, Ross J. Fleischman, MD, MCR, Samuel D. Gaona, Aubyn Stahmer, PhD, and Larissa May, MD, MSPH, MSHS

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Educational Objectives
After reading the article, participants should be able to discuss the effectiveness of two antibiotic stewardship interventions for use in cases of acute respiratory infection.

Activity Disclosures
This activity received no commercial support.

CME Editor Corey Heitz discloses no relevant financial relationships.

This activity underwent peer review in line with standards of editorial integrity and publication ethics. Conflicts of interest have been identified and resolved in accordance with John Wiley and Sons, Inc.’s Policy on Activity Disclosure and Conflict of Interest.

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A Multifaceted Intervention Improves Prescribing for Acute Respiratory Infection for Adults and Children in Emergency Department and Urgent Care Settings

Kabir Yadav, MDCM, MS, MSHS, Daniella Meeker, PhD, Rakesh D. Mistry, MD, MS, Jason N. Doctor, PhD, Katherine E. Fleming-Dutra, MD, Ross J. Fleischman, MD, MCR, Samuel D. Gaona, Aubyn Stahmer, PhD, and Larissa May, MD, MSPH, MSHS

ABSTRACT

Background: Antibiotics are commonly prescribed during emergency department (ED) and urgent care center (UCC) visits for viral acute respiratory infection (ARI). We evaluate the comparative effectiveness of an antibiotic stewardship intervention adapted for acute care ambulatory settings (adapted intervention) to a stewardship intervention that additionally incorporates behavioral nudges (enhanced intervention) in reducing inappropriate prescriptions.

Methods: This study was a pragmatic, cluster-randomized clinical trial conducted in three academic health systems comprising five adult and pediatric EDs and four UCCs. Randomization of the nine sites was stratified by health system; all providers at each site received either the adapted or the enhanced intervention. The main outcome was the proportion of antibiotic-inappropriate ARI diagnosis visits that received an outpatient antibiotic prescription by individual providers. We estimated a hierarchical mixed-effects logistic regression model comparing visits during the influenza season for 2016 to 2017 (baseline) and 2017 to 2018 (intervention).

Results: There were 44,820 ARI visits among 292 providers across all nine cluster sites. Antibiotic prescribing for ARI visits dropped from 6.2% (95% confidence interval [CI] = 4.5% to 7.9%) to 2.4% (95% CI = 1.3% to 3.4%) during the study period. We found a significant reduction in inappropriate prescribing after adjusting for health-system and provider-level effects from 2.2% (95% CI = 1.0% to 3.4%) to 1.5% (95% CI = 0.7% to 2.3%) with an odds ratio of 0.67 (95% CI = 0.54 to 0.82). Difference-in-differences between the two interventions was not significantly different.

Conclusion: Implementation of antibiotic stewardship for ARI is feasible and effective in the ED and UCC settings. More intensive behavioral nudging methods were not more effective in high-performance settings.
Inappropriate use of antibiotics exposes patients to the risk of opportunistic infections and other adverse drug events. It also is an accelerant to the natural selection of antibiotic-resistant bacteria, which kill an estimated 23,000 Americans every year. Encouraging judicious prescribing of antibiotics in emergency departments (EDs) and urgent care centers (UCCs) is necessary in addressing the crisis of emerging antibiotic resistance. Each year 10 million antibiotic prescriptions are written from EDs alone; approximately 5 million of these prescriptions are inappropriate. Given strong evidence, well-established guidelines, and national calls to address antibiotic resistance, strategies are needed to reduce inappropriate antibiotic use in ED and UCC settings.

Despite EDs and UCCs being recognized as important sites for antibiotic stewardship, these programs have had limited success in these settings. Providers in ED and UCC settings are faced with challenges to rational decision making in their day to day practice such as frequent interruptions, the need to see high volumes of patients per hour, boarding and overcrowding, the need to make rapid decisions with limited diagnostic data, frequent handoffs between providers, and concerns with patient satisfaction scores. ED and UCC providers understand the problem of antibiotic resistance, but this has not led to practice change.

Considerable evidence from economic theory and research in other clinical areas suggests that adding a package of feedback, nudges, and peer comparisons could dramatically improve prescribing outcomes. Our investigative team previously showed that relatively simple interventions, grounded in behavioral economics and decision science, that leverage accountability and social norms, can reduce unnecessary antibiotic prescribing for acute respiratory infection (ARI) in primary care practices. Peer comparisons dramatically improve prescribing outcomes in outpatient clinics and doctor’s offices and are sustained for at least 12 months after interventions end. Interventions inspired by these “nudges” tailored to the acute ambulatory care workflow have potential to overcome barriers and promote stewardship for ARIs in EDs and urgent care settings.

**METHODS**

This study compared two interventions. The adapted intervention consisted of education for patients and providers using materials from the CDC’s Get Smart (currently called Be Antibiotics Aware) campaign adapted for the acute care setting, led by a physician champion at each site. The adapted intervention was compared with the enhanced intervention, which was an intensive intervention that incorporated the adapted Get Smart campaign, in addition to individualized audit and feedback, peer comparisons, and nudges. Our hypothesis was that both interventions would reduce inappropriate antibiotic prescribing for antibiotic nonresponsive ARIs by individual providers in EDs and UCCs, but that the enhanced intervention would be more effective.

**Study Design, Setting, and Population**

**Study Design.** This study was a pragmatic cluster-randomized clinical trial of providers at nine ED and UCCs across three academic medical centers in two states. The clinical trial was registered on ClinicalTrials.gov, NCT03022929. The study was approved by the institutional review boards (IRBs) of the University of California (UC) Davis, Harbor–University of California at Los Angeles (UCLA) Medical Center, Children’s Hospital Colorado (CHCO), and the University of Southern California.

**Setting.** Our study included five EDs (UC Davis adult and pediatric ED, Harbor-UCLA adult and pediatric ED, and three CHCO pediatric EDs), and four UCCs (Harbor-UCLA adult UCC and three CHCO pediatric UCCs). We block-randomized sites by medical system in a two-arm design to receive one of two interventions.

**UC-Davis (One Site).** The University of California–Davis is a quaternary care center Level I ED with approximately 65,000 adult and 20,000 pediatric visits per year seeing a mix of urban and rural populations.

**Harbor-UCLA Medical Center (Two Sites).** Harbor-UCLA Medical Center is a Level I trauma center and pediatric critical care center with 65,000 adult ED visits, 24,000 pediatric ED visits, and 11,000 adult UCC visits.

**CHCO (Six Sites).** Children’s Hospital of Colorado is composed of an urban, pediatric tertiary care ED that is the region’s only pediatric trauma center, with two satellite EDs and three satellite UCCs. Across all ED and UCC sites, CHCO receives 170,000 pediatric visits each year.
**Study Population.** Sites were staffed by general emergency physicians, pediatric emergency physicians, advanced care practitioners, internists, and pediatricians. These providers treat a diverse patient population including the underserved (e.g., minorities, rural, elderly, those with poor access to care). All prescribing providers from the UC Davis and Harbor-UCLA adult and pediatric EDs, the Harbor-UCLA adult urgent care clinic, and CHCO pediatric EDs and UCCs were approached for consent to participate after sites were randomized to study arm.

**Study Protocol Inclusion Criteria.** Any licensed clinician at a participating site was eligible to participate as long as he or she was not a resident physician—fellows were eligible if they were practicing as attending physicians at a participating site. Each study site has an electronic health record (EHR) system in place and its own physical space (as opposed to multiple clinics sharing the same space, such as the floor of a hospital, where interactions between providers assigned to different intervention groups would be more likely).

Eligible ED and UCC visits included those with diagnoses (primary and secondary) from the International Classification of Diseases, Tenth Revision (ICD-10-CM) codes consistent with antibiotic-nonresponsive ARI diagnoses with consideration of secondary diagnostic codes as modifiers (see “Exclusion Criteria”). The conditions targeted for reducing antibiotic prescribing were: nonsuppurative otitis media, H65*; acute nasopharyngitis, J00*; laryngitis, J041*; supraglottitis, J043*; croup, J050*; influenza, J09*/J10*/J11*; viral pneumonia, J12*; viral bronchitis, J203*/J204*/J205*/J206*/J207*/J208*; unspecified bronchitis, J209*; bronchiolitis J21*; lower respiratory tract infection unspecified, J22*; vasomotor and allergic rhinitis, J30*; chronic nasopharyngitis, J31*; bronchitis not otherwise specified, J42*; and asthma, J45*. This consensus definition was developed a priori by clinician investigators (LM, KY, RM, RF) and is publicly available as the MITIGATE toolkit hosted online by the Society for Academic Emergency Medicine.15 The parameters for outcome definition were intended to be congruent with existing Healthcare Effectiveness Data and Information Set and National Quality Forum quality metrics on acute bronchitis, but broadened to include all other antibiotic-nonresponsive ARIs as well as pediatric and geriatric populations.

A patient visit was eligible for inclusion in the outcome denominator if: 1) the patient was evaluated by a participating provider at an enrolled practice site and 2) the visit occurred during the baseline or intervention period. If multiple participating providers were involved in a patient’s care, the visit was attributed to the supervising provider (e.g., attending physician rather than resident) and the prescription was also attributed to the discharging provider. We excluded patient encounters of residents with prescribing privileges practicing independently.

**Exclusion Criteria.** Visits were excluded from the primary analysis if patients had either a non-ARI bacterial infection diagnosis or an antibiotic-appropriate ARI diagnosis that cooccurred with their qualifying diagnosis at the visit. The sets of exclusionary diagnoses that were used to calculate the outcomes are listed in the public MITIGATE toolkit.

**Enrollment Procedures.** Provider enrollment was documented in writing at the time of consent for the enhanced intervention and opt-out verbal consent was obtained for providers at the adapted intervention sites. Interventions were initiated after all clinicians at a site had been enrolled or declined to participate.

**Interventions.** We adapted proven antibiotic stewardship approaches to the acute care ambulatory site-level setting for our intervention. We first obtained stakeholder and provider feedback to inform adaptation of outpatient stewardship methods and achieve the greatest public health impact on antibiotic use in ED and UCC settings.16

**Adapted Intervention.** The adapted intervention incorporated strategies from CDC’s Core Elements for Outpatient Antibiotic Stewardship, including provider and patient education, a physician champion, and departmental feedback,17 using implementation tools found to be feasible in the acute care setting and accepted by local providers. We used existing CDC Get Smart materials appropriate to the ED and UCC settings (as determined with stakeholder input16) and adapted brochures and other campaign messages for acute care providers (see Table 1). The physician champion led the educational component.

**Enhanced Intervention.** The enhanced intervention used all of the elements of the adapted
intervention and also included peer comparison feedback and locally tailored public-facing demonstration of commitment to judicious antibiotic prescribing (Table 1). Peer comparison was proposed as an e-mail–based intervention. Peer comparison was distinct from traditional audit-and-feedback interventions, in that individuals were compared to top-performing peers—a strategy shown to sustain performance in prior studies.\textsuperscript{14}

### Timeline
The comparative effectiveness of the enhanced intervention versus the adapted intervention was evaluated using a multicenter cluster randomized trial. The study interventions ran from July 2017 to February 2018 at UC Davis and Harbor-UCLA and from November 2017 to February 2018 at CHCO with a 12-month baseline period used for statistical analysis.

### Randomization
The study used a cluster-randomized design at the site level to avoid contamination that might occur if individual providers within a site are randomized to different interventions (CONSORT diagram, Figure 1; CONSORT checklist, Data Supplement S1, Table S1 [available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1111/1/acem.13690/full]). Clinicians who practiced at multiple sites were assigned to the intervention of the clinic for which they spend at least 80% of their time. True random integer sequences were generated using the random.org integer sequence generator for each of CHCO (n = 6), UC Davis (n = 1), and Harbor-UCLA (n = 2) strata. Random.org uses atmospheric noise to generate random numbers, which can be better than the pseudo-random number algorithms typically used in computer programs. The greatest one-half of integers in the sequence were allocated to the enhanced intervention; this was independently prespecified by a study methodologist (JD) prior to randomization. Each site had an ex ante 50% chance of being randomly assigned to the treatment condition.

### Preimplementation Assessment
Across all participating sites, providers completed a baseline survey to assess provider characteristics and provider attitudes toward practice guidelines, clinical decision support, EHRs, and practice environment. Three to six stakeholders at each site (departmental leadership, nursing staff, and providers) participated in preintervention interviews and a clinical walkthrough with study personnel. Interviews were audio recorded and transcribed at two sites (Harbor-UCLA and UC Davis) and comprehensive notes collected at CHCO for qualitative analysis of barriers and facilitators. Coupled with semistructured stakeholder interviews and clinical environment walkthroughs, qualitative analysis using those surveys and interviews was conducted to triangulate adaptation of the stewardship intervention to local context.\textsuperscript{18} This mixed-methods approach was used to understand how to adapt outpatient antibiotic stewardship intervention components based on site-specific needs.\textsuperscript{19}

Project managers at each location collaborated with clinical and operations staff to adapt each of the intervention components to ensure they were consistent with local workflows, policies, and standards. A plan was developed for implementing and monitoring each

### Table 1
<table>
<thead>
<tr>
<th>Intervention Components by Intervention Package</th>
<th>Definition</th>
<th>Adapted</th>
<th>Enhanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provider education</td>
<td>Educational presentations, electronic reminders of ARI guidelines, Get Smart brochures</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Patient education</td>
<td>CDC Get Smart posters in waiting rooms, discharge handouts</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Provider commitment-enhanced patient education</td>
<td>Personalized posters in examination rooms including modified Get Smart content directed at patients, enhanced with clinicians’ photos and signed public commitment to antibiotic stewardship</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Physician champion</td>
<td>Designated physician at each site who will lead provider education and be an advocate for antibiotic stewardship</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Departmental feedback</td>
<td>Monthly aggregate of antibiotic prescribing practices for ARI from EHR data provided to departmental leadership</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Peer comparison</td>
<td>Personalized monthly performance ranking delivered by e-mail with each physician receiving designation of being a “top performer” (top decile) or “not a top performer” for avoiding antibiotics for ARI.</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

ARI = acute respiratory infection; EHR = electronic health record.
of the components. Standard operating procedures were refined and shared with staff. Clinician enrollment procedures for electronic and in-person enrollment were developed with clinical champions and departmental leads. Risk analysis was conducted with the monitoring plan to ensure that interventions were delivered with fidelity to the original design and deviations were recorded.

**Implementation Phase.** The adapted and enhanced interventions used the stewardship components as described in Table 1 with two exceptions. Based upon stakeholder and provider feedback, two components of the behaviorally enhanced intervention were modified during the MITIGATE trial.

**Public Commitment.** The Centers for Disease Control and Prevention has made available commitment letters to be posted in waiting room or patient care areas. Physician commitment is an evidence-based strategy for antibiotic stewardship in primary care settings. Posters were signed by clinicians to remind both patients and providers of the site’s commitment to appropriately prescribe antibiotics. Given the unique challenges of EDs and UCCs, who are faced with rapid patient turnover, crowding, and multiple providers with potentially different levels of training working in shift-based formats, these posters (with or without signatures and/or headshots) were placed in areas that were visible to both patients and clinicians, such as triage areas, provider stations, screening rooms, or fast track examination rooms. Additional physician and advanced care practitioner commitment modes such as signing a commitment log and wearing visible flair (campaign-branded badge reels, buttons) were strategies developed with stakeholder input, allowing for variation of mode of public commitment across sites.

**Peer Comparison.** A monthly mail merge provided individualized audit and feedback reports for peer comparison. These were sent by the local clinical champion at each site. Every provider in the enhanced group was notified if they were a “top performer” or “not a top performer.” Percentiles were computed within each site. E-mails included the number and proportion of inappropriate antibiotic prescriptions written for non–antibiotic-appropriate ARI cases and the proportion written by top performers. Providers in the lowest decile were sent “top performer” letters, all others were sent “not a top performer” letter templates (further detail available in the MITIGATE toolkit\textsuperscript{15}).

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**Figure 1.** CONSORT diagram. CHCO = Children’s Hospital Colorado; UC = University of California; UCLA = University of California at Los Angeles.
Visit inclusion and exclusion criteria were based on the same diagnostic codes described in the toolkit. If the provider had more than 20 qualifying ARI encounters in the past 30 days, all these encounters were included in the calculation. Otherwise, the most recent 20 qualifying ARI encounters were included if they occurred in the past 5 months. If fewer than 20 occurred in the past 5 months, only encounters in the past 5 months were included.

**Postimplementation Assessment.** Consented providers at each site completed a survey at the conclusion of the intervention period. Providers were asked about attitudes toward antibiotic use and stewardship programs, knowledge of appropriate antibiotic use after the intervention. Additionally, they were asked about the stewardship intervention, their opinions of the program, specific components of the program, barriers, and benefits of the intervention.

**Key Outcomes and Measurements**

The primary outcome was defined as the provider-level antibiotic prescribing rate for ARI diagnoses, defined as patient visits with antibiotic-nonresponsive diagnoses without concomitant diagnostic codes to support antibiotic prescribing (see public MITIGATE toolkit for complete list). Only systemic antibiotic prescriptions were included; we excluded topical, otic, and ophthalmic preparations and any medications given in the ED (study protocol, Data Supplement S1, Appendix S1).

**Data Analysis**

Two analytic approaches were performed by a blinded assessor to measure the impact of the MITIGATE trial, which was a cluster-randomized comparative effectiveness trial. We used a repeated cross-sectional design in which clustered site and its clinicians were followed up over time with regard to their patient visits, an approach employed in similar pragmatic trials of antibiotic stewardship interventions. We analyzed the data using an interrupted time-series approach while accounting for provider- and site-level random and fixed effects using previously published methods.

For inferential analyses of our primary hypotheses of difference-in-differences effectiveness of the enhanced versus adapted interventions, we estimated a hierarchical mixed effects logistic regression model for visits that occurred during the influenza season (from November through February) for 2016 to 2017 (baseline) and 2017 to 2018 (intervention). Temporal trends were modeled as a linear spline with a knot on the first date the messages were sent for each site. We controlled for organization (Harbor-UCLA, UC Davis, CHCO), secular temporal trends, and provider fixed effects. This approach, applied in similar primary care and pediatric studies, models prescribing as an interrupted time series, adjusts for trends in antibiotic prescribing in each group with interaction terms representing the difference-in-differences in prescribing trajectories between groups as well as across both groups before and after the intervention.

For CHCO and UC Davis we used data from the institutional electronic data warehouses and the Patient-Centered Outcomes Research Institute Patient-centered Clinical Data Research Network (PCOR-net). For Harbor-UCLA, we extracted data directly from the EHR (Cerner, Kansas City, MO). All analyses were conducted in Stata 14.0 (StataCorp).

**RESULTS**

We demonstrated fidelity, or the degree to which the intervention elements were executed as planned, in adapting the stewardship intervention into acute care ambulatory settings, completing 100% of planned interviews, 52.4% of preimplementation surveys, 99% collection of public commitment signatures, and 92.6% willingness to display public commitment “flair” (defined as acceptance of Get Smart–branded badge reels and pins as monitoring of flair display was not conducted). All cluster sites participated as allocated, and all providers consented to participate (baseline and intervention period participant numbers varied due to individuals joining or leaving the sites). There were no significant differences between baseline monthly prescribing rates between providers allocated to the enhanced group and those allocated to the adapted groups (Table 2), suggesting that randomization successfully distributed interventions across the sample. All nine participating cluster sites and all consenting providers were included in the analysis based on their assigned intervention arm. No providers at UC Davis or Harbor-UCLA practiced at more than one site, but the site allocation threshold for providers at CHCO sites was lowered from >80% of their time to >50% due to clinical scheduling needs. The trial was ended after all planned data were collected. Demographics of individual providers, or any trainee
data, were not collected per IRB stipulations. The unadjusted prescribing rates at the provider level for the combined intervention effects during flu seasons are shown in Table 3.

Over the entire study period, there was a mean of 84 visits per provider for antibiotic-inappropriate acute ARI diagnoses. The unadjusted baseline antibiotic prescribing rate for antibiotic-inappropriate ARIs during flu season of 2016 to 2017 was 4.3% across all sites. Grouped by academic center, all sites at CHCO had a significantly lower baseline prescribing rate (2.1%) than either those at Harbor-UCLA (7.4%) or those at UC Davis (5.6%).

### Intervention Effectiveness

The unadjusted monthly inappropriate prescribing rate for each of the three academic centers is shown in Figure 2 on a log scale to allow better visualization of high-performing sites. Note that the vertical event lines do not represent the first intervention components occurring at each site—some providers engaged in activities such as interviews and surveys several weeks to months prior (Data Supplement S1, Table S2). However, no intervention activities were part of the 2016 to 2017 flu season. After provider, seasonal, and institutional fixed effects were adjusted for, there was a significant year-over-year reduction from baseline to
intervention period (odds ratio of 0.67 [95% confidence interval {CI} = 0.54 to 0.82]), with an absolute effect size of 0.7% (0.2% to 1.2%).

This decrease was evident across both the enhanced and the adapted groups in Figure 2, with the exception of the CHCO sites (light gray dashed lines), which had low prescribing rates throughout. Of note, the only adult UCC included in the study was randomized to the adapted intervention (noted as HAR—Adapted on Figure 2). After the provider and organization effects as well as changes and temporal trends impacting all providers were accounting for, reductions in prescribing between the two interventions favored the enhanced intervention, with an effect size of 1.9% (~0.7% to 4.6%), but this difference-in-differences was not significant (p = 0.06). The distribution of both baseline rates and changes were significantly skewed (p < 0.001), with the top quartile of providers (high prescribers) accounting for more than 75% of the reduction.

Summary of Survey Responses
As the survey data were exploratory by design, we are not reporting tests of significance for the qualitative data. For the preimplementation survey, 52.5% (159/303) of providers responded (83% attendings and fellows, 17% nurse practitioners and physician assistants).
For the postimplementation survey, 39.9% (120/301) providers responded (83.3% attendings and fellows, 16.7% nurse practitioners and physician assistants). The overall contribution to responses by site was 24% UC Davis, 35% Harbor-UCLA, and 42% CHCO.

Self-reported Prescribing
Providers generally reported low prescribing rates for themselves except for disease where antibiotics are sometimes indicated (acute sinusitis and acute otitis media). They perceived their colleagues to prescribe more frequently than themselves for acute bronchitis (Figure 3).

Attitudes Before and After Interventions
Participants were asked about public health and antibiotic resistance concerns (Figure 4). Both before and after the intervention, almost all participants agreed or strongly endorsed statements that cited 1) resistance as a public health problem and 2) the assertion that inappropriate antibiotic use contributes to resistance. Sentiments about patient education were more evenly distributed with about half agreeing that education was sufficient both before and after the intervention.

There was also conflicting sentiments regarding acute care antibiotic stewardship programs as a result of the program. More people strongly agreed or agreed that acute care antibiotic stewardship is important after the intervention (Figure 4), but there was more neutral or negative sentiments when responding to a negative question, “Do you believe that ED and urgent care based antibiotic stewardship programs would interfere with your usual approach to clinical decision-making in treatment of infectious diseases?”

DISCUSSION

The Core Elements of Outpatient Antibiotic Stewardship have never been evaluated for effectiveness when implemented as a bundle. This study is the first to do so and shows effectiveness in ED and UC settings. Overall, inappropriate antibiotic prescribing rates during our cluster-randomized trial decreased by approximately 33% in our population of academic ED and
UCC providers, who treated both children and adults, although the absolute change was modest 0.7% (0.2%–1.2%). We did not find any significant difference-in-differences between reductions in unnecessary antibiotic prescribing between our two intervention methods: the stewardship intervention adapted for the acute care ambulatory setting (adapted intervention), and the more resource-intensive intervention that included personalized provider-level feedback (enhanced intervention). Nonetheless, we were able to demonstrate the effectiveness of behavioral and educational interventions in reducing inappropriate antibiotic prescribing in the ED and UCC settings, two settings in great need of antibiotic stewardship program implementation.

Our success in reducing inappropriate antibiotic prescribing even with a relatively low intensity intervention is surprising as standard approaches emphasizing the education of patients and providers have previously demonstrated limited success in outpatient settings. We anticipated that a “one-size-fits-all” approach was not feasible for ED- and urgent care–based implementations, and stewardship strategies should be tailored to these settings. One possible explanation for the success was our use of a specialized implementation science approach, which tailored the antibiotic stewardship program to the local context of each ED and UCC and iteratively refined the intervention based on engagement with local champions and stakeholders.

While a systematic review of audit and feedback on clinician behavior has demonstrated a positive effect,23 a more recent antibiotic stewardship study that promoted guidelines through quarterly feedback to primary care physicians in Switzerland did not find significant improvement.24 However, our study differed in that it incorporated social motivation in a positive reinforcement mode (top performer/not top performer), more frequent monthly e-mail notification, and more robust implementation science methods to adapt the intervention to the local setting. We used an automated mail merge that allowed for more efficient and monthly reporting of feedback, which may have had a more regular and repeated impact on provider performance.

Behavioral nudges, based on insights from economics and psychology, have the advantage of being designed to improve care decisions without limiting the choices available to physicians,25 a primary reason for failure of other interventions.26–28 They are also scalable and do not require much extra time to improve quality of care.29 However, despite optimism that efficiency gains of behavioral economics strategies in other settings could be translated to ED and UCC settings, we were not able to show significant impact of the enhanced intervention over the adapted intervention.

The low baseline inappropriate prescribing rate may have limited our ability to detect a difference-in-differences since there was a limit for improvement that could be observed. Post hoc power analysis revealed we underestimated the intraprovier correlation, or interclass correlation (ICC; estimated 0.10, observed 0.27), leading to lower power (0.23) to detect a small difference, which we had originally estimated at 5% to 10% (which was also too large for our unexpectedly low baseline rates; Data Supplement S1, Appendix S1). The higher-than-expected ICC is likely due to the heterogeneous study settings, such that behavior of providers within each site (and the site-based interventions) is more alike than between providers across sites. A lack of difference-in-differences between interventions may also be explained by insights from behavioral science that suggest clinicians may be most motivated to reduce their inappropriate prescribing when they believe that it occurs at a very low rate, especially by peers in their own practice setting. Studies show that eliminating risk is more desirable than lowering it from a higher baseline risk in the same measure.30 Knowing that by changing your prescribing habits you have eliminated the chance your actions will lead to your patient acquiring a Clostridium difficile infection or other negative outcome may be a compelling motivator. This suggests a second interpretation of our null difference-in-differences—to the extent all participating clinicians correctly perceived themselves as low-rate prescribers, study participants in both treatments may have been motivated to “get to zero.” And while “getting to zero” may be a worthy conceptual goal, health systems under pay-for-performance reimbursement programs, like the Public Hospital Redesign and Incentives in Medi-Cal (PRIME) project, are expected to show year-over-year improvements in quality measures like inappropriate antibiotic prescribing for acute bronchitis, and overperformance may allow recovery of unearned funds for other underperforming project metrics.

Our finding of high performance in these three academic settings is not inconsistent with the evidence. High performance settings have inappropriate prescribing rates far lower than 10%, despite reported national
The detection of a robust effect size is encouraging, as any effect of an intervention that produces a small absolute effect (e.g., a 5-percentage-point reduction) in a high-performing ED may have larger absolute effect if carried out in a low-performing ED. Moreover, in a high-rate inappropriate prescribing environment, one treatment approach may well outperform the other. However, there are challenges to scale and spread of rigorous implementation science methods. While such methods have been shown to enable research teams to operationalize and deliver research-developed interventions in the context of research studies, the artificial circumstances and low external validity of these studies (e.g., use of research funds for additional staff and services, highly specialized mixed-methods research expertise, additional technical assistance provided by research teams to local sites and staff, carefully selected sites) reduce generalizability and the likelihood of reproducibility outside of research contexts. Therefore, study of these interventions in community acute care ambulatory settings and improved accessibility of implementation science approaches are critical to have the greatest impact on stewardship.

LIMITATIONS

As this was a comparative effectiveness study without a contemporaneous control, we cannot definitively say that the interventions themselves fulfilled a causal role in reducing inappropriate antibiotic prescribing, although the natural trends in Figure 2 suggest they did. Moreover, we did not have a safety endpoint such that we could measure an unintended harm of return visits for pneumonia or other illness progression, although recent empirical evidence suggests that this is unlikely. There is also limited generalizability since all sites were affiliated with academic health centers located in only two states. Moreover, the study is limited by the use of consensus-defined ICD-10 diagnosis code sets to define included and excluded visits. It is possible that as providers became aware that their behavior was being watched, they altered their diagnosis coding behavior to justify their antibiotic prescribing behavior (e.g., coding a visit as pneumonia or an exacerbation of chronic bronchitis rather than an URI). A corollary to that awareness by providers is the potential for a Hawthorne effect at all sites, whereby all sites improved performance not because of effect of either intervention, but simply because they knew that their performance was under scrutiny. Not all of the outcome effect can be attributed to this package of interventions that produce small absolute effects (e.g., a 5-percentage-point reduction) in a high-performing ED may have larger absolute effect if carried out in a low-performing ED. Moreover, in a high-rate inappropriate prescribing environment, one treatment approach may well outperform the other. However, there are challenges to scale and spread of rigorous implementation science methods. While such methods have been shown to enable research teams to operationalize and deliver research-developed interventions in the context of research studies, the artificial circumstances and low external validity of these studies (e.g., use of research funds for additional staff and services, highly specialized mixed-methods research expertise, additional technical assistance provided by research teams to local sites and staff, carefully selected sites) reduce generalizability and the likelihood of reproducibility outside of research contexts. Therefore, study of these interventions in community acute care ambulatory settings and improved accessibility of implementation science approaches are critical to have the greatest impact on stewardship.

LIMITATIONS

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interventions, as we did identify other antibiotic stewardship initiatives that were ongoing in some of the departments (UC Davis had an skin and soft tissue infection antibiotic stewardship program in the ED that predated this study, and Harbor-UCLA had pediatric ED case-based antibiotic stewardship rounds during the spring and summer of 2017 between the baseline and intervention study periods).

There may also have been limited ability to detect a difference-in-differences between the two interventions due to contamination of the CHCO sites due to provider overlap between sites. In total, at CHCO, 83 (50.9%) providers worked at both sites assigned to the adapted and enhanced intervention. Of these providers, 52 were assigned to the adapted intervention and 31 to the enhanced intervention. Only 38 (45.8%) of the 83 overlapping providers worked at least 80% of their shifts at sites within their allocated treatment arm. A total of 25 (48.1%) of the 52 assigned to the adapted intervention arm spent at least 80% of their time at sites randomized to the adapted arm. For the enhanced arm, 13 (41.9%) of 31 providers spent least 80% within their assigned sites. Coupled with the low baseline rate of antibiotic prescribing, we may have lacked sufficient power to demonstrate a difference-in-differences.

Finally, improvement may not have been possible to reach zero because responses may cluster around a “floor” rate of inappropriate prescribing if unmeasured factors at a small number of visits are not identified as exclusions (including the possibility of trainees prescribing antibiotics in lower acuity patients prior to the attending of record finalizing the visit record). Alternatively, interventions may reach a certain “ceiling” in the type of visits at which they can affect prescribing. In the first case, a low but positive rate of inappropriate prescribing reflects a “logical zero,” beyond which no lower score is possible. In the second case, over-coming residual inappropriate prescribing is impossible. Yet, these concerns are theoretical. The fact that we did find a robust effect size is a strong justification for addressing prescribing with either intervention in acute care settings that have a low inappropriate prescribing rate.

CONCLUSIONS

Antibiotic stewardship programs using behavioral approaches can be feasibly developed and implemented in the ED and urgent care center settings. Overall performance improvements are still needed in systems with both high and low performers as institutions strive toward optimum quality in antibiotic prescribing for their acute ambulatory care patients. Our study demonstrates that getting to zero inappropriate antibiotic use for ARIs is a potentially achievable goal, and for those institutions with average or high inappropriate prescribing rates, antibiotic overuse can potentially be cut by one-third with attention to the problem.

References


33. Hamm RM, Hicks RJ, Bemben DA. Antibiotics and respiratory infections: are patients more satisfied when expectations are met? J Fam Pract 1996;43:56–62.


**Supporting Information**

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13690/full

**Data Supplement S1.** Supplemental material.
ABSTRACT

Objectives: The objective was to determine the prevalence of compassion fatigue (CF), burnout (BO), and compassion satisfaction (CS) and identify potential personal and professional predictors of these phenomena in pediatric emergency medicine (PEM) physicians.

Methods: A modified Compassion Fatigue and Satisfaction Self-Test for Helpers and a questionnaire of personal and professional characteristics were distributed electronically to PEM physicians nationally. The prevalence of these phenomena was calculated. Hierarchical linear regression models for CF, BO, and CS as a function of potential risk factors were constructed.

Results: The final analyzable survey rate represented 22.7% of the physicians invited to participate. The prevalences of CF, BO, and CS were 16.4, 21.5, and 18.5%, respectively. BO score, distress about a “clinical situation,” “physical work environment,” and engaging in prayer/meditation were each significant determinants of higher CF scores, whereas “socializing with family/friends” was significantly associated with lower CF scores. CF score, emotional depletion, and distress due to “coworkers” were each significant determinants of higher BO scores, whereas CS score and “talking with a family member” as a means of self-care were significantly associated with lower BO scores. Socializing with family/friends and >20 years as PEM provider were each significant determinants of higher CS scores, whereas BO score, emotional depletion, distress about the physical work environment and “administrative issues,” 10% to 24% of time spent caring for pediatric patients, and “talking with life partner” about work-related distress were each significant determinants of lower CS scores. We acknowledge that the generalizability of our findings is limited by the sample size and by the fact that participants were largely female, Caucasian, and junior faculty and worked in academic medical centers.

Conclusions: PEM physicians are at risk for developing CF, BO, and low CS. Proactive awareness of these phenomena and their predictors may allow providers to better manage the unique challenges and emotional stressors of the pediatric ED to enhance personal well-being and professional performance.

Pediatric emergency medicine (PEM) physicians function at the frontline of pediatric health care, and with this privilege comes a distinct set of challenges and emotional stressors. While providing medical care for acutely ill children and working closely with families at a time of heightened stress,
PEM physicians also function as child protection advocates alert for signs of nonaccidental trauma, sexual abuse, and neglect.\textsuperscript{1,2} Bearing witness to child abuse has been identified as a major stress trigger in trauma care providers.\textsuperscript{2} While PEM physicians face the death of a child infrequently,\textsuperscript{3} it is particularly distressing when it occurs.\textsuperscript{4,5} Despite these emotional challenges, PEM physicians report high levels of career satisfaction.\textsuperscript{6,7}

General questions about work-related distress and career satisfaction may not capture particular emotions frequently expressed by physicians. Repeated or ongoing exposure to patient suffering can lead to compassion fatigue (CF), which is a form of secondary traumatic stress experienced by both medical and family caregivers.\textsuperscript{8–10} Compassion satisfaction (CS), which some view as an “antidote” to CF, is the emotional fulfillment experienced by health care providers from caring for patients.\textsuperscript{11} Burnout (BO) is chronic occupational distress due to uncontrollable workplace factors that contribute to career dissatisfaction and a sense of being overworked and undervalued by the organization.\textsuperscript{12–15} Emotional exhaustion and depersonalization are key elements of both CF and BO.\textsuperscript{11,13,15} Long-term sequelae of CF and BO in health care professionals include low morale, avoidance of interaction with patients, decreased productivity and quality of care, absenteeism, and medical errors, as well as depression, stress in personal relationships, and substance abuse.\textsuperscript{8–10,16–24}

Although their impact upon a provider’s wellness and job performance may be profound, CF and CS have not been well studied in PEM physicians. This is in stark contrast to the myriad literature on physician BO.\textsuperscript{2,12–21,24} Due to ongoing exposure to the emotional challenges of providing frontline care to children, we hypothesize that PEM physicians are at risk for developing CF. Because favorable work-related events are linked to higher CS,\textsuperscript{25,26} we postulate that PEM physicians experience considerable CS despite the stresses of their specialty. As up to 50% of physicians in the U.S. experience BO at some point in their career, and with a prevalence of BO in adult EM physicians reported as high as 60% in some studies,\textsuperscript{27} we anticipate that PEM physicians may experience BO to a similar extent. We therefore conducted a cross-sectional national study to determine the prevalence of CF, BO, and CS among PEM providers and to identify potential predictors of these phenomena in this population.

**METHODS**

**Study Design and Population**

Potential study participants were identified by searching the websites of accredited fellowship programs for PEM available through the Accreditation Council for Graduate Medical Education (ACGME), as well as websites for all institutions listed in the Children’s Hospital Directory\textsuperscript{28} for faculty names and e-mail addresses. This project was designated as exempt human research by the institutional review board at the Icahn School of Medicine at Mount Sinai.

**Survey Content and Administration**

Two instruments were used for the current study. To determine CF, BO, and CS scores in the study population, the Compassion Fatigue and Satisfaction Self-Test for Helpers (CFST) was utilized. The original CFST is a validated and reliable 66-item instrument with three subscales designed to measure potential for CF, BO, and CS.\textsuperscript{8,9,11,29} The CFST was modified with permission by its author (C.R. Figley, personal communication, 2014) such that the phrasing of statements more accurately reflects a study participant’s role as medical caregiver (rather than a “helper”) to patients (rather than “victims”) and statements that used the words “violence” and “perpetrator” were removed to due to lack of relevance to the practice of clinical medicine. The modified CFST consists of 54 statements, with 18, 13, and 23 items on the CF, BO, and CS subscales, respectively (Data Supplement S1, Appendix S1), available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13670/full.\textsuperscript{30} The second instrument was a 48-item questionnaire of professional details and personal characteristics of study participants (Data Supplement S1, Appendix S2). The questionnaire was originally developed by a focus group of senior neonatology faculty to identify potential predictors of CF, BO, and CS in a national sample of neonologists.\textsuperscript{30} The original questionnaire was modified by PEM faculty at our institution so that personal and professional characteristics relevant to PEM were included in the study.

A brief description of the study, with a hyperlink to the CFST and questionnaire, was distributed electronically via SurveyMonkey. The invitation to participate was resent to nonresponders every 2 weeks for a total of five attempts. Individual survey responses were collected anonymously by SurveyMonkey.
**Data Analysis**

Individual survey responses were downloaded, coded, and entered into SPSS Statistics Version 23. As previously described, subscale scores for CF, BO and CS were summed. For each subscale, internal reliability was evaluated using Cronbach’s alpha, and normality was assessed by kurtosis, skew, and histogram analysis. Descriptive statistics were calculated for subscale scores and questionnaire responses. Pearson’s r and Spearman’s rho were used to examine correlations between subscales and to identify relationships between study variables.

To determine the prevalence of CF, BO, and CS, the subscale score for each phenomenon was examined as a dichotomous outcome with a defined high-end cutoff point (above which the participant was considered to have the phenomenon) for each scale determined in the following manner: we evaluated a numeric score one standard deviation (SD) above the subscale mean and the numeric score greater than the 75th percentile for each subscale and inspected the histogram generated for each subscale. Appraisal of the histogram for each subscale revealed a natural high-end cut point that fell between one standard deviation above the mean and the 75th percentile (CF ≥ 27, BO ≥ 27, CS ≥ 100) and was identical to those determined for neonatologists, pediatric palliative care providers, and pediatric critical care physicians. Bivariate analyses of personal and professional characteristics as a function of scores above and below the high-end cutoff point were performed using chi-square tests, Fisher’s exact tests, or independent t-tests as appropriate.

Hierarchical linear regression models using subscale score for CF, BO, and CS as a continuous variable were constructed as a function of predictors that were significant at p < 0.05 in bivariate analysis. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity. A six-stage hierarchical multiple regression was performed with CF, BO, and CS score as the dependent variables, respectively. Sex was entered as block 1 to control for its effect on all subsequent factors. Subscale scores were entered as block 2. Self-report of physical exhaustion and/or emotional depletion were added as block 3. “Distress” variables (distress about a clinical situation, physical work environment, administrative issues, coworkers, personal issues, and participant’s health) were entered in block 4. “Coping” variables (activities which respondents used to offset work-related stress) were entered as block 5. All other predictors that were significant in bivariate analysis and not easily classified into blocks 1 through 5 were entered as block 6. For each phenomenon, R², R² change, and F change were determined across models.

**RESULTS**

Of the 1,716 surveys delivered by SurveyMonkey, 518 responses were returned. Of these, three individuals declined to participate, and 17 participants returned a blank survey. Ninety-seven surveys were returned because the participant had not completed the CFST, and thus the study phenomena could not be evaluated. An additional 11 participants were excluded as they were not currently practicing PEM physicians. This left a final study population of 390 individuals (Figure 1) and an analyzable response rate of 22.7%.

Characteristics of the study population are shown in Table 1. The overwhelming majority of participants were female and Caucasian and had a partner/spouse and/or children as part of their household. Slightly more than half of participants were currently at the junior faculty level. We acknowledge that the generalizability of our findings is limited by the low response rate and the skew of the sample population. Eighty-one percent of participants described current feelings of “distress” about some aspect of their personal or professional lives. Recent significant emotional depletion and physical exhaustion were reported by 25.3 and 26.8% of respondents, respectively. The variety of self-care activities practiced by participants is also shown in Table 1.

The characteristics of the modified CFST are presented in Table 2. Cronbach alpha values were 0.90 for CF, 0.82 for BO, and 0.94 for CS, which indicated internally reliable scales and were comparable to the alpha values obtained for both the original instrument and our previously described modified instrument. Scores on the three subscales were normally distributed. Associations between subscale scores and between selected predictors were explored using Pearson product moment correlation coefficients and are shown in Data Supplement S1, Appendix S3. As one might anticipate, a strong positive correlation was identified between CF and BO scores (shared variance 53%), and strong negative correlations were demonstrated between CS and BO scores and
between CF and CS scores (shared variances 41 and 34%, respectively). There was no correlation between sex and CF, BO, or CS.

The prevalence of CF in the study population was 16.4% (95% confidence interval [CI] = 12.7%–20.1%). Hierarchical linear regression models for CF, as a function of predictors significant at \( p < 0.05 \) in bivariate analysis, are presented in Table 3. The standardized coefficients (beta values) are presented for each predictor for each of the six models. \( R^2 \), \( R^2 \) change, and F change are shown for each model. In model 1, sex was entered at block 1 and was not statistically significant. After entry of BO score at step 2, the total variance explained by the model as a whole was 54% (\( F(2,334) = 199.06, p < 0.0001 \)). In the final six-block model, the total variance explained by the model as a whole was 62%, with the following factors each statistically significant independent predictors of higher CF scores: BO score, current distress about a “clinical situation,” current distress about the “physical work environment,” and engaging in prayer/meditation as self-care. “Socializing with family/friends” was a significant independent predictor of lower CF scores. Thus, the largest contributing factor to the variance in CF score was the BO score, and while statistically significant, contributed an additional 8% of the variance in CF score.

The prevalence of BO in the study population was 21.5% (95% CI = 17.5%–25.5%). Hierarchical linear regression models for BO are shown in Table 4. Sex was entered at step 1 and was not statistically significant. After entry of CF and CS scores in the second block of the model, the total variance explained by the model as a whole was 61% (\( F(3,191) = 101.73, p < 0.0001 \)). In the final six-block model, the total variance explained by the model as a whole was 71%, with the following variables each statistically significant independent predictors of higher BO scores: CF score, emotional depletion, and current distress about “coworkers.” CS score and “talking with a family member” as a means of self-care were each significant independent predictors of lower BO scores. It should be noted that objective indices of perceived work demands (Data Supplement S2, Appendix S2) were not significantly associated with BO scores as measured by the CFST in this population. Thus, the largest contributing factors to the variance in BO score were the CF and CS scores, with the other significant factors contributing an additional 10% of the variance in BO score.

The prevalence of CS in the study population was 18.5% (95% CI = 14.7%–22.3%). Hierarchical linear regression models for CS are shown in Table 5. Sex was entered at step 1 and was not statistically significant. After entry of BO scores at step 2, the total variance explained by the model as a whole was 41% (\( F(2,325) = 115.33, p < 0.0001 \)). In the final six-block model, the total variance explained by the model as a whole was 59%, with the following variables each statistically significant independent predictors of higher...
CS scores: ≥20 years as PEM provider and socializing with family/friends. BO score, emotional depletion, distress about the physical work environment, distress about “administrative issues,” 10% to 24% of clinical time spent care for pediatric patients, and “talking with a life partner” about as a means of self-care were each significant independent predictors of lower CS scores. Thus, the largest contributing factor to the variance in CS score was the BO score, with the other significant factors contributing an additional 18% of the variance in CS score.

**DISCUSSION**

In this cross-sectional study of PEM physicians, we determined the prevalences of CF, BO, and CS to be 16.4, 21.5, and 16.8%, respectively. We also identified potential predictors of these phenomena in the study population. The prevalence of CF in PEM physicians has not been widely studied. Analyses of pediatric neonatologists, palliative care providers, pediatric critical care physicians, and nurses have reported a prevalence of CF at 10% to 40%. The lack of longitudinal involvement in any one patient’s suffering may explain why the prevalence in our study population fell at the lower end of this range. In studies of adult EM physicians using the Professional Quality of Life Scale (rather than the CFST), the prevalence of “average” or “high” CF has been reported at 0% to 44.5%. The lack of longitudinal involvement in any one patient’s suffering may explain why the prevalence in our study population fell at the lower end of this range. In studies of adult EM physicians using the Professional Quality of Life Scale (rather than the CFST), the prevalence of “average” or “high” CF has been reported at 0% to 44.5%. The lack of longitudinal involvement in any one patient’s suffering may explain why the prevalence in our study population fell at the lower end of this range. The prevalence of CF in our population was at the lower end of this range may reflect the fact that many pediatric medical problems presenting to the ED are more easily and successfully resolved than issues in adults.

CS scores: ≥20 years as PEM provider and socializing with family/friends. BO score, emotional depletion, distress about the physical work environment, distress about “administrative issues,” 10% to 24% of clinical time spent care for pediatric patients, and “talking with a life partner” about as a means of self-care were each significant independent predictors of lower CS scores. Thus, the largest contributing factor to the variance in CS score was the BO score, with the other significant factors contributing an additional 18% of the variance in CS score.

**Table 1**

<table>
<thead>
<tr>
<th>Characteristics of the Study Population (N = 390)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal and Professional Characteristics n/N (%)</td>
</tr>
<tr>
<td>Sex, female</td>
</tr>
<tr>
<td>Race, Caucasian</td>
</tr>
<tr>
<td>Current household members</td>
</tr>
<tr>
<td>Partner/spouse</td>
</tr>
<tr>
<td>Child(ren)</td>
</tr>
<tr>
<td>Additional family member(s)</td>
</tr>
<tr>
<td>Lives alone</td>
</tr>
<tr>
<td>PEM attending</td>
</tr>
<tr>
<td>Years as PEM attending</td>
</tr>
<tr>
<td>0–10 (junior faculty)</td>
</tr>
<tr>
<td>11–20 (midcareer)</td>
</tr>
<tr>
<td>≥21 (senior faculty)</td>
</tr>
<tr>
<td>Academic medical center</td>
</tr>
<tr>
<td>Urban</td>
</tr>
<tr>
<td>Physically exhausted in past 2 weeks</td>
</tr>
<tr>
<td>Emotionally depleted in past 2 weeks</td>
</tr>
<tr>
<td>Involved in the following activities in the past month</td>
</tr>
<tr>
<td>Clinical care for a critically ill child</td>
</tr>
<tr>
<td>Shared bad news with a family about their child’s medical status</td>
</tr>
<tr>
<td>Performed CPR on a patient</td>
</tr>
<tr>
<td>Death of a patient</td>
</tr>
<tr>
<td>Nonaccidental trauma</td>
</tr>
<tr>
<td>Sexual assault</td>
</tr>
<tr>
<td>Any debriefing/meeting following a patient’s death</td>
</tr>
<tr>
<td>Any debriefing/meeting following other traumatic clinical event</td>
</tr>
<tr>
<td>Current feelings of distress ascribed to</td>
</tr>
<tr>
<td>Clinical situation</td>
</tr>
<tr>
<td>Physical work environment</td>
</tr>
<tr>
<td>Administrative issues/academic stress</td>
</tr>
<tr>
<td>Coworkers</td>
</tr>
<tr>
<td>Personal issues</td>
</tr>
<tr>
<td>Participant’s health</td>
</tr>
<tr>
<td>Self-care activities</td>
</tr>
<tr>
<td>Exercise</td>
</tr>
<tr>
<td>Talk about distressing work-related issues</td>
</tr>
<tr>
<td>Engage in creative arts</td>
</tr>
<tr>
<td>Prayer/meditation</td>
</tr>
<tr>
<td>Socialize with family/friends</td>
</tr>
<tr>
<td>Self-care is not a priority</td>
</tr>
<tr>
<td>Personal history of any trauma</td>
</tr>
<tr>
<td>Recent loss of loved one</td>
</tr>
<tr>
<td>Life-threatening illness</td>
</tr>
<tr>
<td>Domestic/criminal violence</td>
</tr>
<tr>
<td>Natural disaster/war/terrorist attack</td>
</tr>
</tbody>
</table>

CPR = cardiopulmonary resuscitation; PEM = pediatric emergency medicine.

*Denominator N may be less than 390 in certain categories due to missing data.

**Table 2**

<table>
<thead>
<tr>
<th>Characteristics of the Modified CFST Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscale Mean ± SD 95% CI Median (IQR) Range</td>
</tr>
<tr>
<td>CF</td>
</tr>
<tr>
<td>CS</td>
</tr>
</tbody>
</table>

BO = burnout; CF = compassion fatigue; CFST = Compassion Fatigue and Satisfaction Self-Test for Helpers; CS = compassion satisfaction; IQR = interquartile range.

In our statistical models for CF, BO score was the most significant determinant of CF score. This
correlation has been previously reported in other subspecialties.\textsuperscript{30–32} When BO was controlled for in the models, current distress about a “clinical situation,” distress about the “physical work environment,” and engaging in prayer/meditation as self-care remained statistically significant, independent predictors of higher CF scores. While we did not inquire about specific aspects of the physical work environment that cause distress, exposure to the intense ED work environment, with the need to provide fast-paced care, noisy and overcrowded patient care areas, and shift-work may be overwhelming for some clinicians.\textsuperscript{38–41} Difficult patients and families, complex clinical situations, and distracting/chaotic work environments have been previously identified as three major barriers to physician compassion.\textsuperscript{27,38} In our study population, when queried about specific, potentially traumatizing clinical situations encountered in the month prior to

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Model 1\textsuperscript{*}</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>0.06</td>
<td>0.08\textsuperscript{a}</td>
<td>0.07\textsuperscript{a}</td>
<td>0.06</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>BO score</td>
<td>0.74\textsuperscript{c}</td>
<td>0.72\textsuperscript{c}</td>
<td>0.70\textsuperscript{c}</td>
<td>0.69\textsuperscript{c}</td>
<td>0.65\textsuperscript{c}</td>
<td></td>
</tr>
<tr>
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<td>0.03</td>
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<tr>
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<td>-0.01</td>
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<td>0.03</td>
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<tr>
<td>Distress about</td>
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<tr>
<td>Clinical situation</td>
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<td>0.17\textsuperscript{c}</td>
<td>0.17\textsuperscript{c}</td>
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<td>0.08\textsuperscript{b}</td>
<td>0.07\textsuperscript{a}</td>
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<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
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<td>.12\textsuperscript{c}</td>
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<td>-0.09\textsuperscript{b}</td>
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<td>0.04</td>
<td>0.05</td>
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</tr>
<tr>
<td>Talk with life partner</td>
<td>0.01</td>
<td>0.02</td>
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<td>0.003</td>
<td>-0.01</td>
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<td></td>
<td>-0.06</td>
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</tr>
<tr>
<td>Delivered bad news within past month</td>
<td></td>
<td>-0.05</td>
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<td></td>
</tr>
<tr>
<td>SW involved when delivering bad news</td>
<td></td>
<td>-0.01</td>
<td></td>
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<tr>
<td>Participant alone when performing CPR</td>
<td></td>
<td>0.04</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SW involved for patient receiving CPR</td>
<td></td>
<td>-0.02</td>
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<tr>
<td>SW involved for child abuse cases</td>
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<tr>
<td>Cared for victim of sexual abuse within past month</td>
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<td>Immediate debriefing occurs after traumatic clinical event</td>
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<td>Survivor of war/natural disaster</td>
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<td>No. of day shift attendings</td>
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<tr>
<td>( R^2 )</td>
<td>0.06</td>
<td>0.54</td>
<td>0.54</td>
<td>0.58</td>
<td>0.60</td>
<td>0.62</td>
</tr>
<tr>
<td>( R^2 ) change</td>
<td>0.003</td>
<td>0.54</td>
<td>0.001</td>
<td>0.04</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>( F ) change</td>
<td>1.1</td>
<td>395.7\textsuperscript{c}</td>
<td>0.30</td>
<td>6.08\textsuperscript{c}</td>
<td>2.66\textsuperscript{b}</td>
<td>1.34</td>
</tr>
</tbody>
</table>

\textsuperscript{BO} = burnout; \textsuperscript{CF} = compassion fatigue; \textsuperscript{CPR} = cardiopulmonary resuscitation; \textsuperscript{NP} = nurse practitioner; \textsuperscript{PA} = physician assistant; \textsuperscript{RN} = registered nurse; \textsuperscript{SW} = social work.

\textsuperscript{*}Standardized coefficients (beta) for each predictor are presented for each model.

\textsuperscript{a}p < 0.05; \textsuperscript{b}p < 0.01; \textsuperscript{c}p < 0.001.
survey, 70% of respondents reported involvement in care related to nonaccidental trauma, 48.5% in care related to sexual assault, 20% had performed CPR on a patient, and 12.5% experienced the death of a patient. Without adequate time, space, and proper avenues to process and manage emotions that inevitably accompany challenging clinical experiences, PEM providers are vulnerable to CF.38 Indeed, in our study population, nearly a quarter of participants reported having no opportunity to participate in any type of debriefing or critical incident management following a death in the ED or other traumatic clinical event.

Surprisingly, “engaging in prayer/meditation as self-care” was associated with higher CF scores. This was an unexpected finding, as frequent practice of prayer and mindfulness has been shown to lower perceived stress scores and improve CS scores.42 Preliminary studies have also suggested a positive effect of religion/spirituality on certain aspects of physician well-being.43 While we suspect that our study participants who were more distressed turned to prayer and/or meditation as a coping strategy than individuals with lower CF scores, this is an interesting area that merits further investigation.

Table 4
Hierarchical Multiple Regression of Predictors of BO Score in PEM Providers

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>Model 1*</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>-0.03</td>
<td>-0.07</td>
<td>-0.08</td>
<td>-0.07</td>
<td>-0.06</td>
<td>-0.04</td>
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<tr>
<td>CS score</td>
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<td>-0.25c</td>
<td>-0.25c</td>
<td>-0.23c</td>
<td>-0.23c</td>
<td>-0.23c</td>
</tr>
<tr>
<td>CF score</td>
<td>0.55c</td>
<td>0.49c</td>
<td>0.51c</td>
<td>0.50c</td>
<td>0.49c</td>
<td>0.50c</td>
</tr>
<tr>
<td>Physical exhaustion</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional depletion</td>
<td>0.19c</td>
<td>0.18c</td>
<td>0.16c</td>
<td>0.15p</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distress about</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical situation</td>
<td>-0.07</td>
<td>-0.06</td>
<td>-0.06</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Physical work environment</td>
<td>-0.06</td>
<td>-0.06</td>
<td>-0.08</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Administrative issues</td>
<td>0.05</td>
<td>0.06</td>
<td>0.07</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Coworkers</td>
<td>0.09a</td>
<td>0.09a</td>
<td>0.09a</td>
<td></td>
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<tr>
<td>Personal issues</td>
<td>0.08</td>
<td>0.06</td>
<td>0.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant’s health</td>
<td>-0.03</td>
<td>-0.03</td>
<td>-0.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cope with work stress through</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Exercise</td>
<td>0.00</td>
<td>0.01</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Socializing with family/friends</td>
<td>0.02</td>
<td>0.01</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Talk with colleagues</td>
<td>-0.04</td>
<td>-0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talk with life partner</td>
<td>-0.08</td>
<td>-0.08</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Talk with family member</td>
<td>-0.10a</td>
<td>-0.09a</td>
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<tr>
<td>Self-care is not a priority</td>
<td>0.05</td>
<td>0.05</td>
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<tr>
<td>Worked at current institution ≥ 10 years</td>
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<tr>
<td>Taught house staff/students on day of survey</td>
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<tr>
<td>RN/NP/PA involved in care of critically ill child</td>
<td>0.02</td>
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<tr>
<td>Participant alone when delivering bad news</td>
<td>-0.05</td>
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</tr>
<tr>
<td>Participant alone when performing CPR</td>
<td>0.03</td>
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<td></td>
</tr>
<tr>
<td>SW involved when patient receiving CPR</td>
<td>-0.001</td>
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<tr>
<td>SW involved for child abuse cases</td>
<td>-0.03</td>
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<td></td>
</tr>
<tr>
<td>Cared for victim of sexual abuse within past month</td>
<td>-0.03</td>
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<tr>
<td>Student involved in care of sexual abuse cases</td>
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<tr>
<td>Any debriefing after traumatic clinical event</td>
<td>-0.03</td>
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<tr>
<td>R²</td>
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<td>0.61</td>
<td>0.65</td>
<td>0.68</td>
<td>0.69</td>
<td>0.71</td>
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<tr>
<td>R² change</td>
<td>0.001</td>
<td>0.61</td>
<td>0.04</td>
<td>0.02</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>F change</td>
<td>0.16</td>
<td>152.39c</td>
<td>10.13c</td>
<td>2.36a</td>
<td>1.69</td>
<td>0.68</td>
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</tbody>
</table>

BO = burnout; CF = compassion fatigue; CPR = cardiopulmonary resuscitation; NP = nurse practitioner; PA = physician assistant; PEM = pediatric emergency medicine; RN = registered nurse; RT = respiratory therapist; SW = social work.

Standardized coefficients (beta) for each predictor are presented for each model. 

*p < 0.05; °p < 0.01; °p < 0.001.
Table 5
Hierarchical Multiple Regression of Predictors of CS Score in PEM Providers

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>Model 1*</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
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</thead>
<tbody>
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<td>Sex</td>
<td>-0.04</td>
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<td>-0.05</td>
<td>-0.04</td>
<td>-0.04</td>
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<tr>
<td>BO score</td>
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<td>-0.08</td>
<td>-0.08</td>
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<tr>
<td>Emotional depletion</td>
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<td>-0.11a</td>
<td>-0.14b</td>
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<tr>
<td>Distress about</td>
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<td>Clinical situation</td>
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<td>-0.07</td>
<td>-0.07</td>
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<td>-0.19c</td>
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<tr>
<td>Administrative issues</td>
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<td>-0.12c</td>
<td>-0.09b</td>
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<td>0.03</td>
<td>0.05</td>
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<tr>
<td>Cope with work stress through</td>
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<tr>
<td>Exercise</td>
<td>0.05</td>
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<tr>
<td>Socializing with family/friends</td>
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<td>0.09a</td>
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<tr>
<td>Talking with colleagues</td>
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<td>0.03</td>
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<tr>
<td>Talking with life partner</td>
<td>-0.04</td>
<td>-0.09a</td>
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<td>0.01</td>
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<tr>
<td>No. of PEM attendings on day shift</td>
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<tr>
<td>No. of patients seen per hour</td>
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<td>≥20 years as PEM provider</td>
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<tr>
<td>≥10 years at current institution</td>
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<tr>
<td>10%–24% of time spent caring for pediatric patients</td>
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<td>-0.09b</td>
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<tr>
<td>Formal training in</td>
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<tr>
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<td>-0.003</td>
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<td>Discussing medical errors</td>
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<tr>
<td>Self-care</td>
<td>0.04</td>
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<td></td>
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</tr>
<tr>
<td>This additional training done during fellowship</td>
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<tr>
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<td>-0.01</td>
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<tr>
<td>Delivered bad news to a family within past month</td>
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<td>Other MD involved when delivering bad news</td>
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</tr>
<tr>
<td>RN/NP/PA involved when delivering bad news</td>
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<td>0.07</td>
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</tr>
<tr>
<td>SW involved when patient receiving CPR</td>
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<tr>
<td>Chaplain involved when patient receiving CPR</td>
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<tr>
<td>Other team members involved for child abuse cases</td>
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<td></td>
<td></td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cared for victim of sexual abuse within past month</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate debriefing occurs after a death</td>
<td></td>
<td></td>
<td></td>
<td>0.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any debriefing occurs after traumatic clinical event</td>
<td></td>
<td></td>
<td></td>
<td>-0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survived life-threatening illness</td>
<td></td>
<td></td>
<td></td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.002</td>
<td>0.41</td>
<td>0.44</td>
<td>0.50</td>
<td>0.52</td>
<td>0.59</td>
</tr>
<tr>
<td>R² change</td>
<td>0.002</td>
<td>0.41</td>
<td>0.02</td>
<td>0.06</td>
<td>0.02</td>
<td>0.07</td>
</tr>
<tr>
<td>F change</td>
<td>0.63</td>
<td>229.58c</td>
<td>7.24c</td>
<td>6.54c</td>
<td>2.10</td>
<td>2.20c</td>
</tr>
</tbody>
</table>

BO = burnout; CPR = cardiopulmonary resuscitation; NP = nurse practitioner; PA = physician assistant; PEM = pediatric emergency medicine; RN = registered nurse; RT = respiratory therapist; SW = social work.

*Standardized coefficients (beta) for each predictor are presented for each model

a p < 0.05; b p < 0.01; c p < 0.001.
BO

The prevalence of BO in PEM physicians has been previously reported at 25% to 88.5%. The prevalence of BO in our study population falls just below the lower end of this range. It has been suggested that physicians working in teaching hospitals or academic research centers experience less BO. The fact that 93% of our participants reported affiliation with an academic medical center may contribute to the lower prevalence is noted our study population. Comparisons of the prevalence of BO across studies are obfuscated by the different instruments used for assessment. Most published studies of physician BO have utilized the Maslach Burnout Inventory. The length of this instrument and the expense of administration, however, constrain its practicality in large samples or in studies with assessments in multiple areas. As our primary goal was to study CF, BO, and CS as interrelated phenomena, it made sense to utilize a well-validated instrument like the CFST, which contained subscales for the phenomena of interest and was not prohibitive either in length or in cost of administration across a large sample.

In our study population, CF and CS scores were the most significant determinants of the BO score, with higher CF scores associated with higher BO scores and higher CS scores associated with lower BO scores. When CF and CS were controlled for in the models of BO, “emotional depletion” remained a significant independent predictor of higher BO scores. In our population, 15.3% of participants reported feeling emotionally depleted within the 2 weeks prior to survey. Although non–work-related issues surely factor into the equation, the cumulative toll of high-acuity patient care and a demanding ED environment are likely integral to this experience. Current distress about coworkers was an additional independent predictor of higher BO scores. Coworker relationships are known to be an important mediator in BO and job satisfaction, and the association between coworker distress and BO has been noted in other pediatric subspecialties. A compassionate work atmosphere may help protect health care providers from emotional exhaustion and mitigate perceived job demands. As such, any mechanism for enhancing CS may be an importance “antidote” to BO. In a similar vein, we found that talking with a family member as a means of self-care was a significant independent predictor of lower BO scores. Self-care activities are known to offset work-related dissatisfaction. Encouraging PEM physicians to ameliorate work-related stress by strengthening supportive relationships with loved ones may be an important target for intervention. While overnight shifts and long work hours have traditionally been considered among the most important stressors for EM physicians, in our study population, objective indices of perceived work demands were not significantly associated with BO scores.

CS

Few studies have reported prevalence and potential predictors of CS in health care providers. In a small sample (n = 29), PEM was previously shown to be a subspecialty with one of the highest rates of career satisfaction. The prevalence of CS in our population of PEM physicians was 18.5%, which is lower than what we have previously reported in neonatologists and pediatric palliative care providers, but higher than in pediatric critical care providers. CS increases throughout one’s career. The fact that > 50% of our study population was junior faculty may help to explain the lower prevalence of CS in our group. In addition, it is unclear whether career satisfaction and CS are synonymous in all cases, in that a provider might simultaneously experience tremendous satisfaction from clinical experiences and frustration/lack of fulfillment about academic/career advancement. Indeed, in our study population, lower CS scores were associated with “distress due to administrative issues” and not with “distress due to a clinical situation.” Heavy administrative burdens, including performance measures and time-based targets, as well as stress from expectations about academic output, combined with loss of time that could be spent on patient care or other more career-affirming activities, likely diminishes CS. Indeed, in our population, spending only 10% to 24% of time caring for pediatric patients was a significant determinant of lower CS scores. Institutions should be cognizant of administrative expectations placed on PEM physicians to ensure that they are realistic and offer channels to receive physician feedback regarding work-related stressors; improved communication is known to promote CS and worker longevity. Finally, socializing with family/friends was found to be a significant predictor of higher CS scores in our study population, whereas talking with a life partner about work-related distress was associated with lower CS scores. We suspect that
participants who were the most distressed (that is, with lower CS scores) found comfort in speaking with their life partner as a coping strategy. As with BO, bolstering supportive relationships outside of the hospital is a vital self-care mechanism that may allow PEM physicians some relief from the challenges of work.

LIMITATIONS

There are several limitations to our study. Of the 247 institutions searched for PEM provider contacts, only 103 facilities had accessible information. Contact information posted online may be outdated; as a result, it is possible our response rate was higher than our calculation.49 Because SurveyMonkey collects anonymous responses, we were not able to determine how many of the 103 institutions were represented in our sample. There is an inherent risk of nonresponse bias in this study. However, because survey data was collected anonymously, characterization of nonresponders could not be determined; it was impossible to compare those who responded to the survey with those who did not. It is possible that individuals at the greatest risk for CF or BO were less likely to participate in our study, or the reverse may be true. Comparisons of the prevalence of CF and BO between studies are complicated by the different instruments used for assessment. The generalizability of our findings is limited by the sample size and by the fact that participants were largely female, Caucasian, and junior faculty, and worked in academic medical centers. Due to the time frame of self-reflection for the survey instrument, there may be bias toward more recent symptoms. In the attempt to limit the survey length, some potentially significant predictors may not have been included. While identified factors accounted for 62, 71, and 59% of the variance in CF, BO, and CS scores, respectively, approximately one-third to one-quarter of the variance in these scores has yet to be explained. Finally, our findings are observed associations to which causality cannot be applied.

CONCLUSIONS

Pediatric emergency medicine providers are uniquely poised at the frontline of pediatric health care and face unique challenges and emotional stressors. While compassion fatigue, burnout, and compassion satisfaction are distinct phenomena, there are degrees of overlap among their predictive factors; these may be the areas most ripe for intervention. At the individual level, positive interpersonal relationships, including therapeutic discussion with loved ones and compassionate connections with coworkers, are key to provider well-being. At the institutional level, providing outlets for coping with difficult clinical situations and optimization of the physical work environment and administrative requirements may similarly improve health across all domains. Greater awareness of compassion fatigue, burnout, and compassion satisfaction, as well as potential predictors of these phenomena, may allow individuals, as well as institutional leadership, to more effectively address the emotional, physical, and cognitive stressors of clinical care in the pediatric ED. Promoting self-care at personal and professional levels is essential to augment compassion satisfaction and protect against compassion fatigue and burnout to sustain emotional well-being throughout one’s career.

References


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**Supporting Information**

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13670/full.

**Data Supplement S1.** Supplemental material.
The Extended Treatment Window’s Impact on Emergency Systems of Care for Acute Stroke

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The window for acute ischemic stroke treatment was previously limited to 4.5 hours for intravenous tissue plasminogen activator and to 6 hours for thrombectomy. Recent studies using advanced imaging selection expand this window for select patients up to 24 hours from last known well. These studies directly affect emergency stroke management, including prehospital triage and emergency department (ED) management of suspected stroke patients. This narrative review summarizes the data expanding the treatment window for ischemic stroke to 24 hours and discusses these implications on stroke systems of care. It analyzes the implications on prehospital protocols to identify and transfer large-vessel occlusion stroke patients, on issues of distributive justice, and on ED management to provide advanced imaging and access to thrombectomy centers. The creation of high-performing systems of care to manage acute ischemic stroke patients requires academic emergency physician leadership attentive to the rapidly changing science of stroke care.

Acutic ischemic stroke in the United States is the fifth leading cause of death and the leading cause of preventable disability and has an incidence of over 700,000 annual events. The treatment of acute ischemic stroke changed dramatically following the publication of the National Institute of Neurological Disorders and Stroke (NINDS) trials in 1995, which demonstrated improved outcomes for patients treated with intravenous tissue plasminogen activator (IV t-PA). Since then, national quality improvement efforts such as Get With The Guidelines - Stroke have sought to promote rapid stroke evaluation and IV t-PA delivery to appropriate patients.

Patients with acute ischemic stroke and large-vessel occlusion (LVO) are at especially high risk of poor outcomes. They represent only one-third of all ischemic stroke cases, but LVO strokes are responsible for over 95% of acute ischemic stroke-related mortality and 60% of acute ischemic stroke-related death or permanent dependency. Without emergent recanalization, 60% to 80% of LVO strokes result in death or permanent disability. Landmark trials published in 2015 used clinical and imaging-based criteria to select LVO stroke patients for endovascular therapy and significantly changed the treatment landscape for acute ischemic...
stroke.\textsuperscript{7–12} These trials demonstrated endovascular therapy as a highly effective treatment for LVO stroke and revealed the potential for beneficial treatment beyond the 4.5-hour IV t-PA treatment window.\textsuperscript{12}

Ongoing advancements in the imaging selection of stroke patients most likely to benefit from reperfusion therapies led to the conduct and recent publication of three trials in 2018 that are highly relevant to emergency care.\textsuperscript{13–15} They shift the paradigm of acute ischemic stroke treatment from time-based to “tissue-based” treatment decisions. Tissue-based assessment determines salvageable brain tissue on advanced imaging rather than rigid treatment windows defined by time from last known well.\textsuperscript{16} This paper summarizes these trials and analyzes their potential impact on stroke systems of care. We analyze the impact on prehospital stroke care, on relevant issues of distributive justice, and on emergency department (ED) management.

**THROMBECTOMY TRIALS EXPANDING TREATMENT UP TO 24 HOURS FROM SYMPTOM ONSET**

The DAWN\textsuperscript{13} and DEFUSE-3\textsuperscript{14} trials were prospective studies that randomized late-presenting patients with anterior LVO stroke to endovascular thrombectomy plus standard medical therapy versus standard medical therapy alone (Table 1). Both studies enrolled patients with a last known well time > 6 hours prior to presentation (6–24 hours for DAWN and 6–16 hours for DEFUSE-3). These studies utilized advanced imaging protocols to ensure the presence of LVO without large areas of core infarct. The primary outcome was the proportion of patients with functional independence at 90 days, defined as a modified Rankin scale (mRS) score of 0 to 2. The DAWN trial also had a coprimary endpoint of the mean utility-weighted mRS, a patient-centered outcome using the mRS and a utility approach to quality of life.

In these trials, subjects had major neurologic deficits with small-volume ischemic core on imaging at the time of enrollment. The trials defined the ischemic core by measurements using computed tomography (CT) perfusion imaging and RAPID software (iSchemaView). In DAWN, patients had to have a mismatch between the volume of the ischemic core and clinical findings determined by the patient’s NIHSS. In DEFUSE-3, patients had to have a ratio of ischemic tissue to infarct volume on perfusion imaging of 1.8 or greater.

### Table 1

Comparing Recent Trials of Extended Treatment Windows for Acute Stroke Patients\textsuperscript{*}

<table>
<thead>
<tr>
<th></th>
<th>DAWN13</th>
<th>DEFUSE-314</th>
<th>WAKE-UP15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention vs. standard care</strong></td>
<td>Thrombectomy</td>
<td>Thrombectomy</td>
<td>IV t-PA</td>
</tr>
<tr>
<td><strong>Enrollment window (hr)</strong></td>
<td>6–24</td>
<td>6–16</td>
<td>&gt;4.5</td>
</tr>
<tr>
<td><strong>Time from randomization (hr), median (IQR)</strong></td>
<td>12.2 (10.2–16.3)</td>
<td>10.9 (8.8–12.3)</td>
<td>10.3 (8.1–12.0)</td>
</tr>
<tr>
<td><strong>Age limit (years)</strong></td>
<td>≥18</td>
<td>18–90</td>
<td>18–80</td>
</tr>
<tr>
<td><strong>Mean (±SD) or median (IQR)</strong></td>
<td>69.4 (±14.1)</td>
<td>70 (59–79)</td>
<td>65.3 (±11.2)</td>
</tr>
<tr>
<td><strong>Lower limit of baseline NIHSS</strong></td>
<td>≥10</td>
<td>≥6</td>
<td>&gt;0</td>
</tr>
<tr>
<td><strong>Baseline NIHSS, median (IQR)</strong></td>
<td>16 (10–20)</td>
<td>17 (13–21)</td>
<td>6 (4–9)</td>
</tr>
<tr>
<td><strong>Preexisting disability limit (mRS)</strong></td>
<td>≤2</td>
<td>≤2</td>
<td>≤1</td>
</tr>
<tr>
<td><strong>Upper limit of infarct volume (mL)</strong></td>
<td>&lt;70</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Volume of ischemic core (mL), median (IQR)</strong></td>
<td>7.6 (2.0–18.0)</td>
<td>9.4 (2.3–25.6)</td>
<td>2.0 (0.8–7.9)</td>
</tr>
<tr>
<td><strong>Ratio of ischemic tissue to infarct core</strong></td>
<td>Clinical mismatch†</td>
<td>≥1.8</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Functional independence at 90 days</strong></td>
<td>49% vs. 13%</td>
<td>45% vs. 17%</td>
<td>53% vs. 42%</td>
</tr>
<tr>
<td><strong>Number needed to treat (95% CI)</strong></td>
<td>3 (2–4)</td>
<td>4 (3–7)</td>
<td>9 (5–36)</td>
</tr>
<tr>
<td><strong>Safety outcomes, intervention vs. control</strong></td>
<td>19% vs. 18%</td>
<td>14% vs. 26%</td>
<td>4.1% vs. 1.2%</td>
</tr>
<tr>
<td><strong>Parenchymal hematoma type 2</strong></td>
<td>1.9% vs. 1.0%</td>
<td>9% vs. 3%</td>
<td>4.0% vs. 0.4%</td>
</tr>
</tbody>
</table>

\textsuperscript{*}Characteristics and results presented of treatment groups only, except where indicated. The enrollment window as measured from the last known normal time. Functional independence defined as a mRS of 0 to 2 in DAWN and DEFUSE-3 but 0 or 1 in WAKE-UP. Parenchymal hematoma type 2 is defined as an intracerebral hemorrhage involving more than 30% of the infarcted area with a substantial space-occupying effect or that is remote from the original infarcted area.

\textsuperscript{†}Clinical mismatch categorized in three groups: A = age ≥ 80 years, NIHSS ≥ 10, infarct volume < 21 mL; B = age < 80 years, NIHSS ≥ 10, infarct volume < 31 mL; C = age < 80 years, NIHSS ≥ 20, infarct volume < 51 mL.
The WAKE-UP study was a randomized, double-blind trial comparing IV t-PA versus placebo among ischemic stroke patients with unknown time of onset and stroke recognized > 4.5 hours prior to presentation. Patient eligibility required emergent magnetic resonance imaging (MRI) and abnormal signal on diffusion-weighted imaging (DWI) with no visible signal change on fluid-attenuated inversion recovery (FLAIR) imaging. Prior research demonstrated that this DWI-FLAIR mismatch indicates an onset time within the past 4 to 5 hours. Major inclusion/exclusion criteria as well as characteristics of the IV t-PA group are summarized in Table 1.

The trial was stopped early due to cessation of funding with 503 of the planned 800 patients enrolled. Patients with favorable DWI-FLAIR mismatch that received IV t-PA were significantly more likely to have a favorable outcome, defined as a mRS score of 0 or 1 at 90 days (adjusted OR = 1.61, 95% CI = 1.09 to 2.36). There was no significant difference in symptomatic intracranial hemorrhage, although there was a higher rate of the most severe form of radiologically classified hemorrhage, parenchymal hemorrhage Type 2, in the IV t-PA group (Table 1, p = 0.03). There was also a nonsignificant trend toward higher mortality rates in the IV t-PA cohort (adjusted OR = 3.38, 95% CI = 0.92 to 12.52).

### EXPANDING IV t-PA TREATMENT PAST 4.5 HOURS

Both DAWN and DEFUSE-3 had substantial numbers of participants with “wake-up” strokes (63 and 53%, respectively) in the thrombectomy groups. Wake-up strokes are those in which a patient awakens with stroke symptoms, but whose last known normal time was before going to sleep. These patients have historically been excluded from IV t-PA treatment due to inability to determine the true time of onset for their stroke. Furthermore, many patients with wake-up strokes do not have an LVO. The recently published WAKE-UP study was a randomized, double-blind controlled trial comparing IV t-PA versus placebo among ischemic stroke patients with unknown time of onset and stroke recognized > 4.5 hours prior to presentation. Patient eligibility required emergent magnetic resonance imaging (MRI) and abnormal signal on diffusion-weighted imaging (DWI) with no visible signal change on fluid-attenuated inversion recovery (FLAIR) imaging. Prior research demonstrated that this DWI-FLAIR mismatch indicates an onset time within the past 4 to 5 hours. Major inclusion/exclusion criteria as well as characteristics of the IV t-PA group are summarized in Table 1.

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### THE EXPANDED TREATMENT WINDOW’S IMPACT ON PREHOSPITAL STROKE CARE

The trials discussed above expand the treatment window to select patients. To translate these findings into clinical practice necessitates change to existing methods of patient selection and triage. Here we discuss the prehospital implications in reengineering stroke systems of care. Thrombectomy is time-sensitive and is only available at a limited number of stroke centers. Rapid identification and direct transport of LVO patients in the field to thrombectomy-capable hospitals has the potential to improve patient outcomes. To do so, however, requires accurate identification of patients with LVO stroke in the prehospital setting.

Despite derivation of more than 30 different stroke severity tools for this purpose, most have not been prospectively validated in the field, and diagnostic performance has been highly variable. The most rigorously studied LVO prediction tools include the Cincinnati Prehospital Stroke Severity Scale (CP-SSS), the Los Angeles Motor Score (LAMS), and Rapid Arterial Occlusion Evaluation (RACE). Based on prehospital data alone, sensitivities for these tools range from 38% to 76%, specificities range from 72% to 87%, and none demonstrate clear superiority. Table 2 demonstrates the accuracy of the common decision aid tools based on pooled data from a recent meta-analysis. The test characteristics of these tools vary substantially due to differences in the amount and type of data collected on neurologic symptoms. The LAMS tool, for instance, only collects data on three aspects of motor function, whereas the NIHSS collects 13 data points on sensory, motor, ocular, and executive function. Current evidence suggests that all scales are at risk of both under- and overtriage of
LVO stroke patients. It is not clear that clinical assessment-based prehospital assessments will adequately capture the heterogeneity of LVO stroke presentations.

To address the complex decision making around prehospital bypass decisions, the American Heart Association’s Mission: Lifeline Stroke committee published a consensus prehospital triage algorithm for use by regional stroke systems. According to this protocol, prehospital providers screen patients with suspected stroke using one of three stroke severity tools (CP-SSS, RACE, LAMS). They then transport patients with a positive LVO screen directly to a thrombectomy-capable center if the patient is within 6 hours of last known well and bypassing a closer ED would add less than 15 minutes to transport time. The real-world impact of such an algorithm is largely unknown, although a randomized controlled trial (RACECAT) using this strategy is ongoing.

In light of the recent trials expanding the thrombectomy treatment window to 24 hours, the 6-hour limit in such protocols requires reexamination. Bypassing stroke-ready hospitals and primary stroke centers up to 24 hours after symptom onset may expedite therapy for those patients who meet thrombectomy criteria. Indeed, interhospital transfer is associated with onset-to-revascularization delays averaging more than 100 minutes. However, such bypass protocols could also negatively impact care by placing patients farther from their families and overwhelming the stroke response systems of comprehensive stroke centers with patients who are not candidates for intervention.

Even if prehospital stroke assessment tools improve substantially in identifying LVO in the extended 6- to 24-hour time frame, many of these patients will ultimately not qualify for thrombectomy based on the selective imaging criteria in DAWN and DEFUSE-3. Development of bypass protocols that address such challenges while still ensuring rapid access to thrombectomy for eligible patients is a major research need. In the interim, prehospital triage algorithms require the input of emergency physicians for local consideration of EMS capacity, transport distances, and hospital resources to design regional protocols that maximize access to thrombectomy for appropriate candidates while minimizing wasteful resource utilization.

### ISSUES OF DISTRIBUTIVE JUSTICE IN CHANGING STROKE SYSTEMS OF CARE TO EXPAND THE TREATMENT WINDOW

The ethics of distributive justice address the balance between benefits and burdens within a population. When considering triage and management of potential LVO stroke patients, there exists a balance between providing the greatest benefit to these patients while limiting burdens to the remaining population of patients seeking emergency medical care at a single site or within a larger system. As noted, bypassing of closer hospitals for potential LVO patients can also strain patient families, consume prehospital resources, and overwhelm academic stroke centers with nonthrombectomy candidates.

The ethical conflicts arise between the utilitarian goal to do the greatest good for the greatest number and the principles of nonmaleficence and equal respect for all. Triage decisions become challenging when a condition is life-threatening and a lifesaving resource is scarce, such as occurs in disaster situations. In the case of thrombectomy, the scarcity of the resource is rapidly changing. With 2011 data, 56% of people within the United States had access by ground to endovascular-capable hospitals within 60-minute transport time. By air transport, this proportion increased to 85%. As health systems create referral patterns and increase their capacity to perform emergent thrombectomy, the scarcity of endovascular care will shrink. Likewise, the scarcity of emergent MRI may shrink and provide added treatment capacity for patients without LVO who present > 4.5 hours from last known well.

### Table 2
Prehospital Clinical Decision Aids for Triaging Suspected LVO Stroke Patients

<table>
<thead>
<tr>
<th>NIHSS*</th>
<th>RACE</th>
<th>CP-SSS</th>
<th>LAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Items scored</td>
<td>13</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Score threshold</td>
<td>≥6</td>
<td>≥5</td>
<td>≥2</td>
</tr>
<tr>
<td>Sensitivity for LVO, % (95% CI)</td>
<td>80 (0.75–0.85)</td>
<td>69 (0.46–0.85)</td>
<td>56 (0.50–0.63)</td>
</tr>
<tr>
<td>Specificity for LVO, % (95% CI)</td>
<td>72 (0.70–0.74)</td>
<td>81 (0.67–0.90)</td>
<td>82 (0.73–0.89)</td>
</tr>
<tr>
<td>Area under the curve*</td>
<td>0.80</td>
<td>0.77</td>
<td>0.72</td>
</tr>
</tbody>
</table>

CP-SSS = Cincinnati Prehospital Stroke Severity Scale; LAMS = Los Angeles Motor Score; LVO = large-vessel occlusion; NIHSS = National Institute of Health Stroke Scale; RACE = Rapid Arterial Occlusion Evaluation.
*95% CI not available.
Thrombectomy for eligible LVO stroke patients is one of the most impactful, evidence-based emergency medical interventions. Hence, relative to many other emergent diagnoses and interventions, there should be a higher rate of tolerance for false positives in screening and for relocating resources from other sick patients. Such tolerance is dependent on the values communities hold and operational decisions by health systems.

THE EXPANDED TREATMENT WINDOW’S IMPACT ON ED AND HOSPITAL STROKE READINESS

At the ED and hospital level, operational decisions largely fall within their stroke care designations. The Joint Commission began designating primary stroke centers (PSCs) in 2004. The PSC was required to demonstrate compliance with specific quality measures and demonstrate a minimum number of strokes that were treated with IV t-PA or thrombectomy.34 Subsequently, the Joint Commission also began recognizing centers capable of providing more advanced stroke care, defined as comprehensive stroke centers (CSC).35 Beyond PSC requirements, CSCs provide neurocritical care, 24/7 access to advanced imaging, endovascular procedure capability, and on-site neurosurgical providers.

Recently, The Joint Commission also began certifying thrombectomy-capable hospitals (TCHs).36 These represented an intermediary between CSCs and PSCs and originally required physician-specific certification to perform acute stroke thrombectomy and minimum procedural volumes. Nevertheless, in September 2018, The Joint Commission suspended physician training and volume requirements for both CSC and TCH hospitals.37 Interventional experts in acute stroke therapy raised concern over this change, noting that evidence to support good outcomes for LVO patients is lacking when thrombectomy is performed by low-volume hospitals.38 Centers with higher volumes and ongoing quality improvement processes demonstrate faster door-to-treatment time for thrombectomy and excellent outcomes in prior trials.39–41 While TCHs have the potential to lower times to treatment in geographic locations where CSCs are sparse, striking the right balance between access and adequate expertise in LVO management requires further investigation.

The advances in stroke therapy have created an imperative for EDs to establish protocols to identify acute ischemic stroke patients who might benefit from reperfusion therapies. This includes screening protocols for LVO for patients up to 24 hours past their last known well time. Many EDs have developed protocols for patients who present within 6 hours since last known well, but the results of DEFUSE-3 and DAWN broaden the challenge of screening many more patients up to 24 hours from onset of symptoms.42 Some EDs have implemented broad screening protocols that include performance of CT angiography (CTA) in every code stroke patient.43 Other systems perform CTA selectively, based on clinical criteria such as a LAMS score ≥ 4 or NIHSS ≥ 6.44 Data indicate that use of a NIHSS ≥ 6 to select patients for CTA has 80% sensitivity and 72% specificity for predicting LVO.22

In addition to expanding the pool of stroke patients who require screening for LVO, the results of DAWN and DEFUSE-3 have implications for the imaging techniques required. These trials used perfusion imaging to determine infarct size and perfusion mismatch with RAPID software.13,14 While RAPID software performs automated calculation of the ischemia to infarct ratio on CT perfusion, it should be noted that such a calculation can be accomplished without proprietary software and that MRI with MRI perfusion is an alternative screening method.42 Figure 1 demonstrates CT perfusion images with RAPID software calculation in a patient with a LVO that stands to benefit from thrombectomy. The perfusion mismatch ratio is 7.9, indicating a significant volume of hypoperfused tissue relative to infarcted tissue. If perfusion imaging is not available, transfer to a facility that can perform appropriate imaging and thrombectomy should be considered. The American Heart Association guidelines endorse telemedicine with stroke teams to assist in the processes around advanced imaging and transfer criteria.42

Health systems are beginning to test protocols to optimally manage wake-up stroke patients. Many stroke patients with unknown onset outside the traditional 4.5-hour treatment window may be candidates for IV t-PA. Nevertheless, based on the WAKE-UP study protocol, determination of eligibility requires estimation of the diffusion-FLAIR mismatch on MRI. Fewer EDs have emergent MRI capacity compared to CTA and CT perfusion imaging. There is a need for further research to determine the real-world application of the WAKE-UP protocol and to determine if select wake-up patients benefit...
from transfer when emergent MRI is not available at a presenting ED.

The complex decision making involved in managing patients eligible for the time-sensitive interventions of IV t-PA and thrombectomy requires well-orchestrated systems of care. Development of clear protocols for EDs without thrombectomy capacity includes simplified decisions for advanced imaging, transfer decisions, and use of telemedicine. Many tertiary hospital systems have associations with smaller community sites that refer stroke patients to the hub hospital. Institutions not affiliated with a tertiary hospital should develop relationships with PSC and CSC hospital systems to develop protocols for the evaluation and transfer process for complex stroke patients who require higher levels of care. Academic emergency physicians at the PSC and CSC sites can be instrumental in fostering these relationships and developing well-orchestrated systems of care.

CONCLUSIONS

The expansion of the stroke treatment window based on advanced imaging criteria represents important advances in acute ischemic stroke therapy. Emergency physicians have significant leadership responsibilities in creating optimal systems of care. These responsibilities include leadership of medical control and prehospital protocols. They also include ED workflow, transport of select patients, and management within comprehensive stroke centers that have growing volumes of high-acuity stroke patients. Emergency physician guidance is critical in adapting the current science to improve systems of care and outcomes of acute ischemic stroke patients.

References


“Full Stomach” Despite the Wait: Point-of-care Gastric Ultrasound at the Time of Procedural Sedation in the Pediatric Emergency Department

Julie Leviter, MD, Dale W. Steele, MD, MS, Erika Constantine, MD, James G. Linakis, PhD, MD, and Siraj Amanullah, MD, MPH

ABSTRACT

Objectives: The objective was to use gastric point-of-care ultrasound (POCUS) to assess gastric contents and volume, summarize the prevalence of “full stomach,” and explore the relationship between fasting time and gastric contents at the time of procedural sedation.

Methods: This was a prospective study of patients aged 2 to 17 years fasting prior to procedural sedation. A single sonographer scanned each patient’s gastric antrum in two positions: supine with the upper body elevated and right lateral decubitus (RLD). Gastric content (empty, liquid, or solid) was noted, and the gastric volume (mL/kg) was estimated from antral cross-sectional area (CSA). “Full stomach” was defined as any solid content or >1.2 mL/kg of liquid gastric content.

Results: We enrolled 116 subjects, with a median fasting time of 5.8 hours. Of the 107 with evaluable images, 74 patients, 69% (95% confidence interval [CI] = 60%–77%), were categorized as having a full stomach. Each hour of fasting was associated with lower odds (odds ratio = 0.79, 95% CI = 0.65–0) of a full stomach. However, the knowledge of fasting time alone provides little ability to discriminate between risk groups (C-index = 0.66).

Conclusions: Gastric POCUS classified many patients as having a full stomach at the time of expected procedural sedation, despite prolonged fasting times. These findings may inform risk–benefit considerations when planning the timing and medication choice for procedural sedation.

There is a current lack of consensus regarding the need for a minimum period of fasting prior to nonelective sedation for urgent or emergent procedures in the pediatric emergency department (PED).1–3 Recommendations from the American Academy of Pediatrics (AAP)4 for children undergoing elective procedures mirror guidelines for general anesthesia from the American Society of Anesthesiologists and recommend fasting prior to sedation for 2 or 6 hours after clear liquid or a light meal, respectively. For children

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Received July 24, 2018; revision received October 12, 2018; accepted October 21, 2018.

This research was presented at the Pediatric Academic Society meeting in Toronto, Ontario, Canada in May 2018, for which the corresponding author received the Travel Award for Young Investigators. It was also presented at the Society for Pediatric Sedation Conference in Atlanta, GA, May 2018.

Funded by a university emergency medicine foundation seed grant.

The authors have no potential conflicts to disclose.

Author contributions: All listed authors have participated in the concept and design of this study, data analysis and interpretation, drafting of the manuscript, critical revision of the manuscript for important intellectual content, and acquisition of funding; JL conducted data acquisition; DWS performed the statistical analyses and created data visualizations; and all authors listed have approved the manuscript as submitted.

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ACADEMIC EMERGENCY MEDICINE 2019;26:752–760.

ISSN 1553-2712 © 2018 by the Society for Academic Emergency Medicine doi: 10.1111/acem.13651
requiring urgent/emergent sedation, the AAP guideline states that “the risks of sedation and possible aspiration are as-yet unknown and must be balanced against the benefits of performing the procedure promptly.” The 2014 clinical policy statement from the American College of Emergency Physicians (ACEP) summarized studies that found no association between the duration of preprocedural fasting and the risk of emesis or aspiration. They recommended that “future research should focus on the identification of a potential high-risk population that might benefit from a fasting time . . . if such a delay is to be relevant in any ED procedural sedations.”

Prolonged fasting is not always benign. It can increase patient hunger and anxiety, reduce intravascular volume, prolong ED length of stay, cause hypoglycemia, and reduce parental and patient satisfaction.

Unlike patients fasting prior to elective sedation, PED patients awaiting procedural sedation often have painful injuries, are frequently treated with opioids, and may have eaten large fatty meals immediately preceding injury, all of which can slow gastric emptying. Large, multicenter studies are necessary to estimate the risk of pulmonary aspiration in any setting. Gastric point-of-care ultrasound (POCUS), a technique developed by anesthesiologists, allows us to address a simpler question—what are the stomach contents and volume after a period of fasting prior in patients awaiting procedural sedation in our PED?

The terms “full stomach” and “empty stomach” are a convenient, albeit overly simplistic, shorthand to describe gastric contents and volume. As described by Kinsella, “the fullness of a stomach is different from the fullness of a glass. It can contain a variable amount of contents, which may comprise clear or particulate liquids and solids in various degrees of chunkiness.”

Prior studies in both adults and children have used POCUS to identify liquid or solid contents and to assess gastric volume. We adopted the Perlas scale, which combines a qualitative description of stomach contents (empty, liquid, solids) and quantitative gastric volume estimated from antral cross-sectional area (CSA). The Perlas category labels are ordered by “risk of aspiration,” reflecting their intended application in the preoperative setting, as applied to healthy pediatric patients who have fasted for elective surgery. Patients with either an empty antrum (“low risk”) or a negligible volume (typically ≤ 1.2 mL/kg) of gastric secretions (“suggests low risk”) are classified as having an empty stomach. Conversely, patients with solid contents or higher volumes of clear fluid are considered to have a full stomach.

This study does not undertake the ambitious goal of determining whether procedural sedation can be safely performed in patients with full stomach. Rather, we aimed to: 1) use POCUS to describe gastric contents and volume, based on Perlas categories; 2) summarize the prevalence of full stomach; and 3) explore the relationship between fasting time and these measures of gastric content and volume in patients undergoing procedural sedation in the PED.

**METHODS**

**Study Design and Setting**

We performed a prospective observational study in the PED at an urban academic children’s hospital with pediatric Level 1 trauma designation and an annual census of 55,000 patients, from June to December 2017. Approximately 800 patients undergo procedural sedation in our department each year. The study protocol was reviewed and approved by the hospital institutional review board.

**Study Population**

We enrolled patients aged 2 to 17 years who were fasting in anticipation of procedural sedation. We excluded patients with conditions likely to affect gastric emptying including gastrointestinal pathology, presence of an acute or chronic systemic illness, or multisystem trauma and those taking medications with gastrointestinal effects. Potential participants were identified by PED staff and research assistants. Patients were enrolled after obtaining informed consent if the primary investigator was available. Parents received a gift card of $10 value following participation.

**Study Protocol and Measures**

All POCUS evaluations were performed by a single sonographer (principal investigator JL) who had previously completed over 30 gastric POCUS scans supervised by the study site’s pediatric POCUS director (coinvestigator EC). Patients were scanned using gastric POCUS at the time of “readiness for procedural sedation,” defined in our PED as at least 2 hours since last liquid intake and 4 hours since last solid intake. The exact timing of this measurement varied based on the availability of the sonographer and the actual time...
that each participant was sedated. Patient care was not delayed or interrupted by participation in this study, and no additional analgesic or sedative medications were administered to aid in obtaining images. Furthermore, the medical team managing the patient was blinded to ultrasound findings.

A Sonosite M-Turbo portable ultrasound machine was used to obtain a cross-sectional view of the antrum in the sagittal plane at the level of the liver and aorta using a 5–2 MHz curvilinear probe placed in the epigastrium. Scans were done in two positions: supine with the upper body elevated at 45° (SUBE) and right lateral decubitus (RLD), following the protocol described by Perlas and colleagues (Figure 1). Antral contents were assessed qualitatively in the SUBE and RLD positions, and interpreted as empty, liquid, or solid (Figure 2). The sonographer then traced the antral circumference in the RLD position, in between antral contractions, using the manual caliper tool. From this, the machine calculated the antral CSA. Images were automatically uploaded to a password-protected database. The time required to complete each POCUS examination was recorded.

All study data were managed on REDCap (Research Electronic Data Capture), a secure, Web-based application designed to support data capture for research studies. To evaluate inter-rater reliability, POCUS images were deidentified and retrospectively reviewed by the study site’s pediatric POCUS director (co-investigator EC), who was blinded to the clinical information and to the principal sonographer’s interpretation.

At the time of enrollment, the researcher recorded baseline information from the patient and electronic medical record on a standardized data sheet. This included patient age, weight, height, race, ethnicity, time, and nature of the most recent oral intake, timing of injury, self-reported pain severity, and medications received. Adverse events were noted through retrospective chart review of the procedure note, as well as nursing notes that followed the patient’s course through to discharge. Possible adverse events included retching/vomiting, oxygen desaturation, bradycardia, hypotension, allergic reaction, adverse behavioral reactions, and suspected or confirmed aspiration.

**Data Analysis**
We adopted the Perlas score, developed by anesthesiologists for preoperative aspiration risk assessment, as a metric to combine information about gastric content and volume into one of four ordinal categories (Figure 3). Gastric volume (mL/kg) was estimated from CSA (cm$^2$) and age (months) using a previously developed prediction equation:

$$\text{Volume} = -7.8 + (3.5 \times \text{CSA}) + (0.127 \times \text{age}).$$

We used 1.2 mL/kg as a cutoff of fasting gastric secretions based on estimates from prior studies, which range from 1.2 to 1.5 mL/kg in a pediatric patient. Gastric contents were deemed “low risk” if the antrum qualitatively appeared empty (flat and collapsed or round and targetoid with a thick and prominent antral wall) in both SUBE and RLD positions. Contents were categorized as “suggests low risk” if liquid was present in either RLD or SUBE with a volume $\leq$ 1.2 mL/kg and as “suggests high risk” if liquid volume was $> 1.2$ mL/kg. “High risk” was defined as solid contents seen in either position. The former two categories (low risk and suggests low risk) were considered empty stomach and the latter two (suggests high risk and high risk) were considered full stomach (Figure 3).

Data were analyzed using R version 3.5.1. The zanthro extension for Stata (StataCorp, 2017, Stata Statistical Software, Release 15) was used to calculate body mass index categories. Categorical measurements were summarized as counts and percentages. Continuous data were summarized by mean and standard deviation (SD), and skewed data, by the median and 25th and 75th percentiles. We calculated that a minimum sample size of 93 patients was needed to ensure that the 95% Wilson score confidence interval (CI) for the proportion of patients with a full stomach was not
The R package *ggplot2* was used to plot kernel density estimates for the distribution of patients in each Perlas category over the range of fasting times. This technique produces a continuous curve from the data located a small distance from each data point and then adds individual kernels to obtain a smooth distribution.

![Gastric content as visualized by POCUS](image)

**Figure 2.** Gastric content as visualized by POCUS. Ultrasound images of the gastric antrum in the epigastric area obtained in a sagittal plane in the RLD position, representing (A) empty, (B) liquid, and (C) solid contents. An empty antrum appears flattened and devoid of contents. Liquid contents appear hypoechoic or anechoic, and solid contents appear hyperechoic, often with particulate content. Yellow arrow = antrum. Ao = aorta; L = liver; POCUS = point-of-care ultrasound; RLD = right lateral decubitus.

<table>
<thead>
<tr>
<th>Patients Screened</th>
<th>N = 126</th>
</tr>
</thead>
<tbody>
<tr>
<td>Met exclusion criteria = 4</td>
<td></td>
</tr>
<tr>
<td>Declined participation = 6</td>
<td></td>
</tr>
<tr>
<td>Consent n = 116</td>
<td></td>
</tr>
<tr>
<td>Discharged early = 1</td>
<td></td>
</tr>
<tr>
<td>n = 112</td>
<td></td>
</tr>
<tr>
<td>Indeterminate content or volume = 5</td>
<td></td>
</tr>
<tr>
<td>• No RLD: empty in SUBE (3)</td>
<td></td>
</tr>
<tr>
<td>• No CSA: liquid in SUBE &amp; RLD (2)</td>
<td></td>
</tr>
</tbody>
</table>

**Gastric contents**

- **Empty in RLD & SUBE** |
  - n = 20 |
  - • No CSA (1)

- **Liquid content in RLD or SUBE** |
  - n = 18

- **Solid Content in RLD or SUBE** |
  - n = 69 |
  - • No RLD (4), No CSA (19)

<table>
<thead>
<tr>
<th>Perlas Score</th>
<th>Volume ≤ 1.2 ml/kg</th>
<th>Volume &gt; 1.2 ml/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Low Risk&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
  - n = 20 |
| "Suggests Low Risk" |
  - n = 13 |
| "Suggests High Risk" |
  - n = 5 |
| "High Risk" |
  - n = 69 |

- **"Empty Stomach"** |
  - n = 33 |

- **"Full Stomach"** |
  - n = 74 |

**Figure 3.** Patient flow diagram and classifications by Perlas category. *Bulleted lists* describe reasons for incomplete POCUS evaluation with counts in parentheses. *Arrows* indicate explanations for lack of evaluable images. No RLD = no POCUS images in right lateral decubitus position; No CSA = antral cross-sectional area could not be measured; N = total number of patients screened; n or (n) = number of patients in each category. CSA = cross-sectional area; POCUS = point-of-care ultrasound; RLD = right lateral decubitus; SUBE = supine with the upper body elevated.

Wider than ±0.10. The R package *ggplot2* was used to plot kernel density estimates for the distribution of patients in each Perlas category over the range of fasting times. This technique produces a continuous curve from the data located a small distance from each data point and then adds individual kernels to obtain a smooth distribution.
a smoothed histogram. Logistic regression was used to estimate the effect of fasting time on the predicted probability of a full stomach. The concordance index (C-index), equivalent to the area under the receiver operating characteristic curve, was calculated. The C-index ranges between 0.5 and 1.0. A value of 0.5 indicates the model has no ability to discriminate between low- and high-risk subjects, whereas a value of 1.0 indicates the model can perfectly discriminate between these groups. Inter-rater agreement between the researcher and expert reviewer was summarized by weighted kappa coefficients, where the disagreements are weighted so as to be proportional to the square of the distance between the pair of measures.

## RESULTS

We enrolled 116 subjects, 115 of whom had a POCUS examination (Table 1). An unambiguous Perlas score was determined in 107 subjects. Of these, 74 subjects 69% (95% CI = 60%–77%) were categorized as having a full stomach (Figure 3). Figure 4A shows the number and percentage of subjects assigned to each category. For subjects in whom a CSA could be obtained and gastric volume estimated, Figure 4B illustrates the observed gastric volumes and the distributions of gastric volume in each group.

The stacked kernel density plot displays the number of subjects in each Perlas category over the observed range of fasting times, with a preponderance of subjects in the “high-risk” category (Data Supplement S1, available as supporting information in the online version of this paper, which is available at http://online library.wiley.com/doi/10.1111/acem.13651/full). The median fasting time was 5.8 hours. As illustrated in Figure 5, there is considerable overlap between the fasting times in each group. The predicted probability of a full stomach remains substantial despite prolonged fasting times. Although each hour of fasting was associated with lower odds (odds ratio = 0.79, 95% CI = 0.65 to 0.94) of having a full stomach, the knowledge of fasting time alone provides little ability to discriminate between risk groups (C-index = 0.66).

Point-of-care ultrasound assessments took a median of 4 minutes (IQR = 3 to 5 minutes) to complete. The weighted kappa for inter-rater agreement was 0.74 (95% CI = 0.68 to 0.79). Of 115 participants undergoing an ultrasound, 32 (28%) had their gastric POCUS scan a median of 44 minutes (IQR = 29 to 53 minutes) after, rather than before, the onset of procedural sedation (18 due to either lack of investigator availability prior to sedation or parental preference and 14 due to an inability of the patient to tolerate RLD positioning for a complete scan prior to sedation).

### Table 1

Demographic and Clinical Characteristics of the 116 Enrolled Patients Fasting in Preparation for Procedural Sedation in a Pediatric ED: June–December 2017

<table>
<thead>
<tr>
<th>Demographics</th>
<th>n = 116</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>8.4 (±4.0)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>37 (31.9)</td>
</tr>
<tr>
<td>BMI classification</td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>14 (12.1)</td>
</tr>
<tr>
<td>Healthy weight</td>
<td>60 (51.7)</td>
</tr>
<tr>
<td>Overweight</td>
<td>26 (22.4)</td>
</tr>
<tr>
<td>Obese</td>
<td>16 (13.8)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>75 (64.7)</td>
</tr>
<tr>
<td>African American</td>
<td>8 (6.9)</td>
</tr>
<tr>
<td>Asian</td>
<td>4 (3.4)</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>24 (20.7)</td>
</tr>
<tr>
<td>Other/not reported</td>
<td>5 (4.3)</td>
</tr>
<tr>
<td>Fasting time (hours)</td>
<td></td>
</tr>
<tr>
<td>Solids</td>
<td>5.8 (4.6–7.7)</td>
</tr>
<tr>
<td>Liquids</td>
<td>5.2 (4.1–6.8)</td>
</tr>
<tr>
<td>Maximum pain reported</td>
<td></td>
</tr>
<tr>
<td>None/mild</td>
<td>2 (1.8)</td>
</tr>
<tr>
<td>Moderate</td>
<td>23 (19.8)</td>
</tr>
<tr>
<td>Severe</td>
<td>88 (75.9)</td>
</tr>
<tr>
<td>Not reported</td>
<td>3 (2.6)</td>
</tr>
<tr>
<td>Received opioid</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>75 (64.7)</td>
</tr>
<tr>
<td>Received ondansetron</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24 (20.7)</td>
</tr>
<tr>
<td>Reason for sedation</td>
<td></td>
</tr>
<tr>
<td>Fracture reduction</td>
<td>95 (81.9)</td>
</tr>
<tr>
<td>Laceration repair</td>
<td>9 (7.8)</td>
</tr>
<tr>
<td>Other</td>
<td>12 (10.3)</td>
</tr>
<tr>
<td>Recent fried/fatty food or meat</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>75 (64.7)</td>
</tr>
<tr>
<td>No</td>
<td>40 (34.5)</td>
</tr>
<tr>
<td>Not reported</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Procedural sedation agent used</td>
<td></td>
</tr>
<tr>
<td>Ketamine</td>
<td>43 (37.1)</td>
</tr>
<tr>
<td>Ketamine + midazolam</td>
<td>58 (50.0)</td>
</tr>
<tr>
<td>Intranasal midazolam*</td>
<td>3 (2.6)</td>
</tr>
<tr>
<td>No medication</td>
<td>12 (10.3)</td>
</tr>
</tbody>
</table>

Data are reported as mean (±SD), n (%), or median (IQR). BMI = body mass index; n = number of patients; IQR = interquartile range.

*Intranasal midazolam considered to be minimal sedation (anxiolysis).
Ultimately, 15 of 116 enrolled patients (19%) did not receive sedation. Of these, four were admitted for operative management, eight had injuries that were repaired or temporized without sedation, and three received only low-dose midazolam for anxiolysis. Medications used for sedation in those who did undergo procedural sedation are listed in Table 1. Of the 101 participants who ultimately received procedural sedation, four (4%, 95% CI = 1.6%–9.7%) vomited during the recovery period. Of the patients who vomited, three had been identified by gastric POCUS as high risk and one as suggests high risk. There were no other adverse events, including no suspected or confirmed aspiration events (0%, 95% CI = 0%–3.6%).

DISCUSSION

We found that a majority of enrolled PED patients would be considered as having a full stomach at the time of “readiness for procedural sedation” based on POCUS finding of residual solids or high-volume liquid contents. Moreover, fasting periods of 6 or more hours did not ensure an empty stomach. As summarized in Table 1, the majority of our patients had recently eaten fried/fatty food or meat, and the majority reported severe pain and received opioid analgesia, all of which can slow gastric emptying. Our findings mirror those of Bouvet and colleagues, who demonstrated that 56% of adults undergoing emergency surgical procedures had a full stomach at the time of anesthesia despite a mean fasting duration of 18 hours.

Two recent studies in the PED setting have evaluated the relationship between duration of preprocedural fasting and the risk of sedation-related adverse events. In a multicenter prospective cohort study of sedation safety, 48.1% of the 6,166 children receiving procedural sedation did not meet fasting guidelines. There were no cases of clinically apparent pulmonary aspiration, and the authors found no association between fasting duration and any adverse event and concluded that “delaying sedation to meet established fasting guidelines does not improve sedation outcomes for children in the ED and is not warranted.” A nonrandomized before-and-after comparison of 2,188 children concluded that shortening preprocedural fasting from 6 to 3 hours did not result in increased vomiting and decreased ED length of stay. These studies suggest that fasting prior to procedural sedation may be unnecessary, particularly in otherwise low-risk patients, when ketamine is the sedative agent.

This study does not aim to determine whether procedural sedation can be safely performed in patients with a full stomach. Taken alone, our small sample provides scant additional information regarding the safety of procedural sedation of patients with high gastric volume or solid contents.

A methodologic criticism of studies of aspiration risk in children with fasting noncompliance has been that not all included children had full stomach. To the extent that patients in these large cohorts are similar to our patients, the low observed risk of adverse outcomes may occur despite a high prevalence of patients with solid or large-volume gastric contents. Thus, as a research tool, gastric POCUS could augment future prospective studies, allowing risk estimates conditional on full stomach status. In our patients, fasting time alone is an imperfect predictor of gastric contents and volume. Since gastric POCUS provides an objective measure of gastric content, the technique

![Figure 4. (A) Number (inside bar) and percent (above bar) of patients in each Perlas score category. (B) Gastric volume by Perlas score category. The colored dots (corresponding to Perlas score category) represent the estimated gastric volume (mL/kg) for each subject. The middle line in each box is the median. Lower and upper hinges correspond to the first and third quartiles. The whiskers extend from the hinge to the largest and smallest values no further than 1.5 × IQR from each hinge. CSA = cross-sectional area.](image-url)
could be used to develop and validate models to predict which patients have a full stomach from multiple predictors such as the time from intake to injury, pain severity, and/or opioid administration, in addition to fasting time.

As a clinical tool, gastric POCUS could be used to evaluate patients with risk factors for aspiration such as severe systemic illness, bowel obstruction, obesity, or obstructive sleep apnea; in patients with an anticipated need for airway manipulation; and in those undergoing deep sedation using agents likely to blunt airway reflexes.30

LIMITATIONS

We recruited a convenience sample of patients; therefore, our findings may not be representative of the population of patients undergoing procedural sedation in our ED. Also, parent and child reports of the timing and details of recent intake are likely not entirely reliable, but are consistent with a realistic clinical scenario in the PED.

Our choice of 1.2 mL/kg as the upper limit of baseline fasting gastric secretions represents a conservative estimate.11,13 A variety of studies in adult patients have documented fasting baseline gastric volumes of up to 1.5 mL/kg in patients considered to be at negligible risk for aspiration.18 For pediatric patients, the upper limit of normal fasting volume varies based on body size and habitus and has been reported to be approximately 1.2 to 1.5 mL/kg.11,13

There are some limitations associated with obtaining and interpreting gastric ultrasound findings. Gastric anatomy may be obscured by air or difficult to visualize due to patient habitus. In this study, no useful images could be obtained in three subjects, and an additional five patients could not be unambiguously assigned to a Perlas category (Figure 3). Also, a small amount of baseline air in the antrum may resemble solid content and lead to a false-positive identification of solid content.31 While antral CSA can be measured with high intra- and inter-rater reliability,32 the estimation of gastric volume based on available prediction equations introduces some degree of variability.

Some patients with painful injuries were unable to tolerate the RLD position required to estimate gastric volume from antral CSA. This may represent a practical limitation of the applicability of gastric POCUS in the PED to assist in decision making. In total, 30 patients (27.2%) were scanned after sedation, at a

Figure 5. Predicted probability of a full stomach versus fasting time from logistic regression. The shaded area represents a 95% confidence envelope. The dots (colored by Perlas score category) indicate the fasting time for subjects with a full stomach (upper row) and those with an empty stomach (lower row).
median of 44 minutes after ketamine administration. An animal study demonstrated an inhibitory effect of ketamine on intestinal motility; thus there is a potential that further delay in emptying of gastric contents occurred in those patients who were evaluated after sedation. A single investigator performed all POCUS examinations. We assessed inter-rater reliability via a review of digital images only; hence, the reliability and repeatability of study results is uncertain. This study did not aim to determine the degree of training and/or prior experience required to be competent in gastric POCUS. Typically, ACEP requires 25 to 50 scans to achieve baseline competency in most modalities, and we felt that 30 scans was sufficient in the case of our primary investigator. However, ultrasound competency, in general, is highly dependent on the user’s prior sonography experience.

CONCLUSIONS

The majority of patients in this study had a full stomach at the time of expected sedation, many of whom had prolonged fasting times. Given the results of our study, providers should not feel confident or reassured that a fasted patient in the pediatric ED has an empty stomach. These findings may inform risk–benefit considerations when planning timing and medications for procedural sedation in the ED.

References


Supporting Information

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13651/full

Data Supplement S1. Stacked kernel density plot (smoothed histogram) representing the number of patients in each Perlas score category over the range of fasting times.
ABSTRACT

**Background:** The pediatric emergency department (PED) provides care for adolescents at high risk of unintended pregnancy, but little is known regarding the efficacy of PED-based pregnancy prevention interventions. The objectives of this PED-based pilot intervention study were to 1) assess the rate of contraception initiation after contraceptive counseling and appointment facilitation in the PED during the study period, 2) identify barriers to successful contraception initiation, and 3) determine adolescent acceptability of the intervention.

**Methods:** This pilot intervention study included females 14 to 19 years of age at risk for unintended pregnancy. Participants received standardized contraceptive counseling and were offered an appointment with gynecology. Participants were followed via electronic medical record and phone to assess contraception initiation and barriers. Chi-square tests were used to examine the association between contraception initiation and participant characteristics.

**Results:** A total of 144 patients were eligible, and 100 were enrolled. In the PED, 68% (68/100) expressed interest in initiating hormonal contraception, with 70% (48/68) of interested participants indicating that long-acting reversible contraception (LARC) was their preferred method. Twenty-five percent (25/100) of participants initiated contraception during the study period, with 19 participants starting LARC. Thirty-nine percent (22/57) of participants who accepted a gynecology appointment attended that appointment. Barriers to follow-up include transportation and inconvenient follow-up times. Participants were accepting of the intervention with 93% agreeing that the PED is an appropriate place for contraceptive counseling.
Conclusions: PED contraceptive counseling is acceptable among adolescents and led to successful contraception initiation in 25% of participants. The main barrier to contraception initiation was participant follow-up with the gynecology appointment.

Unintended teen pregnancy is a significant public health problem that affects thousands of adolescent females in the United States each year. Despite a decline in the teen pregnancy rate, there are still over 450,000 adolescent females who become pregnant in the United States annually, which is the highest teen pregnancy rate among all developed countries. Unintended teen pregnancy has proven negative health and social consequences for the mother, father, and infant. The vast majority (75%) of teenage pregnancies are unintended, indicating a substantial unmet need for effective and reliable contraception. Long-acting reversible contraceptives (LARC), which include intrauterine devices (IUD) and the contraceptive implant, are the most effective forms of contraception and are safe in adolescent females. The American College of Obstetricians and Gynecologists and the American Academy of Pediatrics both recommend that LARC be offered as first-line contraception in adolescent females; however, only up to 7% of sexually active adolescents use LARC. The Contraceptive CHOICE project completed in St. Louis, Missouri, showed a significant decline in teen pregnancy rates by offering no-cost contraception to adolescents in the community at risk for unintended pregnancy after “LARC-first” contraceptive counseling (counseling that offers contraceptive options in order of efficacy).

The pediatric emergency department (PED) provides care for adolescents who are at high risk for unintended pregnancy. In one study conducted in an urban PED, nearly one-third of adolescent females ages 15 to 19 were either pregnant or at high risk of becoming pregnant in the next year. Studies have also shown that adolescent females seeking care in the PED would welcome contraception counseling at the time of the PED visit. However, it is unclear if contraceptive counseling in the PED is an effective mechanism for increasing contraception initiation.

The study team, with members from pediatric emergency medicine and adolescent gynecology, worked collaboratively to address pregnancy prevention for the high-risk PED population. We designed an intervention based on the contraceptive CHOICE project that involved contraceptive counseling and a facilitated gynecology follow-up appointment for contraception initiation among participants with a desire to initiate contraception. Previous studies show low rates of follow-up when referred from the ED. To our knowledge, no studies have shown rates of follow-up after a PED intervention with a facilitated appointment (i.e., patient given appointment date, time, and location while in PED as opposed to referral requiring the patient to call and schedule an appointment). Thus, we designed a pilot intervention study to 1) assess rates of contraception initiation after contraceptive counseling and appointment facilitation in the PED during the study period, 2) identify barriers to successful initiation, and 3) determine adolescent acceptability of the intervention.

METHODS

Study Design and Setting
This is a single site pilot quasi-experimental study with no comparison group conducted at an urban Level 1 PED with approximately 60,000 annual visits. The local institutional review board approved the study with a waiver of documented informed consent/assent and waiver of parental consent. Parental consent was waived because contraceptive counseling does not require parental permission outside of the research study, the study confers minimal risk to the patient, and requiring parental permission would prevent many adolescents from participating. We obtained verbal consent from the participant prior to enrollment. We anticipated at least onefold increase in the rate of successful start of LARC after the intervention from the national rate of 7% and a sample size of 100 participants will achieve over 90% power to detect a onefold increase from the national rate (from 7% to 14%) based on two-sided binomial test.

Study Participants
Participants were a nonconsecutive, convenience sample of adolescent females 14 to 19 years of age who presented to the PED with any chief complaint and screened at risk for unintended pregnancy. Females meeting all of the following criteria on the screening survey were considered at risk for unintended pregnancy: 1) sexually active with a male partner at any point in her lifetime or intent to become sexually active with a male partner within the next 6 months,
2) no desire for pregnancy in the next 12 months, 3) not currently using a LARC method, and 4) not currently pregnant per patient report. These screening questions were based on the inclusion criteria used in the Contraceptive CHOICE project. We included patients using a Tier 2 contraceptive method (oral contraceptive pill, contraceptive patch, contraceptive vaginal ring, and medroxyprogesterone injection) since they may benefit from access to Tier 1 methods (IUD and contraceptive implant). Exclusion criteria included previous hysterectomy or sterilization procedure, altered mental status from injury or medication, developmental delay, non-English speaking, presenting for psychiatric evaluation, presenting for sexual assault, or previous participation in this study or if the screening survey could not be completed confidentially (i.e., alone in the room without family/friends present). While patients presenting for psychiatric evaluation or sexual assault may benefit from contraceptive counseling, we felt that these were vulnerable populations presenting during a time of crisis and did not include them in the study. Patients were also excluded if they had a positive pregnancy test in the PED, obtained as part of their clinical care. A negative pregnancy test was not required, as pregnancy testing was completed at the gynecology visit.

Intervention
The study intervention was a two-part process consisting of a contraceptive counseling session and an appointment facilitation with gynecology at our institution for those desiring to initiate contraception. Participants also agreed to allow the principal investigator (PI) to follow up at 60 days (±2 weeks) via electronic medical record (EMR) and phone.

Contraceptive Counseling. The contraceptive counseling was designed based on the counseling method used in the CHOICE project, which modeled their intervention after the GATHER process for counseling. GATHER is a client-centered process that focuses on the woman, her needs, and her concerns. The CHOICE project also used a “LARC-first” counseling method which counsels about Tier 1 methods (LARC) first, followed by Tier 2 methods. The PI reviewed the CHOICE project script, training module, and contraceptive fact sheets that were made available to the public. The script was modified to fit our setting and used as a guide during the counseling session. Models of the IUD, contraceptive implant, and vaginal ring were available to aid participant education. If a participant indicated a preferred method of contraception, the fact sheet on that particular method was reviewed to assess for contraindications. If the participant preferred LARC, we also reviewed information provided by our pediatric and adolescent gynecology department in preparation for the procedure.

The contraceptive counseling was completed by the PI or one of two study-trained resident physicians. With the PI present, the two study-trained physicians reviewed counseling session videos provided by the CHOICE project. The PI reviewed all study procedures with both study-trained physicians and was available in the PED during their first counseling session to answer any questions in real time. The two study-trained physicians also notified the PI after every enrollment and any patient concerns or questions were addressed by the PI.

Facilitated Appointment. The second part of the intervention was appointment facilitation with our institution’s pediatric and adolescent gynecology clinic for participants who desired to start contraception. The outpatient gynecology clinic is staffed by gynecologists with specialty training in pediatric and adolescent gynecology, and they see patients by appointment only. Gynecology reserved approximately 10 appointments per month that were available to study patients and could be scheduled by the PI, regardless of the time of day the PED visit occurred. The participant was able to choose an appointment time available within the next 60 days. Ideally, appointments were scheduled within 30 days; however, if there was concern for cervicitis or pelvic inflammatory disease in a patient opting for an IUD or if the participant preferred a particular date, appointments were scheduled outside of this time frame by the PI. The participant left the PED visit with an appointment time, date, and location provided on a reminder card. Gynecology was made aware of scheduled appointments by the PI on the next business day. The participant was contacted by the gynecology staff to register for the appointment and review their policies. Per department policy, gynecology obtains parental/guardian consent to treat and bill at all new visit appointments. Gynecology agreed to waive the cost for contraception for any uninsured patient or for patients whose insurance denied coverage.

Study Procedures
All study procedures, including screening, were completed in the patient’s treatment room in the PED.
Participants completed a preintervention questionnaire followed by the intervention and an immediate postintervention survey. The preintervention questions were read to the participant and answers recorded in a REDCap database. The main goal of the preintervention questions was to gather information about the participant to help understand her contraceptive needs and goals in preparation for the intervention. Many of the preintervention survey questions were from the Youth Risk Behavioral Surveillance System. These specific data were not further analyzed. For participants who were not receptive to starting contraception following the counseling session, each answered open-ended and multiple-choice questions about reasons for refusal and barriers. At completion of the intervention, participants were given a tablet to answer three questions regarding their opinions on the intervention. All questions were developed by the study team and pilot tested to ensure adequate content validity.

We completed a review of the EMR to assess for attendance at the Gynecology appointment and contraception initiation. Participants were contacted via text and/or phone call approximately 60 days following the index PED visit. A designated study phone with a non–hospital-based number was used for all participant contact. Three text/phone call attempts were made. Participants were called first. If there was no answer, participants were texted explaining what the call was about and asking them to return the call or notify us of a time they could be reached. The follow-up survey was conducted using voice-to-voice phone contact. This survey assessed for barriers to starting contraception and contraception initiation outside of our institution that would be missed by EMR review. We attempted to contact all participants. Those who scheduled an appointment but did not attend their appointment were asked more specific questions about reasons for not attending the appointment.

Data Analysis
Our primary outcome measure, the rate of successful contraception initiation after PED-based contraceptive counseling, was defined as initiation of a Tier 1 contraceptive method, initiation of a Tier 2 method, or changing from a Tier 2 to a Tier 1 method during the study period. We included initiation of Tier 1 and Tier 2 methods in our primary outcome, as the overarching purpose of the intervention was to reduce pregnancy risk in adolescent females, which can be accomplished by both Tier 1 and Tier 2 methods. Determination of successful start was through EMR review and/or verbally from the participant at the 60-day phone follow-up. Chi-square or Fisher’s exacts were used to assess relationships between successful contraception initiation and multiple variables including age, race, chief complaint (dichotomized as nonproductive or potentially reproductive), relationship status, and time to appointment. Odds ratios (ORs) were used to quantify the association of these variables with the successful contraception initiation. Chi-square tests were also used to assess whether there were significant differences in the successful contraception initiation among the three counselors, and analyses of variance were used to test whether there was any difference in the mean length of intervention among the three counselors. Our secondary outcome measure, participant-centered barriers to initiating contraception with our intervention, are reported as descriptive data. Data were collected directly into a REDCap database, and SAS (Version 9.1.4) was used to conduct data analysis.

RESULTS
Subjects were enrolled from January 2016 to March 2017. Among 388 adolescent females screened, 144 were eligible. The primary reason for ineligibility was reported lack of sexual activity (194/388; 50%). Of those eligible (n = 144), 101 (70%; 101/144) agreed to participate. One potential participant left prior to completion of enrollment; thus 100 were enrolled. Table 1 shows the demographic data of our eligible (n = 144) and enrolled populations (n = 100). There were no significant differences between the eligible and enrolled populations. The study population had a mean (±SD) age of 17 (±1.31) years and was 58% black.

All 100 participants received contraceptive counseling. Sixty-eight participants expressed interest in initiating hormonal contraception after counseling, and 57 scheduled an appointment with pediatric and adolescent gynecology (Figure 1). Of the 57 participants who scheduled an appointment, 22 (22/57; 39%) attended the appointment. The mean (±SD) time to appointment was 20 (±18) days. Twenty-one participants who attended the appointment initiated contraception. One was pregnant at the time of the appointment and therefore not started on contraception. Four other participants reported going to another provider and starting contraception during the study period, for a total of 25 participants with contraception initiation.
Of the remaining 32 participants who received contraceptive counseling but did not express interest in initiating new contraception during the study period, 16 participants were already on a Tier 2 method when they enrolled, and none of those participants opted to start LARC. The remaining 16 participants were not using a Tier 2 method and chose not to start contraception and refused a gynecology appointment (Figure 1). The top barrier reported by these 16 participants was a concern about the side effects of contraception (7/16; 44%) and participant perception of low pregnancy risk (3/16; 19%). Two (2/11; 18%) participants identified the requirement for parental consent at the gynecology appointment as their main reason for not scheduling an appointment.

The majority (70%; 48/68) of those with interest in contraception initiation expressed a preference for LARC with 28 preferring hormonal IUD and 20 preferring the contraceptive implant. Nineteen adolescents completed follow-up appointments and were started on LARC. The study participant rate of LARC initiation was 19%. The bivariate analysis (Table 2) demonstrated no significant association between successful contraception initiation and age, race, relationship status, sexual health–related chief complaint, insurance status, previous pregnancy, or appointment time < 14 days from index PED visit.

Contact was attempted for all 100 participants, and 70 % (70/100) were reached by phone in follow-up. Eighteen of the participants that started contraception were reached by phone and answered all follow-up questions. All 18 participants were still using the form of contraception initiated and 17 of 18 expressed satisfaction with current method and intended continued use for 1 year. One participant was not satisfied due to undesired side effects.

Of the 35 participants that scheduled an appointment, but did not attend the appointment, 23 (23/35; 65%) were reached by phone and participated in the follow-up survey. Transportation (8/23; 35%) was the top barrier cited as the reason for not attending the follow-up appointment. Other frequently cited barriers included inconvenient appointment times (5/23; 22%), side effect concerns (3/23; 13%), and forgotten appointments (3/23; 13%).

Participants that cited transportation as their reason for failure to show were asked if a cab voucher would have helped them in attending their chosen appointment time and all (8/8; 100%) responded yes. Participants who scheduled an appointment but did not attend were asked during phone follow-up if they would have started contraception in the PED at the time of counseling if made available, and 77% (17/22) stated that they would have started contraception in the PED (one participant with missing data for this question).

Participants were also asked three questions regarding their opinion on the intervention at completion of the survey. Almost all participants (97/100) agreed with the statement, “The information that I received in the emergency room today will help me prevent pregnancy.” Additionally, 93% (93/100) agreed with the statement, “I believe the emergency room is a good place to have contraceptive counseling offered to patients,” and 88% (88/100) thought that pregnancy prevention counseling should be offered to all adolescent females in the ED regardless of chief complaint.

The mean (±SD) time of the intervention was 26.9 (±11.7) minutes and the median (range) time was 24.5 (10–67) minutes. The counseling session was interrupted as needed for clinical care. Based on two-sample t-test, the mean length of the intervention was longer when a preferred contraceptive method was stated compared to when no preferred method was

### Table 1
Demographic Data of Eligible Participants Agreeing and Declining Enrollment

<table>
<thead>
<tr>
<th></th>
<th>Total Eligible (N = 144)*</th>
<th>Enrolled (n = 100)</th>
<th>Declined Enrollment (n = 43)</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>58 (58)</td>
<td>23 (53)</td>
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<tr>
<td>White</td>
<td>38 (38)</td>
<td>18 (42)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4 (4)</td>
<td>2 (5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
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<td>0 (0)</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>97 (97)</td>
<td>43 (100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14–15</td>
<td>14 (14)</td>
<td>10 (23)</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>16–17</td>
<td>52 (52)</td>
<td>19 (44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–19</td>
<td>34 (34)</td>
<td>14 (33)</td>
<td></td>
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<td>Insurance status</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Self-pay</td>
<td>13 (13)</td>
<td>4 (9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chief complaint</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual health related</td>
<td>56 (56)</td>
<td>20 (47)</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Non-sexual health related</td>
<td>44 (44)</td>
<td>23 (53)</td>
<td></td>
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</table>

Data are reported as n (%).
*One eligible patient left prior to completion of enrollment.
identified (21.6 min vs. 29.4 min, p = 0.0016). There was no difference in the rate of successful contraception initiation or the mean length of intervention among the three counselors.

**DISCUSSION**

This study aimed to evaluate the utility of a PED contraception counseling intervention to increase contraceptive initiation among the PED population. Successful contraception initiation among 25 adolescents is of the utmost importance as it significantly decreases their individual risk for pregnancy. However, on a larger scale, this study suggests that the PED may be an important setting for pregnancy prevention services for a high-risk population.

Our rate of contraception initiation in this pilot study was higher than similar PED-based studies on pregnancy prevention. One such study had a 7% follow-up appointment show rate after offering wallet cards advertising a family planning clinic to adolescent females at risk for pregnancy in the PED. The main enhancement in our intervention is the dedicated time a study-trained physician spent conducting contraception counseling and appointment facilitation.

While our overall success rates were encouraging, we recognize that there was a no-show rate of 61% (35/57). This is comparable to other show rates for PED referrals in the adolescent population; however, this is still concerning given that the participants were all at risk for pregnancy and left the PED without contraception. The Centers for Disease Control and Prevention recommends same day initiation of contraception whenever possible, if the provider can be reasonably certain that the patient is not pregnant. Miller et al. found that the majority (66%) of adolescents surveyed in the PED were interested in same-day contraception initiation. Similarly, in our study, the majority of participants who did not attend their appointment stated that they would have started contraception in the PED. While there are several barriers to contraception initiation in the PED, this study suggests that providing counseling and facilitation for a contraceptive initiation appointment may

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**Figure 1.** Flow diagram of study recruitment and participants. Depo = medroxyprogesterone injection; IUD = intrauterine device; OCP = oral contraceptive pill; PMD = primary medical doctor.
overcome some of these barriers and would likely benefit many young women.

As previously stated, the pediatric and adolescent gynecology division at our institution requires parental consent at initial visits, either in person or via telephone. This consent covers any testing or treatment performed at the current and future visits. While they do not require parental consent for individual contraceptive methods, there was concern that need for initial parental consent would be a barrier for patients. Only two patients who refused gynecology appointment reported the requirement for parental consent as a barrier. Many providers, including those at Title X clinics, offer confidential contraceptive services, which is imperative for many adolescents. However, the requirement for parental consent was not a significant barrier to contraception initiation in this study.

Many studies report cost concerns as a barrier to contraception initiation, especially LARC. Gynecology agreed to waive the cost for contraception among any uninsured patient or among those whose insurance denied coverage. Patients were informed of this process at the time of enrollment, therefore removing cost as a barrier. This study also showed that there was no association between insurance status and successful contraception initiation. However, at final review, it was noted that insurance was billed and covered costs of contraception among all participants initiating contraception.

The study intervention was conducted by the PI or a study-trained physician, rather than a physician on a clinical shift. This intervention would likely not be feasible to conduct during clinical time due to competing priorities and provider time constraints for adequate contraceptive counseling. While we believe that the in-person physician intervention was a component of our success, there are other options for implementation in the PED setting, such as video-based counseling or a health promotion advocate. A recent study demonstrated the potential benefits of a health promotion

<table>
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<tr>
<th>Variable</th>
<th>Total With Characteristic (n = 100)</th>
<th>Total With Characteristic and Successful Start (n = 25)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
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<td>Age (years)</td>
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<td></td>
<td>16–17</td>
<td>52</td>
<td>17</td>
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<td>0.94 (0.36–2.44)</td>
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<tr>
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<td>Relationship status*</td>
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<td>12</td>
<td>0.86 (0.30–2.49)</td>
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<td></td>
<td>&lt;14 days</td>
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<td>11</td>
<td>1</td>
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<tr>
<td>Pregnant before*</td>
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<td>3</td>
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</table>

*n = 99 due to missing data.
†n = 57 with characteristic of scheduling appointment and n = 23 with scheduled appointment and successful contraception initiation (21 showed to appointment and started contraception, two scheduled but missed appointment and started by another provider in study period)
advocate in the PED, and contraceptive counseling may be another beneficial use of an advocate.

At our institution, we are continuing to work with collaborators from the ED, adolescent medicine, and gynecology to address this challenge of identifying and providing contraception for adolescents at risk for pregnancy in the PED. Future interventions will be aimed at overcoming the barrier of the low attendance rate at follow-up appointments identified in this study. Cab vouchers and same-day/next-day appointments are interventions that may improve follow-up rates.

LIMITATIONS
This study is not without limitations. This is a pilot study without a control group for direct comparison, which limits our ability to draw definitive conclusions regarding efficacy. These data are specific to a single institution and thus may not be generalizable to other institutions. Also, due to the exploratory nature of the study, we did not adjust for multiple comparisons, so the actual Type I error rate might be larger than the specified Type I error rate of 0.05. There was no fidelity monitoring among counselors and counseling may have differed slightly among the three physicians completing contraceptive counseling in the PED; however, all were trained equally per the CHOICE project materials. The requirement for parental consent also limits the generalizability, as adolescents accepting of the need for parental consent may be different from the general population. This is a convenience sample of participants enrolled when the PI or study physician was available to complete the intervention. Participants self-selected and agreed to participate knowing that contraceptive counseling and appointment facilitation would be offered.

CONCLUSIONS
The pediatric ED providers care for a patient population at high risk for unintended pregnancy, and adolescent females are receptive to contraceptive counseling in the pediatric ED. Our intervention of contraceptive counseling and appointment facilitation led to contraception initiation in 25% of participants. The main barrier to contraception initiation was participant follow-up with the scheduled gynecology appointment. While there are many barriers to utilizing the pediatric ED for contraception initiation, this study suggests that providing contraceptive counseling and facilitation for a contraception initiation appointment may overcome those barriers and be beneficial in pregnancy prevention for many adolescents. Further research is needed to determine methods to increase contraception use among the high-risk pediatric ED population in a real-world clinical setting.

References


Pilot Trial of an Emergency Department–based Intervention to Promote Child Passenger Safety Best Practices

Michelle L. Macy, MD, MS, Deepika Kandasamy, MPH, Ken Resnicow, PhD, and Rebecca M. Cunningham, MD

ABSTRACT

Background: Despite demonstrated effectiveness of child restraint systems (CRSs), use remains suboptimal. In this randomized pilot trial, we sought to determine the feasibility, acceptability, and potential efficacy of “Tiny Cargo, Big Deal” an ED-based intervention to promote guideline-concordant size-appropriate CRS use.

Methods: Parents of children < 11 years old were recruited in two EDs and randomized in a 2 × 2 factorial design to four conditions: 1) generic information sheet, 2) tailored brochure mailed after the ED visit, 3) a single motivational interviewing-based counseling session in the ED, and 4) full intervention (counseling session plus tailored brochure). We assessed feasibility (recruitment, completion, follow-up rates) and acceptability (parent attitudes, uptake of information) in the ED, at 1 month and at 6 months. We obtained preliminary estimates of effect sizes of the intervention components on appropriate CRS use at 6-month follow-up.

Results: Of the 514 parents assessed for eligibility, 456 met inclusion criteria and 347 consented to participate. Enrolled parents were mostly mothers (88.1%); 48.7% were 18 to 29 years old; 52.5% were non-Hispanic, white; and 65.2% reported size-appropriate CRS use. Completion rates were 97.7% for baseline survey, 81.6% for counseling, 51.9% for 1-month follow-up, and 59.3% for 6-month follow-up. In the ED, 70.5% rated thinking about child passenger safety in the ED as very helpful. At 1 month, 70.0% expressed positive attitudes toward the study. Of 132 parents who reported receiving study mailings, 78.9% reviewed the information. Parents randomized to the full intervention demonstrated an increase (+6.12 percentage points) and other groups a decrease (–1.69 to –9.3 percentage points) in the proportion of children reported to use a size-appropriate CRS at 6-month follow-up.

Conclusions: Suboptimal CRS use can be identified and intervened upon during a child’s ED visit. A combined approach with ED-based counseling and mailed tailored brochures shows promise to improve size-appropriate CRS use.
In 2011, the American Academy of Pediatrics (AAP) and the National Highway Traffic Safety Administration (NHTSA) updated their child passenger safety recommendations based on a growing body of evidence showing the effectiveness of age and size-appropriate child restraint systems (CRSs; i.e., car seats and booster seats). Since then, little progress has been made in the use of recommended CRSs and motor vehicle collisions remain a leading cause of unintentional injury-related deaths for children in the United States. Many U.S. children travel completely unrestrained and differences in CRS use between minority and white children contribute to disparities in crash-related fatalities. Additionally, nonfatal injuries place a substantial burden on children, their families, and society.

Given these patterns, effective interventions to promote use of appropriate CRSs and address disparities are needed. The emergency department (ED) is a promising setting for injury prevention efforts. Prior studies, focused on traditional age categories < 4 years for car seats and 4 to 7 years for booster seats, have demonstrated that education can increase parental knowledge but results for behavior change have been mixed.

In this randomized pilot study, we sought to determine the feasibility, acceptability, and the potential efficacy of a novel ED-based counseling session and tailored brochures to promote appropriate CRS use among parents of children < 11 years old. We addressed the following objectives to inform the design of a future fully powered randomized controlled trial (RCT): 1) to assess feasibility in terms of recruitment, completion of ED-based study interactions, counseling session fidelity, receipt of mailings, and follow-up; 2) to evaluate the acceptability to parents of intervention during their child’s ED visit and their uptake of information; 3) to determine if remote data collection with digital photographs is possible; and 4) to obtain preliminary effect size estimates.

### Materials and Methods

#### Study Design

We conducted a pilot trial of the intervention described below. Subjects were recruited June 9, 2015, to September 29, 2015, in two Michigan EDs and randomized to one of four treatment conditions of increasing intensity in a 2 × 2 factorial design: 1) enhanced usual care (EUC)—generic information sheets, 2) generic information sheet plus tailored brochure(s), 3) single motivational interviewing (MI)-based counseling session plus generic information sheets, and 4) full intervention—single MI-based counseling session plus generic information sheets and tailored brochure(s). Counseling sessions were conducted in the ED after a baseline survey. Generic information sheets were distributed in the ED. Tailored brochures were mailed in the following week. Measures were assessed at ED discharge, 1 month, and 6 months. One- and 6-month follow-up assessments were completed by research assistants (RAs), blinded to randomization group, who entered responses to scripted questions into a survey on the Qualtrics platform (Qualtrics, LLC). The institutional review boards of the University of Michigan Medical School and Hurley Medical Center (HMC) approved this study. The study was registered on ClinicalTrials.gov (NCT02496481).

#### Setting

Parents were recruited during their child’s ED visit at: 1) the Michigan Medicine (MM) C.S. Mott Children’s Hospital or 2) the HMC. The MM pediatric ED is located in a suburban tertiary care, academic hospital with a predominantly white and privately insured patient population. The HMC general ED is located within an urban community hospital where higher proportions of patients are African American and covered by Medicaid compared with MM. The Hispanic populations at both sites are <5%.

#### Subjects

The potentially eligible study population included adult parents (parents, step-parents, grandparents, and guardians) of children < 11 years’ old receiving ED care for any reason during shifts staffed by RAs. Parents were systematically approached based on order of arrival. Parents were not approached if their child was critically ill or injured (e.g., Triage Category 1, care in the resuscitation bay), was flagged as admitted or discharged when the RA screened the tracking board, or was being evaluated for suspected child abuse. Parents were excluded if they were < 18 years old or did not understand/speak English or if the caregiver did not regularly travel in a car with the child. RAs measured the child’s height and excluded parents of children ≥57-inches tall, the height at which proper seat belt fit can be achieved without a CRS.
Recruitment and Randomization

Research assistant shifts were scheduled between 10 AM and 11 PM. Recruitment days were varied to ensure weekday and weekend enrollment. RAs used a standard script to approach parents after the child was in their treatment room. We tracked patients who were not approached. Written informed consent was obtained after the RA reviewed study procedures. Parents who enrolled in the study self-administered an online survey on study tablets (iPad Air, Apple Inc.) using Qualtrics. Parents were randomized by the survey software to one of four treatment conditions. The survey prompted parents to hand the tablet back to the RA if they were randomized to receive counseling.

Our recruitment target \( (n = 175\) participants from each ED) was based on available resources. We set a goal of retaining 80% at 6-month follow-up (70 per condition). As this was a pilot trial, we did not conduct a priori power calculations.

Incentives

Parents received a $15 gift card for the ED portion of the study and a $30 gift card for in-person interview or a $10 gift card for telephone interview at 6 months.

Enhanced Usual Care

After completing the ED portion of the study, every participant, regardless of randomization group, received a single-page generic information sheet that summarized Michigan’s child passenger safety law and listed child passenger safety websites and telephone numbers for local resources. All counseling was provided before the information sheet was given and no counseling was provided when providing the information sheet. Parents who were randomized to receive generic information sheets were mailed a single page NHTSA flyer presenting 2011 child passenger safety recommendations by age group.

Tiny Cargo, Big Deal Intervention

Self-Determination Theory\(^{37,38}\) provided the theoretical basis for the intervention components: 1) a single brief MI-based counseling session and 2) tailored brochure(s).

MI-based Counseling Session. Counseling occurred during the child’s ED visit with the goal of motivating consistent use of an appropriate CRS while providing parents with knowledge and education on child passenger safety topics of interest. RAs had prior training in MI techniques including supporting autonomy, reflecting emotion, eliciting change talk, and rolling with resistance. RAs completed a half-day study-specific training on the counseling session and CRSs. RAs guided parents through the session using prompts on the tablet. The session began with an exercise to draw connections between parent-identified values and child safety. Importance and confidence rulers were utilized. The RA explored why and how the parent selected their child’s usual restraint and challenges with CRS use. The RA presented age group-specific social norms for guideline-adherent CRS use and asked parents how this information relates to them. RAs elicited change talk when working to align behaviors with recommendations. Parents were provided an opportunity to set a learning agenda by selecting up to three CRS topics from a pick list. The session closed with a summary.

Tailored Brochures. Families were mailed demographically tailored brochure(s) relevant to their child’s usual CRS and the appropriate CRS if different from the usual in the week following the ED visit. We developed four trifold brochures addressing appropriate CRS transitions and a “back seat pocket guide” with a weight-based overview of recommendations. Our messages were crafted to align with guidance for effective child passenger safety education.\(^ {39}\) Brochures were tailored on demographic characteristics including child name, age, and size during the ED visit. We used the child’s weight/height growth percentiles from the ED visit to project the age at which the child would need to transition to the next CRS based on typical CRS size limits. The brochures contained information about proper fit and referred parents to their child’s CRS instructions to ensure correct installation and use.

Measures

Child Passenger Safety Behaviors. Child passenger safety behaviors were assessed at baseline and 6 months with a series of questions adapted from our prior work.\(^ {17}\) Before randomization, parents were asked about the child’s frequency of motor vehicle travel and use of restraints. If the parent reported using a restraint, they were asked to indicate which type was used on most trips in the past 6 months. Parents who indicated their child did not use any restraint were asked to confirm that response prior to continuing on
with the survey. Parents also were asked where their child usually sits in the car and how often the child sat in the front seat in the past 6 months. Our previous research demonstrated substantial agreement (82.6%, $\kappa = 0.74$) between parent-reported CRS and the observed CRS at ED discharge.\cite{17}

**Parent and Child Characteristics.** Demographic characteristics including parent age, sex, relationship to child, race/ethnic background, highest education level attained, and annual household income in strata were obtained. Child age, sex, and weight were obtained from the ED record. Child height was measured by the study RA. For children present at 6-month follow-up, weight and height were remeasured.

**Feasibility of Enrollment, Intervention, and Follow-up.** To assess feasibility, we tracked rates of recruitment, completion of baseline assessments and counseling sessions, receipt of mailings, and 6-month follow-up.

**Counseling Session Fidelity.** Counseling sessions were audio-recorded with the permission of the parent. Trained RAs rated the counseling sessions utilizing the OnePass coding system.\cite{40} Scores range from 1 to 7 with higher scores indicating greater competence. Counseling sessions with complete and audible recordings were scored. A 10% sample of the audio-recordings was coded by two RAs independently. There were significant differences in total points assigned to the first seven recordings (range $= -9$ to $+8$). The team met and discussed coding. Reliability was achieved with the next seven recordings (range of differences in total points $= -3$ to $+5$). The remaining audio-recordings were coded by two RAs independently.

**Acceptability.** In an immediate postintervention survey, all parents were asked to rate how helpful it was to think about child passenger safety while in the ED on a scale of 1 (not at all) to 10 (very). At 1-month follow-up, we gauged parental attitudes by asking, “How did you feel about being asked about car seats in the ED?” and probing for specific likes and dislikes. Responses were transcribed by the RA. At 6-month follow-up, we explored preferred modalities for receiving car safety information in relation to their child’s ED visit using fixed choice options: 1) in the ED during the child’s visit, 2) in person a few days after being in the ED, 3) by phone a few days after being in the ED, 4) in the ED and again a few days later in person, and 5) in the ED and again a few days later by phone. Parents were also asked to indicate their level of interest on a 5-point scale (1 = not at all; 5 = a lot) in three other modalities to promote child passenger safety: 1) prompts to help them remember to buckle their child up, 2) text messages with information about keeping their child safer in the car, and 3) an online tool to help them know which seat is right for their child. We assessed acceptability immediately after the ED portion of the study, by telephone 1 month after the ED visit, and in person or by telephone approximately 6 months after the ED visit.

**Information Uptake.** At the conclusion of study interaction in the ED, all parents were asked to rate how likely they will be to talk about car safety with family and friends on a scale of 1 (not at all) to 10 (very). At 1-month follow-up, we assessed parent-reported receipt of mailings. Parents who received the mailing were asked if they reviewed the information and, if so, how much of the information they read (none to all on a 10-point scale). We also asked if they examined the information a second time. Information uptake was assessed in the ED and at 1 month.

**Outcome Measure: Appropriate CRS Use.** We determined age- and size-appropriateness of the parent-reported CRS in use at 6-month follow-up based on a combination of the 2011 recommendations from AAP and NHTSA, Michigan law, and typical weight limits for CRS (Table 1).\cite{2,41} When possible, parent-reported CRS type at 6 months was verified by direct in-vehicle observation of the restraint ($n = 93$) or assessment of the restraint pictured in a digital photograph ($n = 16$) taken by the parent and submitted via the study e-mail/Web link. RAs used a standard checklist for these observations and recorded information about the type of restraint. For children who were not present at 6-month follow-up, we estimated growth based on the assumption that a typical 2- to 10-year-old child gains 3 pounds over 6 months.\cite{42} Although infants experience more rapid growth, there were only seven children < 2 years with missing follow-up weights and only one child’s restraint was changed from recruitment to follow-up. That child was moved prematurely to a booster seat (baseline weight 27.5 pounds, minimum booster seat weight 40 pounds). We assessed the outcome of appropriate CRS use at 6 months.
We initially planned for all 6-month follow-up assessments to occur in person. In preparing to schedule 6-month follow-up appointments, we found that 67 of 172 families recruited at MM and 14 of 176 families recruited at HMC lived >15 miles from a follow-up location. To reduce the burden of travel for follow-up on families, we offered a telephone follow-up option to those families living >15 miles from a follow-up location. Parents were contacted by telephone, text, mail, and e-mail to schedule their 6-month follow-up. We invited 32 parents, without additional incentives, to submit digital photographs to pilot test this approach to supplement self-reported CRS use.

Data Analyses

Descriptive statistics were calculated. We set feasibility targets of 80% for recruitment, survey and counseling session completion, receipt of mailings, and 6-month follow-up. MI-session fidelity was assessed by calculating the average score on the OnePass for each counseling session with an audible recording. A counselor who scores an average 5 of 7 points is considered competent in MI.40 Chi-square tests were used to compare acceptability of the intervention and uptake across treatment groups and for minority compared with non-Hispanic, white parents. For analyses, we set a threshold of 8 or more on the 10-point scale as indicative of a high level of helpfulness or likelihood to share information. We considered selection of anything other than “not at all” as having at least some interest in the alternative modalities to promote child passenger safety. We examined the amount of mailed information that the parent reviewed in three categories: 1) half or less, 2) more than half but not all, or 3) all. We did not have a priori targets for acceptability or uptake. We present results in terms of proportions with 95% confidence intervals (CIs). The kappa statistic was used to assess the agreement between reported and observed CRS at 6-month follow-up when observations were available, with a goal of at least substantial agreement (kappa of greater than 0.61).43

Responses to the 1-month follow-up question “How did you feel about being asked about car seats in the ED?” were coded as positive, negative, or neutral by a study investigator (MLM) blinded to randomization group using the text analysis tool within Qualtrics. Comments that used terms such as good, happy, pleasant, nice, and helpful were considered positive; fine and ok were considered neutral; and stressful, inconvenient, and hard were considered negative. Coding was then reviewed by a study RA and discrepancies were resolved with discussion.

Intention-to-treat analyses were used for the preliminary outcome assessment. We calculated differences in proportions with 95% CI for changes in appropriate CRS from baseline to 6-month follow-up for the four intervention groups. We conducted a multiple variable analysis of the intervention components in a logistic regression model of appropriate restraint use at 6 months. We explored socioeconomic covariates that influence child passenger safety behaviors based on prior literature. We retained variables with p ≤ 0.20 in bivariate analyses. We completed planned stratified analyses by child age category (<2, 2–4, and 5–10 years) and use of an appropriate CRS at baseline. We hypothesized that the type of restraint recommended for each age group and the use of the appropriate CRS at baseline may influence the response to the intervention; however, there was insufficient sample size to

<table>
<thead>
<tr>
<th>Table 1</th>
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<tbody>
<tr>
<td><strong>Age- and Size-appropriate Child Passenger Restraints</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age Group (Years)</th>
<th>Weight (Pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2</td>
<td>Rear-facing to 35 pounds*</td>
</tr>
<tr>
<td>2–4</td>
<td>Rear-facing to 35 pounds</td>
</tr>
<tr>
<td></td>
<td>Harness 30 to 50 pounds</td>
</tr>
<tr>
<td></td>
<td>Booster 50 to 80 pounds</td>
</tr>
<tr>
<td>5–10</td>
<td>Harness 30 to 50 pounds</td>
</tr>
<tr>
<td></td>
<td>Booster 40 to 100 pounds</td>
</tr>
</tbody>
</table>

*The weight ranges for children in the sample by age category were as follows: <2-year-olds, 5 to 32 pounds; 2- to 4-year-olds, 21.5 to 78.5 pounds; 5- to 10-year-olds 38 to 163 pounds. Child weight at follow-up was estimated (using baseline weight + 3.3 pounds) for 18 of 111 in person follow-up visits and 90 telephone follow-ups. Analysis assuming children did not grow over the 6-month period, 56.2% of CRS would be considered appropriate at follow-up. When we assumed growth, 62.7% of CRS were considered appropriate at follow-up.
formally test for these possible interaction effects. Analyses were conducted using Stata 13.1 (StataCorp).

RESULTS

Subject flow is presented in Figure 1. There were 514 parents assessed for eligibility. Of the 456 who met inclusion criteria, 76.0% consented. Parents who consented were similar to those who declined in terms of study site, child age, triage level, and ED length of stay prior to being approached (results not shown). Recruitment was evenly divided between sites. Baseline assessments were completed by 339 parents who enrolled (97.7%). Most parents were mothers (88.1%), 48.7% of parents were 18 to 29 years old, and 52.5% of parents were non-Hispanic, white. At baseline, for the full sample, independent of treatment arm, 65.2% (95% CI = 59.9%–70.1%) of parents reported in the past 6 months their child usually used a CRS that was considered to be appropriate by our study definition, 86.8% (95% CI = 82.7%–90.1%) reported that their child never traveled unrestrained, and 89.6% (95% CI = 85.9%–92.5%) reported that their child always sat in the back seat. Baseline parent and child characteristics were similar across intervention arms with the exception of annual family income, which was lower among parents randomized to the full intervention (Table 2).

Counseling Session Feasibility and Fidelity

Of the 163 parents randomized to receive counseling, 133 (82.6%, 95% CI = 75.9%–87.75%) completed the session. The main reason for noncompletion was because the child was discharged during the study interaction. The survey was not programmed with a hard stop after the baseline assessment and four parents did not hand the tablet back to the RA when the survey prompted them to do so. These parents went through the counseling session screens without interacting with the RA. Counseling sessions were on average 13 minutes in duration (standard deviation [SD] ± 4.9). For the 135 counseling sessions with audible recordings, the mean (±SD) OnePass Score was 5.0 (±0.69) on the 7-point scale, indicating that the counselors were skilled.

Follow-up Feasibility

We reached 180 parents by telephone at 1 month (51.9%, 95% CI = 46.6%–57.2%). The ability to reach families was similar across treatment groups and between study sites. Of the families who could not be reached, there were 17 wrong numbers, 26 numbers were no longer in service, and 12 numbers were not accepting calls. Seventy-five percent of parents reported receiving the study mailings, without differences between those randomized to tailored (76.5%, 95% CI = 66.2%–84.3%) versus generic information (75.8%, 95% CI = 65.9%–83.6%). Only six mailings were returned by the postal service (three tailored and three generic information).

Six-month follow-up was completed by 201 parents (59.3%, 95% CI = 54.0%–64.4%) and 55.2% (95% CI = 48.3%–62.0%) of follow-up appointments were conducted in person. Parents who completed 6-month follow-up were similar to those who did not in terms of randomization group and baseline behaviors (appropriate restraint use, 65.7%, 95% CI = 58.8%–71.9% vs. 64.5%, 95% CI = 56.1%–72.0%; never traveled unrestrained, 88.5%, 95% CI = 83.3%–92.2% vs. 84.3%, 95% CI = 77.1%–89.6%) but were more likely to have been recruited at MM and to have attained higher education levels (Table 2). We attained higher rates of in-person follow-up at HMC (59.6%, 95% CI = 49.0%–69.3%) than MM (51.8%, 95% CI = 42.5%–60.9%).

Acceptability

Measures of acceptability are presented in Table 3. In the immediate postintervention survey, overall 70.5% (95% CI = 65.3%–75.2%) of parents rated thinking about child passenger safety in the ED as very helpful (8 or more on a 10-point scale), with slightly higher proportions of parents who received an MI session giving a rating of 8 or higher. At 1-month follow-up, 70.0% (95% CI = 62.9%–76.5%) of parents provided open-ended comments indicating positive attitudes toward the study interaction in the ED, 27.0% (95% CI = 20.9%–34.1%) were neutral, and 2.9% (95% CI = 1.2%–6.8%) were negative. Responses were similar for those who were randomized to receive an ED-MI session and those who were not. When asked specifically about dislikes, 11 parents shared an example, most commonly that the interaction took too long or the timing was bad. Higher proportions of minority parents rated the information as very helpful (81.0%, 95% CI = 74.0%–86.5%) versus non-Hispanic, white (61.0%, 95% CI = 53.5%–68.1%) and expressed neutral feelings about the ED intervention (35.6%, 95% CI = 25.4%–47.3%) vs. non-Hispanic, white (20.8%, 95% CI = 13.9%–29.9%). At 6-month follow-up, parents had varied preferences for receiving information about child passenger safety but more than half of parents selected an option that included the ED visit.
Figure 1. Consort flow diagram of study recruitment and participation. CRS = child restraint system; MI = motivational interviewing; RA = research assistant.
Preferences did not differ significantly by treatment group. Few parents completing 6-month follow-up had at least some interest in prompts to remind them to buckle their child up (12.1%, 95% CI = 8.2%–17.6%). More parents indicated at least some interest in receiving informational texts about child passenger safety (40.8%, 95% CI = 34.1%–48.0%). Most parents indicated some interest in an online tool that would help them know what safety seat is right for their child (74.9%, 95% CI = 68.2%–80.5). Comparisons by intervention group are shown in Table 3. Minority parents were more interested in prompts but equally interested in texts and online tools as non-Hispanic, white parents (results not shown).

### Information Uptake

In the immediate postintervention survey, higher proportions of parents randomized to counseling reported they were very likely to share the information with family (71.1%, 95% CI = 63.3%–77.7%) and friends (68.8%,
95% CI = 61.0%–75.8%) compared with parents who were not (60.3%, 95% CI = 52.9%–67.4% for family and 56.3%, 95% CI = 48.8%–63.5% for friends). Most of the 132 parents who received the study mailing reported reviewing the information (78.0%, 95% CI = 70.1%–84.3%). A slightly higher proportion of parents who received tailored brochures reported reviewing the information (82.5%, 95% CI = 71.0%–90.1%) compared with those who received generic information (73.9%, 95% CI = 62.2%–83.0%). Of parents who reviewed the mailings, 29.1% (95% CI = 21.1%–38.7%) indicated they read half of the information or less, 28.2% (95% CI = 20.2%–37.7%) read more than half but not all of the information, 42.7% (95% CI = 33.4%–52.5%) read all of the information, and 35.3% (95% CI = 26.6%–45.1%) referred back to the information a second time. Results were similar for parents who received tailored brochures and generic information sheets. Higher proportions of minority parents indicated they would be very likely to share information with family (72.9% [95% CI = 65.3%–79.3%] vs. 58.5% [95% CI = 50.9%–65.7%] non-Hispanic, white) and friends (68.8% [95% CI = 61.1%–75.7%] vs. 56.1% [95% CI = 48.6%–63.4%] non-Hispanic, white). Although fewer minority parents reviewed the mailed information (71.2% [95% CI = 57.4%–81.9%] vs. 82.5% [95% CI = 72.5%–89.4%] non-Hispanic, white), more minority parents referred back to the information if they had read it (51.3% [95% CI = 35.5%–67.0%] vs. 26.1% [95% CI = 16.9%–38.3%] non-Hispanic, white).

**Preliminary Effect-Size Estimates**

At 6-month follow-up, 62.7% (95% CI = 55.8%–69.1%) of parents reported that in the past 6 months their child usually used a CRS considered appropriate, 86.1% (95% CI = 80.5%–90.2%) reported that their child never traveled unrestrained, and 88.1% (95% CI = 82.8%–91.9%) reported that their child always sat in the back seat. Parent-reported CRS was verified with in-vehicle observation for 109 families (93 in person and 16 photographs). CRS appropriateness did not differ by method (64.0% [95% CI = 54.6%–72.4%] in person vs. 61.1% [95% CI = 50.6%–70.6%] photograph). Agreement between reported and observed CRS was 92.6% (κ = 0.90, p < 0.001) overall, 91.4% for in person (κ = 0.88, p < 0.001), and 100% for photograph (κ = 1, p < 0.001).

### Table 3

**Acceptability of the Intervention**

<table>
<thead>
<tr>
<th></th>
<th>No ED MI</th>
<th></th>
<th>ED MI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 173</td>
<td>n = 152</td>
<td></td>
</tr>
<tr>
<td>At the conclusion of study interaction in ED</td>
<td>% (95% CI)</td>
<td>% (95% CI)</td>
<td></td>
</tr>
<tr>
<td>Information was very helpful*</td>
<td>67 (60–74)</td>
<td>74 (67–81)</td>
<td></td>
</tr>
<tr>
<td>At 1-month follow-up</td>
<td>n = 77</td>
<td>n = 97</td>
<td></td>
</tr>
<tr>
<td>Response to “How did you feel about being asked about”</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>71 (61–79)</td>
<td>69 (58–78)</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>27 (19–37)</td>
<td>27 (19–38)</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>2 (0.5–8)</td>
<td>4 (1–12)</td>
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</tr>
<tr>
<td>At 6-month follow-up</td>
<td>n = 58</td>
<td>n = 42</td>
<td>n = 48</td>
</tr>
<tr>
<td>Preference for setting to receive child passenger safety education</td>
<td>% (95% CI)</td>
<td>% (95% CI)</td>
<td>% (95% CI)</td>
</tr>
<tr>
<td>ED visit only</td>
<td>17 (9–29)</td>
<td>21 (11–36)</td>
<td>23 (13–37)</td>
</tr>
<tr>
<td>ED visit and then by phone</td>
<td>40 (28–53)</td>
<td>29 (17–44)</td>
<td>27 (16–41)</td>
</tr>
<tr>
<td>ED visit and then in person</td>
<td>10 (5–21)</td>
<td>17 (8–31)</td>
<td>11 (5–25)</td>
</tr>
<tr>
<td>By phone a few days after ED visit</td>
<td>22 (13–35)</td>
<td>26 (15–41)</td>
<td>19 (10–32)</td>
</tr>
<tr>
<td>In person a few days after ED visit</td>
<td>10 (5–21)</td>
<td>7 (2–20)</td>
<td>12 (6–25)</td>
</tr>
<tr>
<td>Interest in other methods to improve child passenger safety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prompts to help me remember to buckle my child up</td>
<td>19 (11–32)</td>
<td>10 (4–23)</td>
<td>13 (6–26)</td>
</tr>
<tr>
<td>Text messages with information about keep my child safer in the car</td>
<td>47 (34–59)</td>
<td>38 (25–54)</td>
<td>38 (26–53)</td>
</tr>
<tr>
<td>An online tool to help me know which seat is right for my child</td>
<td>78 (65–87)</td>
<td>76 (61–87)</td>
<td>70 (56–82)</td>
</tr>
</tbody>
</table>

EUC = enhanced usual care; MI = motivational interviewing.

*Rating of ≥8 on a 10 point scale.
Parents randomized to receive the full intervention demonstrated an increase (+6.1 percentage points) and other groups a decrease (−1.7 to −9.3 percentage points) in the proportion of children reported to use a CRS considered appropriate at 6-month follow-up, although differences were not statistically significant (Figure 2). Table 4 shows results stratified by child age group and restraint appropriateness at baseline. Overall, parents of children < 2 years showed decreased appropriate restraint use at 6 months, with smaller decreases among those randomized to the full intervention or EUC. Parents of 2 to 4 and 5 to 10 year olds randomized to the full intervention had greater increases in appropriate CRS use than other groups. Among parents of children who were using an appropriate CRS at baseline, the smallest decrease in appropriate restraint use was observed for those randomized to the full intervention. Among children who were not using an appropriate CRS at baseline, the greatest increase in appropriate restraint use was observed for those randomized to receive tailored brochure(s).

The unadjusted odds ratio of appropriate CRS use at 6 months was 1.45 (95% CI = 0.65–3.23) for the full intervention versus EUC (0.98 [95% CI = 0.44–2.18]) for the tailored brochure(s) versus EUC and 0.96 (95% CI = 0.44–2.07) for counseling versus EUC. Among parents who reported using an appropriate CRS at baseline, unadjusted odds of appropriate restraint use at 6 months was 3.38 (95% CI = 0.65–17.66) for the full intervention versus EUC, 0.54 (95% CI, 0.18–1.69) for the tailored brochure versus EUC, and 0.76 (95% CI = 0.24–2.38) for counseling versus EUC. Among children reported to not be using an appropriate CRS at baseline, the unadjusted odds of appropriate restraint use at 6 months was 1.02 (95% CI = 0.25–4.14) for the full intervention versus EUC, 1.67 (0.39, 7.17) for the tailored brochure versus EUC, and 0.89 (95% CI = 0.20–3.67) for counseling versus EUC. Similar patterns were observed in the adjusted analyses (Table 5).

**DISCUSSION**

In this two-site, randomized pilot trial we demonstrated that the ED-based “Tiny Cargo, Big Deal” child passenger safety intervention was feasible and acceptable across our diverse sample of parents. Almost half of study parents reported using a CRS that was not considered appropriate and about 10% had allowed their child to travel unrestrained or sit in the front seat. Minority parents found talking about child passenger safety in the ED to be more helpful and they were more likely to plan to share information learned with family and friends than non-Hispanic, white parents. These findings support our assertion that suboptimal child passenger safety behaviors can be identified in the ED and the ED may be an opportune setting to address disparities. We also demonstrated that digital photographs can be used to remotely assess CRS use and verify parent self-report without the burden of in-person follow-up.
This study allowed us to learn several important lessons for improvement prior to a full-scale RCT. Our MI-based counseling session was acceptable to and completed by the majority of parents. We anticipate that completion rates can be increased by engaging with parents earlier in their child’s ED visit. Parents who received tailored brochures were more likely to review information. This signals that even minimal demographic tailoring increases uptake. In addition, participants were interested in online tools for child passenger safety. Prior to a planned RCT, we will convert the print materials into an online resource with deeper tailoring on psychosocial variables and knowledge. Many parents who completed 6-month follow-up indicated interest in receiving additional information after discharge. A telephone counseling session in the days after ED discharge may be a useful addition. These modifications may strengthen the impact of the intervention on appropriate CRS use.

We found evidence for the potential additive benefit of the intervention components on appropriate CRS use at 6 months, particularly among parents who were using an appropriate restraint at baseline. The full intervention may encourage parents to delay the transition out of an appropriate restraint. This hypothesis could be tested by studying parents who plan to make a premature transition in the months following enrollment. The tailored brochure was associated with increased appropriate restraint use among children who were not using an appropriate restraint at baseline. Future research targeting parents who are not guideline adherent at baseline may be higher yield.

Table 4
Change in Parent-reported Usual Restraint Considered Age- and Size-appropriate by Intervention Group

<table>
<thead>
<tr>
<th></th>
<th>Usual Restraint Is Considered Appropriate</th>
<th>Baseline</th>
<th>Follow-up</th>
<th>Δ (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall (n = 201)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUC</td>
<td></td>
<td>62.7</td>
<td>61.0</td>
<td>−1.7 (−19.2 to 15.8)</td>
</tr>
<tr>
<td>Tailored brochure(s)</td>
<td></td>
<td>69.8</td>
<td>60.5</td>
<td>−9.3 (−29.3 to 10.7)</td>
</tr>
<tr>
<td>ED MI + generic information sheet</td>
<td></td>
<td>68.0</td>
<td>60.0</td>
<td>−8.0 (−26.7 to 10.7)</td>
</tr>
<tr>
<td>ED MI + tailored brochure(s)</td>
<td></td>
<td>63.3</td>
<td>69.4</td>
<td>+6.1 (−12.6 to 24.8)</td>
</tr>
<tr>
<td>&lt;2 years (n = 72)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUC</td>
<td></td>
<td>72.7</td>
<td>68.2</td>
<td>−4.5 (−37.1 to 28.1)</td>
</tr>
<tr>
<td>Tailored brochure(s)</td>
<td></td>
<td>86.7</td>
<td>60.0</td>
<td>−26.7 (−52.8 to −0.57)</td>
</tr>
<tr>
<td>ED MI + generic information sheet</td>
<td></td>
<td>85.0</td>
<td>65.0</td>
<td>−20.0 (−50.1 to 10.1)</td>
</tr>
<tr>
<td>ED MI + tailored brochure(s)</td>
<td></td>
<td>66.7</td>
<td>53.3</td>
<td>−13.4 (−42.0 to 15.3)</td>
</tr>
<tr>
<td>2 to 4 years (n = 70)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUC</td>
<td></td>
<td>53.3</td>
<td>46.7</td>
<td>−6.6 (−36.8 to 74.6)</td>
</tr>
<tr>
<td>Tailored brochure(s)</td>
<td></td>
<td>50.0</td>
<td>62.5</td>
<td>+12.5 (−19.6 to 73.1)</td>
</tr>
<tr>
<td>ED MI + generic information sheet</td>
<td></td>
<td>55.6</td>
<td>55.5</td>
<td>−0.1 (−34.5 to 34.3)</td>
</tr>
<tr>
<td>ED MI + tailored brochure(s)</td>
<td></td>
<td>57.1</td>
<td>71.4</td>
<td>+14.3 (−19.6 to 48.2)</td>
</tr>
<tr>
<td>5 to 10 years (n = 59)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUC</td>
<td></td>
<td>59.1</td>
<td>63.6</td>
<td>+4.5 (−32.9 to 41.9)</td>
</tr>
<tr>
<td>Tailored brochure(s)</td>
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<td>75.0</td>
<td>58.3</td>
<td>−16.7 (−53.8 to 20.4)</td>
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<tr>
<td>ED MI + generic information sheet</td>
<td></td>
<td>58.3</td>
<td>58.3</td>
<td>0 (−39.4 to 39.4)</td>
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<tr>
<td>ED MI + tailored brochure(s)</td>
<td></td>
<td>69.2</td>
<td>84.6</td>
<td>+15.4 (−9.1 to 39.9)</td>
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<tr>
<td>Using an appropriate CRS at baseline (n = 132)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUC</td>
<td></td>
<td>100</td>
<td>81.1</td>
<td>−18.9 (−30.1 to −0.06)</td>
</tr>
<tr>
<td>Tailored brochure(s)</td>
<td></td>
<td>100</td>
<td>70.0</td>
<td>−30.0 (−46.4 to −13.6)</td>
</tr>
<tr>
<td>ED MI + generic information sheet</td>
<td></td>
<td>100</td>
<td>76.5</td>
<td>−23.5 (−37.8 to −9.25)</td>
</tr>
<tr>
<td>ED MI + tailored brochure(s)</td>
<td></td>
<td>100</td>
<td>93.6</td>
<td>−6.4 (−15.0 to −2.22)</td>
</tr>
<tr>
<td>Not using an appropriate CRS at baseline (n = 69)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUC</td>
<td></td>
<td>0</td>
<td>27.3</td>
<td>+27.3 (8.7 to 45.9)</td>
</tr>
<tr>
<td>Tailored brochure(s)</td>
<td></td>
<td>0</td>
<td>38.5</td>
<td>+38.5 (12.0 to 64.9)</td>
</tr>
<tr>
<td>ED MI + generic information sheet</td>
<td></td>
<td>0</td>
<td>25.0</td>
<td>+25.0 (3.8 to 46.2)</td>
</tr>
<tr>
<td>ED MI + tailored brochure(s)</td>
<td></td>
<td>0</td>
<td>27.8</td>
<td>+27.9 (7.1 to 48.5)</td>
</tr>
</tbody>
</table>

CRS = child restraint system; EUC = enhanced usual care; MI = motivational interviewing.
than intervening with parents who plan to continue appropriate CRS use.

The lack of intervention effect among parents of children < 2 may be due to limited acceptance of newer guidance to keep U.S. children rear-facing until at least 2 years of age. The AAP has recently reaffirmed their position on rear-facing car seat use and several states have passed legislation mandating rear-facing until age 2. Policy changes specific to rear-facing car seat use for toddlers can be incorporated to make the intervention more influential on parent decision making about when to turn their child from a rear- to forward-facing car seat.

LIMITATIONS

This pilot study has several limitations. First, there are several factors that decreased our chances of detecting an intervention effect. The lack of a true control condition (all parents received some educational materials) decreases the potential for differences in the outcome between conditions. It is also possible that the intervention dose was too low to show an effect or that the individual intervention components led parents to different conclusions about the appropriate CRS. Second, we were able to retain just over half of enrolled parents. Our results may be biased toward parents who were more willing and able to complete follow-up and possibly parents who were more interested in child passenger safety. The EUC group had the highest 6-month follow-up rates. Third, our results may not be generalizable to settings with robust public transportation systems or to non–English-speaking populations. Fourth, there is potential for social desirability bias. We estimate these effects are minimal as many parents reported socially undesirable behaviors including allowing their child to travel unrestrained.

We also found high agreement between the parent-reported and observed CRS. Finally, recruitment of parents from June through September and during daytime and evening hours may introduce sampling bias but we cannot estimate the direction of this effect.

CONCLUSION

In conclusion, suboptimal child passenger safety behaviors can be identified and intervened upon during a child’s ED visit. An motivational interviewing–based counseling session in the ED combined with mailed tailored brochures resulted in raw improvements in appropriate child restraint system use among parents of children < 11 years old compared with enhanced usual care.

Table 5
Adjusted Odds of Parent Reported Child Passenger Safety Behaviors Considered Guideline Adherent at 6-month Follow-Up Stratified by CRS Use at Enrollment and Child Age

<table>
<thead>
<tr>
<th>Study Condition</th>
<th>Full Sample (n = 201)</th>
<th>Age- and Size-appropriate CRS Use at Enrollment (n = 132)</th>
<th>No (n = 69)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted OR 95% CI</td>
<td>Adjusted AOR* 95% CI AOR† 95% CI AOR‡ 95% CI AOR§ 95% CI</td>
<td></td>
</tr>
<tr>
<td>EUC</td>
<td>Ref — Ref — Ref — Ref —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tailored brochure</td>
<td>0.98 0.44–2.18 0.61 0.23–1.64 0.65 0.18–2.31 1.14 0.20–6.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED MI</td>
<td>0.96 0.44–2.07 0.64 0.23–1.76 0.81 0.22–3.05 0.55 0.10–2.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED MI + tailored brochure</td>
<td>1.45 0.65–3.23 1.13 0.39–3.24 3.3 0.55–19.91 0.86 0.18–4.08</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AOR = adjusted odds ratio; EUC = enhanced usual care; MI = motivational interviewing.
*Adjusted for study site, parent race/ethnicity, family income, size-appropriate restraint use at enrollment, never traveled unrestrained in the 6 months prior to enrollment, always sit in back seat in the 6 months prior to enrollment.
†Stratified by size-appropriate restraint use at enrollment and adjusted for study site, parent race/ethnicity, family income, never traveled unrestrained in the 6 months prior to enrollment, and always sit in back seat in the 6 months prior to enrollment.

References

Reduction of Computed Tomography Use for Pediatric Closed Head Injury Evaluation at a Nonpediatric Community Emergency Department

Melissa S. Puffenbarger, MD, Fahd A. Ahmad, MD, MSCI, Michelle Argent, RN, Hongjie Gu, MS, Charles Samson, MD, and Kimberly S. Quayle, MD, and Jacqueline M. Saito, MD, MSCI

ABSTRACT

Objective: The purpose of this study was to determine if implementation of a Pediatric Emergency Care Applied Research Network (PECARN)-based Closed Head Injury Assessment Tool could safely decrease computed tomography (CT) use for pediatric head injury evaluation at a nonpediatric community emergency department (ED).

Methods: A quality improvement project was initiated at a nonpediatric community ED to implement an institution-specific, PECARN-based Pediatric Closed Head Injury Assessment Tool. Baseline head CT use at the participating ED was determined for children with closed head injury through retrospective chart review from March 2014 through November 2015. Head injury patients were identified using International Classification of Disease (ICD)-9 codes for head injury, unspecified (959.01) and concussion with and without loss of consciousness (850–850.9) until October 2015, after which ICD-9 was no longer used. To identify eligible patients after October 2015, lists of all pediatric patients evaluated at the participating ED were reviewed, and patients were included in the analysis if they had a physician-assigned discharge diagnosis of head injury or concussion. Exclusion criteria were age ≥18 years, penetrating head trauma, history of brain tumor, ventriculoperitoneal shunt, bleeding disorder, or presentation >24 hours postinjury. Medical history, injury mechanism, symptoms, head CT use, and disposition were recorded. Implementation of the Pediatric Closed Head Injury Assessment Tool was achieved through provider education sessions beginning in December 2015 and ending in August 2016. Head CT use was monitored for 12 months postimplementation, from September 2016 through August 2017. Patients were classified into low, intermediate, or high risk for clinically important traumatic brain injury (cTBI) by chart review. ED length of stay (LOS), disposition, and ED returns within 72 hours were recorded. Categorical variables were compared using chi-square test or Fisher’s exact test, and continuous variables, using Kruskal-Wallis test.

Results: A total of 252 children with closed head injury were evaluated preimplementation (March 2014 through November 2015), 132 children were evaluated during implementation (December 2015 through August 2016), and 172 children were evaluated postimplementation (September 2016 through August 2017). Overall CT use decreased from 37.7% (95% confidence interval [CI] = 31.7–43.7) preimplementation to 16.9% (95% CI = 11.3–22.5) postimplementation (p < 0.001). Only 1% (95% CI = 0%–2.9%) of low-risk patients received a head CT postimplementation compared to 22.6% (95% CI = 16.1%–29.1%) preimplementation (p < 0.001). CT use among patients ≥24 months decreased from 42.9% (95% CI = 36.5%–49.6%) to 19.6% (95% CI = 13.1%–26.1%);

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Received August 1, 2018; revision received October 13, 2018; accepted November 12, 2018.

Presented at the Pediatric Academic Societies Meeting, Baltimore, MD, May 2018; and the Society for Academic Emergency Annual Meeting, Indianapolis, IN, May 2018.

The authors have no relevant financial information or potential conflicts to disclose.

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ACADEMIC EMERGENCY MEDICINE 2019;26:784–795.
Head trauma is a common reason for evaluation in the emergency department (ED), with the highest rates of traumatic brain injury–related visits occurring among the elderly and children aged 0 to 4 years and 15 to 24 years.1 Since publication in 2009, the Pediatric Emergency Care Applied Research Network (PECARN) head injury decision tool has been implemented among pediatric EDs and has safely decreased cranial computed tomography (CT) use without missing clinically important traumatic brain injuries (ciTBIs).2–5

Most ill and injured children, however, first present to nonpediatric EDs and may comprise approximately 20% of visits within these EDs.6–8 These community EDs thus hugely impact the care of pediatric patients nationwide. Previously published reports demonstrate that CTs are more frequently obtained in low- and intermediate-risk head-injured children by physicians with emergency medicine training compared to pediatric training and in nonteaching, suburban, and nonfreestanding children’s hospitals.9,10 It follows that implementation of pediatric best-practice guidelines such as the PECARN head injury decision tool within community EDs may have a large, positive impact on pediatric emergency care.

Ionizing radiation with CT increases the lifetime risk for malignancy in exposed children.11–13 The PECARN head injury decision tool helps identify patients at very low risk for ciTBI.2 By identifying children at very low risk for ciTBI, CT use in head-injured patients can be safely reduced and thus limit unnecessary ionizing radiation exposure. The goal of this study was to reduce head CT use among pediatric head-injured patients at a nonpediatric community ED with implementation of a PECARN-based Pediatric Closed Head Injury Assessment Tool.

METHODS

Study Design
This was a quality improvement (QI) study designed to reduce head CT use among pediatric head injury patients at a nonpediatric community ED through implementation of an institution-specific, PECARN-based Pediatric Closed Head Injury Assessment Tool (Figure 1). As such, the Washington University Human Research Protection Office determined that this project did not involve activities that are subject to institutional review board oversight.

Study Setting and Population
Pediatric patients presenting to a single nonpediatric community ED with head injury were eligible for the study. Prior to October 2015, eligible patients were identified by International Classification of Disease (ICD)-9 codes for head injury, unspecified (959.01) and concussion with and without loss of consciousness (850–850.9), and confirmed by chart review. After October 2015, when ICD-9 codes were no longer in use, head injury patients were identified by reviewing lists of all pediatric patients evaluated at the target ED and selecting patients with physician-assigned discharge diagnoses for head injury, minor head trauma, and concussion (Table 1). Excluded patients were older than 18 years of age; presented greater than 24 hours after injury or had unknown time of injury; underwent head imaging prior to ED arrival; or had penetrating head trauma, a ventriculoperitoneal shunt, history of a brain tumor, or bleeding or platelet disorder.

The participating ED is one of 13 partner hospitals within our regional healthcare system that spans two states and includes one American College of Surgeons–verified Level 1 pediatric trauma center. This ED had more than 42,000 visits in 2014 and employs emergency medicine physicians, nurse practitioners (NPs), and physician assistants (PAs). Pediatric trauma patients who require hospital admission are transferred to a pediatric trauma center.

Study Protocol
A retrospective chart review was performed by a single reviewer (MP) on each identified patient before, during, and after implementation of the Pediatric Closed Head Injury Assessment Tool to assess the efficacy and safety of this tool at the participating ED. The
This guideline is informational only and does not supersede sound clinical judgement.

PEDIATRIC CLOSED HEAD INJURY ASSESSMENT TOOL

Closed Head Injury Algorithm < 2 years

GCS < 15
Other signs of altered mental status
Agitation
Somnolence
Repetitive questioning
Slow response to verbal communication
Palpable skull fracture

Yes
4.4% risk ciTBI

CT recommended

CT recommended

Worsening

Observe up to 4 hours post-injury

Improving**

1-2 predictors

Discharge with PMD follow-up

0.9% risk ciTBI

0-1 predictor

**If not improving during observation, consider further observation (ED vs. transfer/inpatient) vs. CT.

≥ 3 predictors

CT not recommended

Consider CT vs. 4-hour observation based on clinical picture and experience

Presence of predictors of TBI
Occipital, parietal or temporal scalp hematoma
History of LOC ≥ 5 seconds
Not acting normally to parents
Severe mechanism of injury
MVC if ejected, death of passenger, rollover
Pedestrian struck by motor vehicle
Falls more than 3 feet
Head struck by high-impact object
Use clinical judgement/experience when considering children aged ≤ 3 months

No predictors present
<0.02% risk ciTBI

CT not recommended

No

1. Closed Head Injury Decision Support Tool Supplement for Children aged 0-18 years. Puffenbarger, Quayle, and Ahmad, 2016

* ciTBI = death from TBI, TBI requiring neurosurgery, intubation for longer than 24 hours, and hospital admission greater than 2 nights with CT evidence of TBI.

Figure 1. Pediatric closed head injury assessment tool. ciTBI = clinically important traumatic brain injury; GCS = Glasgow Coma Scale; LOC = loss of consciousness; MVC = motor vehicle collision; PMD = primary medical doctor; TBI = traumatic brain injury.
This guideline is informational only and does not supersede sound clinical judgement.

**PEDIATRIC CLOSED HEAD INJURY ASSESSMENT TOOL**

### Closed Head Injury Algorithm ≥ 2 years

**GCS < 15**
- Other signs of altered mental status
  - Agitation
  - Somnolence
  - Repetitive questioning
  - Slow response to verbal communication
  - Signs of a basilar skull fracture

- **Yes**
  - 4.3% risk cTBI
  - CT recommended

- **No**
  - Observation up to 4 hours post-injury
    - **Improving**
      - 1-2 predictors
        - 0.9% risk cTBI
        - Discharge with PMD follow-up
      - **If not improving during observation, consider further observation (ED vs. transfer/inpatient) vs. CT.**
    - **Worsening**
      - ≥ 3 predictors
        - Consider CT vs. 4-hour observation based on clinical picture and experience

**Presence of predictors of TBI**
- History of LOC
- Vomiting
- Severe headache
- Severe mechanism of injury
  - MVC if ejected, death of passenger, rollover
  - Pedestrian struck by motor vehicle
  - Bicyclist without helmet struck by MV
  - Falls > 5 feet
  - Head struck by high-impact object

- **No predictors present**
  - <0.05% risk cTBI
  - CT not recommended

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1. Closed Head Injury Decision Support Tool Supplement for Children aged 0-18 years. Pufferbarger, Quayle, and Ahmad, 2016

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* cTBI = death from TBI, TBI requiring neurosurgery, intubation for longer than 24 hours, and hospital admission greater than 2 nights with CT evidence of TBI.

**Updated 12/08/2016**
Melissa Pufferbarger, MD; Kimberly Quayle, MD; Fahd Ahmad, MD, MSCI

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Figure 1. Continued
The preimplementation period was from March 2014, which was when electronic medical records (EMR) became available at the study site, through November 2015. The implementation period involved efforts to introduce the Pediatric Closed Head Injury Assessment Tool, described below, from December 2015 through August 2016. The postimplementation period occurred for 12 months after implementation, from September 2016 through August 2017.

The Pediatric Closed Head Injury Assessment Tool (Figure 1) was developed for use within our pediatric ED. This tool was derived from the original PECARN head injury decision tool,2 with modifications based on subsequent secondary analyses of the original study.14–16 Similar to the PECARN head injury decision tool our tool consists of two components: one for children aged less than 2 years and one for children 2 years and older. By using the age-specific history and physical examination findings and the percent risk for ciTBI published by Kupperman et al.,2 the Pediatric Closed Head Injury Assessment Tool helps the medical provider risk stratify the patient into high, intermediate, and low risk for ciTBI. The patient’s assigned risk stratification then prompts the provider to consider the appropriate treatment or disposition (CT vs. observation vs. discharge). The Pediatric Closed Head Injury Assessment Tool was designed by a pediatric emergency medicine (PEM) fellow (MP) with oversight by two pediatric emergency medicine (PEM) attending physicians (FA and KQ) and approved and adopted for use by the Divisions of Pediatric Emergency Medicine, Pediatric Trauma, and Pediatric Neurosurgery at our institution.

The Pediatric Closed Head Injury Assessment Tool was first introduced to the participating ED leadership and medical staff at a medical staff meeting in December 2015. Once buy-in was achieved from the ED leadership, in-depth education regarding the supporting evidence and strategies to use the Pediatric Closed Head Injury Assessment Tool was accomplished through several face-to-face sessions for all ED medical providers and nursing staff. Education also focused on history and physical examination findings to document in the medical chart and how to calculate a pediatric Glasgow Coma Scale (GCS). These sessions were facilitated by a PEM fellow (MP) with experience in application of the Pediatric Closed Head Injury Assessment Tool. Those who could not attend a face-to-face education session had access to the educational materials through a prerecorded presentation.

The ED staff was provided with pocket-sized reminder cards detailing the pediatric GCS calculation and desired history and physical examination findings to document in the patient’s medical chart, discharge education materials for the parents, and a letter to the primary care doctor detailing the patient’s ED visit. Education regarding this QI effort was also provided to local pediatricians who often refer patients to the participating ED. Copies of the Pediatric Closed Head Injury Assessment Tool were available for reference within the ED and through an electronic link to an institution-specific pediatric guideline website. No additional electronic decision support was established during the study period. Repeat education sessions and individual provider feedback regarding head CT use were not provided.

Data were collected through retrospective chart review of pediatric head injury visits during the study period. The EMR at the participating ED does not utilize standardized documentation templates for pediatric head-injured patients. Collected data included demographic information, injury time and mechanism, presenting symptoms and physical examination findings, results of any head imaging performed during the index visit, discharge diagnosis, diagnosis of a ciTBI,

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Physician-assigned Discharge Diagnoses</th>
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<tbody>
<tr>
<td>Head injury</td>
<td>Concussion</td>
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<tr>
<td>Acute head trauma/acute head injury</td>
<td>Cerebral concussion</td>
</tr>
<tr>
<td>Acute head injury with LOC*</td>
<td>Concussion</td>
</tr>
<tr>
<td>Acute head injury without LOC</td>
<td>Concussion syndrome/postconcussion syndrome</td>
</tr>
<tr>
<td>Blunt head trauma/blunt head injury</td>
<td>Concussion with LOC of unspecified duration</td>
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<td>Closed head injury</td>
<td>Concussion with brief LOC</td>
</tr>
<tr>
<td>Closed head injury due to bicycle accident</td>
<td>Concussion without coma</td>
</tr>
<tr>
<td>Closed head injury due to snowboarding</td>
<td>Concussion without LOC</td>
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<tr>
<td>Frontal head injury</td>
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<tr>
<td>Head injury</td>
<td></td>
</tr>
<tr>
<td>Head injury, closed, with brief LOC</td>
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<tr>
<td>Head injury, closed, without LOC</td>
<td></td>
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<tr>
<td>Head injury, intracranial, with concussion</td>
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<tr>
<td>Head injury without skull fracture</td>
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<td>Head trauma in child</td>
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<td>Mild closed head injury</td>
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<tr>
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<tr>
<td>Minor head injury without LOC</td>
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</table>

LOC = loss of consciousness.
patient disposition, and ED length of stay (LOS), which was defined as the time from initial triage to physician discharge order. The definition of ciTBI was consistent with that of Kupperman et al.2 and included death, neurosurgical intervention, intubation for greater than 24 hours, or hospitalization for greater than 48 hours due to traumatic brain injury. The medical provider selected a final discharge diagnosis from a large selection of options provided by the EMR. For patients transferred from the participating ED to another hospital within our health care system the EMR at the receiving facility was also reviewed and the ED course, head imaging results, final diagnosis, and final disposition were recorded. We were unable to obtain additional information for patients transferred to a hospital outside of our health care system.

Based on the documentation in the EMR children were classified into low, intermediate, or high risk for ciTBI by the reviewer performing the chart review (MP) using the Pediatric Closed Head Injury Assessment Tool. Missing data such as the GCS or severity of headache were inferred from other documented information such as the neurologic examination and nursing pain scores. A pain score of 8 of 10 or higher was considered to be severe pain. Any additional history or physical examination findings that were not documented were assumed to be negative.

The EMR was queried for returns to any ED within the regional health care system for head trauma within 72 hours of the index visit. Additional clinical data were recorded from the return visit chart and included symptoms, head imaging, and missed ciTBIs.

Key Outcome Measures
The primary study outcome was overall head CT use before, during, and after implementation of the assessment tool. Head CT use was also evaluated by age, as was done by Kupperman et al.,2 and by risk category. Key balancing measures included ED LOS, transfers to a pediatric trauma center, returns to the ED within 72 hours of the index visit, and missed ciTBIs.

Data Analysis
All data were entered into REDCap (REDCap 7.3.5, ©2018 Vanderbilt University, supported by Clinical and Translational Science Award (CTSA) Grant [UL1 TR000448] and Siteman Comprehensive Cancer Center and NCI Cancer Center Support Grant P30 CA091842).17 Data were analyzed using SAS version 9.4 (SAS Institute Inc.). Categorical variables were compared with the chi-square test or Fisher’s exact test, and continuous variables were analyzed with the Kruskal-Wallis test. p-charts were generated using QICCharts, a control chart add-in for Microsoft Excel (Microsoft, 2016). Mean head CT use and upper and lower control limits were generated using the first 20 months of data in the preimplementation
period. Mean head CT use was recalculated after special cause variation was noted in the data, which was defined as a trend of 8 points in a row below the original mean.\textsuperscript{18}

### RESULTS

A total of 841 pediatric head injury visits were reviewed, and 556 visits were included in the final

### Table 2: Demographics

<table>
<thead>
<tr>
<th></th>
<th>Preimplementation</th>
<th>Implementation</th>
<th>Postimplementation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Charts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>252 (45.3)</td>
<td>132 (23.7)</td>
<td>172 (31.0)</td>
<td></td>
</tr>
<tr>
<td>&lt;24 months</td>
<td>40 (39.2)</td>
<td>33 (32.4)</td>
<td>29 (28.4)</td>
<td></td>
</tr>
<tr>
<td>≥ 24 months</td>
<td>212 (46.7)</td>
<td>99 (21.8)</td>
<td>143 (31.5)</td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>138 (54.8)</td>
<td>72 (54.6)</td>
<td>98 (57.0)</td>
<td>0.90</td>
</tr>
<tr>
<td>&lt;24 months</td>
<td>16 (40)</td>
<td>14 (42.4)</td>
<td>15 (51.7)</td>
<td>0.61</td>
</tr>
<tr>
<td>≥ 24 months</td>
<td>122 (57.6)</td>
<td>58 (58.6)</td>
<td>83 (58.0)</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8.2 (7.5–8.8)</td>
<td>7.4 (6.3–8.4)</td>
<td>7.2 (6.4–8.0)</td>
<td>0.14</td>
</tr>
<tr>
<td>&lt;24 months</td>
<td>0.6 (0.4–0.7)</td>
<td>0.5 (0.3–0.7)</td>
<td>0.6 (0.3–0.8)</td>
<td>0.71</td>
</tr>
<tr>
<td>≥ 24 months</td>
<td>9.6 (8.9–10.2)</td>
<td>9.6 (8.7–10.6)</td>
<td>8.5 (7.7–8.9)</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Risk for ciTBI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>159 (63.1)</td>
<td>86 (65.1)</td>
<td>105 (61.1)</td>
<td>0.67</td>
</tr>
<tr>
<td>Intermediate</td>
<td>80 (31.7)</td>
<td>40 (30.3)</td>
<td>53 (30.8)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>13 (5.2)</td>
<td>6 (4.6)</td>
<td>14 (8.1)</td>
<td></td>
</tr>
<tr>
<td>&lt;24 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>29 (72.5)</td>
<td>23 (69.7)</td>
<td>15 (51.7)</td>
<td>0.19*</td>
</tr>
<tr>
<td>Intermediate</td>
<td>9 (22.5)</td>
<td>10 (30.3)</td>
<td>11 (37.9)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>2 (5.0)</td>
<td>0 (0)</td>
<td>3 (10.3)</td>
<td></td>
</tr>
<tr>
<td>≥ 24 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>130 (61.3)</td>
<td>63 (63.6)</td>
<td>90 (62.9)</td>
<td>0.83</td>
</tr>
<tr>
<td>Intermediate</td>
<td>71 (33.5)</td>
<td>30 (30.3)</td>
<td>42 (29.4)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>11 (5.2)</td>
<td>6 (6.1)</td>
<td>11 (7.7)</td>
<td></td>
</tr>
</tbody>
</table>

Data are reported as n (%) or mean (95% CI). p-values were generated with the chi-square test for categorical variables and the Kruskal-Wallis Test for continuous variables. ciTBI = clinically important traumatic brain injury.

* p-value was generated with the Fisher’s exact test due to small sample size.

![Figure 3. Computed tomography use over time for all included patients. Dashed lines indicate important events during the study. LCL = lower control limit; UCL = upper control limit.](image-url)
analysis after exclusions were applied (Figure 2). Table 2 describes the demographics of the patients included in the analysis. Of note, all groups were similar with regards to sex, age, and ciTBI risk category. The majority of patients were older than 24 months.

The primary outcome, head CT use, decreased significantly after implementation of the Pediatric Closed Head Injury Assessment Tool (Figure 3). Special cause variation was demonstrated after initial introduction of the assessment tool to the medical providers in

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Proportion of Head CT Use by Age and Risk for ciTBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk for ciTBI</td>
<td>Preimplementation</td>
</tr>
<tr>
<td>All risk levels</td>
<td>Total</td>
</tr>
<tr>
<td>≥24 months</td>
<td>Total</td>
</tr>
<tr>
<td>&lt;24 months</td>
<td>Total</td>
</tr>
<tr>
<td>Low risk</td>
<td>Total</td>
</tr>
<tr>
<td>≥24 months</td>
<td>Total</td>
</tr>
<tr>
<td>&lt;24 months</td>
<td>Total</td>
</tr>
<tr>
<td>Intermediate risk</td>
<td>Total</td>
</tr>
<tr>
<td>≥24 months</td>
<td>Total</td>
</tr>
<tr>
<td>&lt;24 months</td>
<td>Total</td>
</tr>
<tr>
<td>High risk</td>
<td>Total</td>
</tr>
<tr>
<td>≥24 months</td>
<td>Total</td>
</tr>
<tr>
<td>&lt;24 months</td>
<td>Total</td>
</tr>
</tbody>
</table>

Proportion of head CTs performed during each time period, stratified by age and risk for ciTBI. The 95% CIs were calculated based on the following assumptions: proportion of head CT use was normally distributed and each patient encounter represented an independent event. p-values were generated with the chi-square test unless otherwise indicated.

ciTBI = clinically important traumatic brain injury; n_CT = number of patients on which a CT scan was performed; n_total = total number of head injury patients.

*p-values generated with the Fisher's exact test.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Proportion of CTs Performed by Medical Provider Stratified by Risk for ciTBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Provider</td>
<td>Risk for ciTBI</td>
</tr>
<tr>
<td></td>
<td>n_CT/n_total (%)</td>
</tr>
<tr>
<td>Physician (MD, DO)</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Low risk</td>
</tr>
<tr>
<td></td>
<td>Intermediate risk</td>
</tr>
<tr>
<td></td>
<td>High risk</td>
</tr>
<tr>
<td>Physician assistant (PA)</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Low risk</td>
</tr>
<tr>
<td></td>
<td>Intermediate risk</td>
</tr>
<tr>
<td></td>
<td>High risk</td>
</tr>
<tr>
<td>Nurse practitioner (NP, CFNP)</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Low risk</td>
</tr>
<tr>
<td></td>
<td>Intermediate risk</td>
</tr>
<tr>
<td></td>
<td>High risk</td>
</tr>
</tbody>
</table>

Change in the proportion of CTs performed by each type of medical provider stratified by age and risk for ciTBI. p-values were generated with the chi-square test unless otherwise indicated.

ciTBI = clinically important traumatic brain injury; n_CT = number of patients on which a CT scan was performed; n_total = total number of head injury patients.

*p-value generated with the Fisher's exact test.
December 2015 and was sustained for 12 months after the completion of the implementation period. Most significantly, head CT use was reduced from 22.6% (95% confidence interval [CI] = 16.1–29.1) preimplementation to 0.9% (95% CI = 0–2.9) postimplementation (p < 0.001) in all patients considered to be at low risk for ciTBI (Table 3). While head CT use in children younger than 24 months did decrease from 10% (95% CI = 0.7–19.3) preimplementation to 3.4% (95% CI = 0–10.2) postimplementation, this did not reach statistical significance (p = 0.15). Head CT use was reduced by 23.3% (95% CI = 14.0–32.6) in patients older than 24 months (Table 3). Head CT use also decreased significantly in patients at intermediate risk for ciTBI postimplementation, but remained unchanged for patients at high risk for ciTBI (Table 3).

Most patients were evaluated by physicians and PAs during the study, and overall CT use by these providers was reduced after implementation of the Pediatric Closed Head Injury Assessment Tool (Table 4). CT use by NPs remained low and unchanged. The largest reduction in head CT use was observed in low-risk patients evaluated by physicians, among whom CT use decreased from 36.1% preimplementation to 2.6% postimplementation (p < 0.001). PAs performed zero CTs on low-risk children postimplementation, while NPs performed zero CTs on low-risk children during the entire study period. Physicians saw the largest proportion of intermediate- and high-risk patients. CT use among intermediate-risk patients evaluated by physicians was reduced from 68.4% to 38.2% (p < 0.001), but a significant reduction in head CT use was not observed in the intermediate risk patients evaluated by PAs or NPs. CT use among high-risk patients remained unchanged regardless of medical provider.

Balancing measures included ED LOS, transfers to a pediatric trauma center, and 72-hour returns to any ED within our health care system. ED LOS improved from 1.5 hours to 1.3 hours after intervention (p = 0.03), while transfers to a pediatric trauma center and 72-hour returns remained unchanged (Table 5). There were no missed ciTBIs. For the few patients that did return for evaluation within the study period, the primary complaints were headache and/or vomiting. These patients were again discharged with the diagnosis of postconcussive syndrome without additional head imaging.

### DISCUSSION

Implementation of the PECARN head injury decision tool\(^2\) has significantly reduced head CT use at pediatric EDs without missing ciTBIs.\(^3\)–\(^5\) Additionally, subanalyses of data collected by Kupperman et al.\(^2\) have demonstrated that isolated vomiting and headache are not associated with increased risk for ciTBI and offering a period of observation to pediatric patients with minor head injury has been shown to decrease head CT utilization.\(^14\)–\(^16\) These data were used to develop the Pediatric Closed Head Injury Assessment Tool at our institution. Because most pediatric head-injured patients first present to community EDs,\(^6\)–\(^8\) it is clear that dissemination of this or similar PECARN-based decision support tools among community EDs represents an important opportunity to reduce potentially unnecessary radiation exposure.

Previously, a similar study published by Jennings et al.\(^19\) showed an impressive reduction in head CT use among pediatric patients in a community ED. Our study not only joins this study in demonstrating that QI efforts safely and effectively reduce CT use in community EDs, but goes farther to show how head CT use changed among patients at varying risk levels without missing ciTBIs or increasing ED LOS.

In our study, overall head CT use was reduced from 37.7% preimplementation to 16.9% postimplementation (p < 0.001). The greatest impact was seen in patients at low risk for ciTBI, among whom CT use was nearly eliminated. Head CT use also significantly decreased in intermediate-risk patients but remained unchanged in patients at high risk for ciTBI. Of note, not all high-risk patients received a head CT (Table 3). Although not explicitly stated on the Pediatric Closed Head Injury Assessment Tool, during our education intervention we did discuss with the medical providers that transfer to a pediatric trauma center is an appropriate alternative to
performance of head CT and should be driven by clinical judgment. In our study, approximately 50% of high-risk patients were transferred to a pediatric trauma center while the rest were discharged home from the participating ED. The overall amount of transfers to a pediatric trauma center remained unchanged after implementation of the Pediatric Closed Head Injury Assessment Tool. Head CT use decreased among pediatric head-injured patients in this community ED without missed ciTBIs or increased returns to the ED. LOS within the ED was significantly decreased, unlike that reported by Jennings et al. We hypothesize that this improvement in LOS may be due to several factors. Low-risk patients, once identified, can be readily discharged home without a head CT after delivering appropriate anticipatory guidance and follow-up instructions. Similarly, patients at high risk for ciTBI may undergo emergent head imaging and/or be transferred to a pediatric trauma center expeditiously. Intermediate-risk patients may need a period of observation to allow their symptoms to improve prior to the decision to discharge or perform head imaging. We hypothesize that in some instances a short period of observation for symptom improvement may be faster than performing and interpreting a head CT; however, data regarding this hypothesis were not collected.

Because most children first present to nonpediatric facilities, further dissemination of tools similar to the Pediatric Closed Head Injury Assessment Tool represents an opportunity to significantly decrease radiation exposure in pediatric head injury patients. QI efforts to implement pediatric best-practice guidelines at nonpediatric facilities could potentially lead to decreased resource utilization and increased parent and provider satisfaction and improve pediatric care overall. Partnership between community hospitals and pediatric tertiary care centers may aid these QI efforts, as demonstrated by this study and Jennings et al. In the future we plan to implement the Pediatric Closed Head Injury Assessment Tool at each nonpediatric ED within our health care system through electronic decision support. While not essential, we do feel that electronic decision support may enhance guideline adoption as integration of the PECARN head injury decision tool into the EMR has been shown to also help reduce head CT use in pediatric patients. To broadly monitor the efficacy and safety of the Pediatric Closed Head Injury Assessment Tool at these nonpediatric EDs we are matching the physician-assigned discharge diagnoses used in this study to ICD-10 discharge diagnoses to identify future head injury patients without chart review. This will enable reporting of head CT use among head-injured patients to providers along with balancing measures such as ED returns and missed ciTBIs, thus facilitating further safety monitoring of this process.

LIMITATIONS

Our study occurred during the transition from ICD-9 to ICD-10 diagnosis codes, which occurred 2 months before the end of the preimplementation period. While this likely introduced some selection bias, after ICD-9 codes expired we elected to use physician-assigned discharge diagnoses rather than the more detailed and numerous ICD-10 codes to identify head injury patients for several reasons. As previously published studies regarding implementation of the PECARN head injury decision tool used ICD-9 codes, at the time of our study there was no published precedent that established what ICD-10 codes encompass a comparable cohort of closed head injury patients. Additionally, billing code assignment practices were predicted to shift during initial ICD-10 utilization, which could also introduce selection bias. Thus, we felt that using the physician-assigned discharge diagnosis at the time of the study would most accurately identify a comparable cohort of closed head injury patients. Given that our patient demographics and distribution of ciTBI risk remained constant across the three study periods we do believe that this was achieved. Comparison of physician-assigned discharge diagnoses to final ICD-10 assignment could help identify the appropriate collection of diagnostic codes to utilize for future QI studies.

Similar to Nigrovic et al. and Jennings et al., we only included patients with ICD-9 codes or discharge diagnoses for head injury and concussion. Thus, patients with a discharge diagnosis of ciTBI such as skull fracture would have been missed if they were not also assigned a head injury or concussion discharge diagnosis. In our entire data set of 841 patients, only one patient had a discharge diagnosis of skull fracture without also having a head injury or concussion discharge diagnosis and was not included in the final analysis.

Data were collected by retrospective chart review; thus, missing data may have led to misclassification of
ciTBI risk. Additionally, risk stratification was based on data extracted from the EMR by one reviewer. While generation of a kappa statistic after chart review by another author could have provided context regarding the inter-rater agreement of risk stratification, we did not think this was necessary as our primary outcome was overall reduction in CT use. As patient demographics and distribution of patients into each risk category among all three time periods remained constant, we do not think that missing data or lack of assessment of inter-rater agreement significantly impacts our results.

No missed ciTBIs were identified among patients that returned to the ED within 72 hours for reevaluation; however, patients that presented to another ED outside of our health care system would have been missed. This limitation is similarly discussed by Nigrovic et al., who argue that most patients tend to revisit the hospital at which they were originally evaluated for follow-up. As we were able to provide surveillance for returns across all 13 hospitals within our regional health care system and demonstrate a low and unchanged rate of return of 1% across the study, we do not think it likely that we missed a significant number of patients that re-presented to another ED.

Additionally, six of 556 (1.08%) of the included patients were transferred to a hospital outside of our health care system after evaluation in the participating ED, which prevented us from determining their final diagnosis due to lack of access to their medical records. Since this is a small subset of our included patients, we do not think this significantly impacts our results.

Finally, a medical provider may seek the advice of a PEM fellow or attending physician at our regional pediatric trauma center by calling through our physician’s access line, a service that was available prior to this QI effort. Thus, medical providers at the participating ED may have utilized this service during the study period; however, the frequency and impact of this was not determined. While we list this as a limitation, as not all community emergency providers may have access to such a service, this important partnership between the participating ED and our pediatric trauma center possibly contributed to our success and may be difficult to replicate at other sites.

**CONCLUSION**

Use of the Pediatric Minor Head Injury Assessment Tool safely reduced head computed tomography use at a nonpediatric community ED. The greatest impact was seen in children considered to be at low risk for clinically important traumatic brain injury. This study suggests that quality improvement efforts to implement pediatric clinical practice guidelines at nonpediatric facilities can positively affect pediatric care by non–pediatric-trained medical providers.

The authors would like to thank Michael Wallendorf, PhD, for his assistance with statistical analysis.

**References**


ABSTRACT

Objectives: While immediate diagnosis and irrigation is standard chemical eye burn practice, it is unknown to what extent specific pH measurements influence management, given the frequent clinical availability of narrow-spectrum nitrazine pH strips. We hypothesize that exclusive broad-spectrum pH strip implementation leads to more accurate measurement and expedited ophthalmologic consultation.

Methods: At a Level I trauma center over 25 months, all emergent adult ophthalmology consultations for chemical burns were included in a pre-intervention (n = 22) and post-intervention (n = 20) study design. During this time, narrow-spectrum nitrazine pH strips available to non-obstetric emergency department (ED) staff were exclusively replaced by broad-spectrum strips. Causative chemical, time from triage to ophthalmology consultation, examination findings, ocular pH by ED and ophthalmology staff, and irrigation quantity were analyzed.

Results: Most burns were alkaline. Time from triage (p = 0.043) and irrigation quantity following consultation (p = 0.047) each decreased following exclusive ED implementation of broad-spectrum pH strips. There was greater pH congruence between consulting and primary physicians after intervention (p = 0.03).

Conclusions: Exclusive non-obstetric implementation of broad-spectrum pH strips may allow greater accuracy and faster management of ocular chemical burns. Availability of narrow-spectrum pH strips may be dangerous clinically by falsely reassuring the examiner with inherent inaccuracy.

Corneal chemical burns are ophthalmic emergencies that may lead to irreversible blindness requiring immediate treatment and are responsible for up to 20% of all eye injuries. Prompt and accurate evaluation of the acidity or alkalinity of a chemical eye burn is essential for the treatment and prognosis of the injury. Typically, alkaline burns are associated with greater damage to the cornea and surrounding tissues. Although management of chemical burns necessitates detecting pH, guidance regarding adequate pH testing range in the literature is sparse as “litmus paper” is vaguely stated, for example. One investigation uses broad-spectrum pH strips (Duotest, Macherey-Nagel Inc.) for a study of severe skin burns. It is otherwise unclear what pH range is necessary and to which extent different spectra are being tested across different hospitals and emergency departments (EDs). For example, narrow-spectrum pH paper like nitrazine strips (i.e., phenaphthazine) are commonly used and often suffice for obstetrics, especially when managing...
conditions like premature rupture of membranes \(^6\) (by providing an obvious bluish chromatic change for all alkaline pH values, even those indicating mild alkalinity \([\text{pH} > 7 \text{–} 7.5]\) relative to acidic vaginal flora). These same strips cannot differentiate mild alkalinity from alkalinity greater than pH 7.5, an unfortunate feature when used for chemical eye injuries, as the normal ocular surface pH is between 7 and 7.5 \(^7\) and most chemical eye burns are caused by alkaline substances.\(^2\)

While precise evaluation and prompt irrigation\(^2\) is standard practice for eyes with any chemical burn, it is unknown to what extent specific pH measurements influence management and outcomes given the wide clinical availability of various pH paper ranges. The adult ED at an academic Level I trauma center replaced its nitrazine strips \((\text{pH 4.5–7.5})\) exclusively with broad-spectrum strips \((\text{pH 1–14})\) by October 1, 2016, as part of a quality improvement intervention to ensure consistent and accurate alkalinity detection. We hypothesize that broad-spectrum strips lead to more accurate pH measurement and expedited ophthalmologic consultation in the setting of emergent chemical eye burns.

**METHODS**

**Study Design**

Institutional review board approval and Health Insurance Portability and Accountability Act compliance were satisfied for pre- and postinterventional investigation at the adult hospital of an academic Level I trauma center. On approximately October 1, 2016, all narrow-spectrum \((\text{pH 4.5–7.5})\) nitrazine strips \((\text{pHizatest, Micro Essential Laboratory})\) were replaced exclusively by broad-spectrum \((\text{pH 1–14})\) strips \((\text{Hydron, Micro Essential Laboratory})\), for the adult ED (Figure 1); nitrazine strips were still immediately available as needed for obstetrics only. Consulted ophthalmologists continued to use Hydron broad-spectrum pH strips \((\text{pH 1–14})\) supplied by their own department. Aside from informing ED and consultation administrators of the one change with pH testing equipment by necessity, no additional intervention such as in-service education module highlighting the change or emphasizing the emergent nature of chemical eye burns to clinical staff was made within the emergency or ophthalmology departments.

**Study Setting and Population**

All emergent adult ophthalmology consultations for chemical ocular burns were identified and grouped into a pre-intervention cohort (between October 1, 2015, and September 30, 2016) and post-intervention cohort (October 1, 2016, to October 31, 2017) study design. Cases were cumulatively gathered using regularly performed search queries of all adult ophthalmology consultations for “chemical burn” within the trauma center’s in-house electronic medical record system during the entire duration of the study, both before and after intervention. Collection data were obtained for each case using standard ophthalmology consultation and ED physician history and physical forms. Timing information was gathered using immediately recorded time stamps in the same medical record system that are automatic for both ED triage.
(when the ED physician was made first aware of the patient) and placement of ophthalmology consultation (when the ophthalmologist was made first aware of the patient); timing of first contact between the patient and each physician was not performed. Physicians and other staff were unaware that collection of data regarding each case were being gathered. A minimum two of three different investigators (MPB, HRD, and ST) independently reviewed and verified the data for each case without any discrepancies. This study only included cases of chemical eye burns where an ophthalmologist was consulted.

**Study Protocol and Measurements**

Causative chemical agent classification, age, sex, laterality, time interval from ED triage to ophthalmology consultation, irrigation management per eye before and after consultation, ocular surface pH values obtained by consulting ED staff and consulted ophthalmologists, visual acuity (VA) in logMAR ([logarithm of the minimum angle of resolution] given recent studied advantages over Snellen; briefly, 20/20 Snellen is equivalent to 0.00 logMAR, and a lower logMAR value represents a superior VA), and ophthalmologic examination findings (including corneal epithelial defect [KED] and limbal ischemia) both at consultation and at last follow-up were recorded. KED and limbal ischemia were recorded and converted from clock hours or diametric values to percentages, based on approximate normal adult corneal diameter of 12 mm, by using standard area formula calculation.

**Data Analysis**

Statistical analyses were performed with simple t-test, Fisher’s exact test, and Pearson’s chi-square test when appropriate.

**Funding and Support**

This study was supported by donation from the Vanderbilt Eye Institute’s Lefkovitz Discovery Grant (MPB) and an unrestricted departmental grant from Research to Prevent Blindness (Vanderbilt Eye Institute).

**RESULTS**

Chemical injuries were identified in 42 adult patients, combined pre- and post-intervention, four of which had unknown chemical causes; most patients (n = 30) had alkaline burns, followed by acid (n = 8) in etiology (Table 1). Age, sex, mean triage time to consultation, and irrigation quantity before and after consultation were no different between patients with

<table>
<thead>
<tr>
<th>Table 1</th>
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<tr>
<td><strong>Comparison of All Adult Chemical Acid and Alkaline Burns</strong></td>
</tr>
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<table>
<thead>
<tr>
<th></th>
<th>Acid Burns (pH &lt; 7)</th>
<th>Alkaline Burns (pH &gt; 7)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of affected patients</td>
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<td>30</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>51 (±12)</td>
<td>40 (±13)</td>
<td>0.1108</td>
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<tr>
<td>Sex (male)</td>
<td>5 (62.50)</td>
<td>17 (56.67)</td>
<td>1.0000</td>
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<td>Narrow-spectrum testing (#)</td>
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<td>0.1066</td>
</tr>
<tr>
<td>Broad-spectrum testing (#)</td>
<td>6 (75.00)</td>
<td>11 (36.67)</td>
<td></td>
</tr>
<tr>
<td>Triage to consultation time (min)</td>
<td>54 (±36)</td>
<td>72 (±71)</td>
<td>0.3936</td>
</tr>
<tr>
<td>Irrigation (L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before consult</td>
<td>0.85 (±1.24)</td>
<td>1.43 (±1.53)</td>
<td>0.4006</td>
</tr>
<tr>
<td>After consult</td>
<td>0.95 (±1.99)</td>
<td>0.74 (±1.59)</td>
<td>0.8828</td>
</tr>
<tr>
<td>KED (n = 30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At presentation</td>
<td>8.82% (±17.21%)</td>
<td>42.36% (±40.79%)</td>
<td>0.0039*</td>
</tr>
<tr>
<td>At last follow-up</td>
<td>0.21% (±0.60%)</td>
<td>5.36% (±14.95%)</td>
<td>0.1216</td>
</tr>
<tr>
<td>Change in KED (n = 30)</td>
<td>8.61% (±17.32%)</td>
<td>36.99% (±35.20%)</td>
<td>0.0071*</td>
</tr>
<tr>
<td>VA (n = 26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At presentation</td>
<td>0.11 (±0.24)</td>
<td>0.37 (±0.72)</td>
<td>0.2081</td>
</tr>
<tr>
<td>At last follow-up</td>
<td>0.72 (±0.92)</td>
<td>0.33 (±0.63)</td>
<td>0.2227</td>
</tr>
<tr>
<td>Change in VA (n = 26)</td>
<td>0.43 (±0.65)</td>
<td>0.01 (±0.61)</td>
<td>0.2994</td>
</tr>
<tr>
<td>Patients with limbal ischemia (#)</td>
<td>0 (0)</td>
<td>5 (16.67)</td>
<td>0.5632</td>
</tr>
<tr>
<td>Limbal ischemia (n = 47)</td>
<td>0% (±0%)</td>
<td>10.19% (±28.45%)</td>
<td>0.0410*</td>
</tr>
</tbody>
</table>

Data shown ± SD and/or extent (%).

KED = corneal epithelial defect; n = number of affected eyes; VA = visual acuity (logMAR).

*Significant p-value < 0.05
Acid and alkaline burn injuries (p > 0.05). There was no difference in acid and alkaline burn quantity captured pre- and post-intervention (p > 0.05). Adequate data with last follow-up (median = 22.5 days, range = 2–720 days) were available for 30 eyes (n = 30 total; eight acid, 22 alkaline) regarding KED and 26 eyes relating to VA (three patients were unable to participate in subjective examination at presentation). Mean KED among eyes at presentation (p = 0.0039), mean change in KED (p = 0.0071), and mean limbal ischemia (p = 0.0410, n = 47 total; 11 acid, 37 alkaline) were significantly greater among alkaline than acid injuries (Figure 2), while number of patients with KED, mean KED at last follow-up, mean VA at presentation, mean VA at last follow-up, mean change in VA, and number of patients with limbal ischemia were similar between burn groups (p > 0.05).

When comparing pre- and post-intervention findings overall regardless of burn causative agent (including unknown) among patients (n = 42), the age, sex, irrigation before consultation, number of patients with KED or limbal ischemia, mean limbal ischemia, mean KED at presentation, change and last follow-up, as well as VA at presentation, change and last follow-up were all similar (p > 0.05) between those associated with consultation prior to (n = 22) and after (n = 20) exclusive ED broad-spectrum pH strip implementation (Table 2). Numbers of acid, alkaline, and unknown burn patients were also similar pre- and post-intervention (p > 0.05). Triage to consultation time (p = 0.0425) and mean irrigation after consultation (p = 0.0470) decreased significantly following intervention. Subgroup analysis of alkaline chemical burns revealed significant decrease in triage time to consultation after intervention (p = 0.0252), but not for acid burns (Figure 3). No significant difference in irrigation quantity after consultation was detected pre- and post-intervention for subgroup analyses of alkaline burns (p = 0.1518) or acid burns (p = 0.5119). Among 13 pre-intervention consultations with sufficient data, four (31%) demonstrated higher pH by ophthalmology staff upon initial evaluation compared to primary staff, while all 16 post-intervention consultations with adequate data showed congruity of initial pH measurements between consulting and ophthalmology staff (Table 3; p = 0.0301). Among the four cases of discrepant pH readings, all were alkaline-related injuries pre-intervention and had primary emergency physicians obtaining pH readings of 7.5; the ophthalmologist measured pH 8 for two of the cases and pH 9 for the remaining two upon arrival. All pH values pertained to initial evaluation by the respective physician.

**DISCUSSION**

The exclusive, non-obstetric implementation of broad-spectrum pH strips may allow for greater accuracy in chemical burn diagnosis. In turn, clinical management of ocular chemical burns may be hastened with faster ophthalmology consultation times and less required subsequent irrigation by the consultant.

The decreased irrigation quantity after consultation following broad-spectrum pH strip intervention most likely demonstrates enhanced ocular chemical burn
management by primary ED physicians; they were probably better equipped to precisely detect alkaline burns and perform more adequate flushing prior to (and thus leading to a decrease in) subsequent irrigation upon ophthalmologist arrival. It is possible that the decrease in post-consultant irrigation following intervention could reflect more trust by the ophthalmologists with the ED staff’s ability to adequately measure alkalinity of the eye burns once the proper strips became exclusively available. The higher irrigation quantity (though statistically insignificant) prior to consultation in the setting of nitrazine strip usage could relate to the lack of clarity in pH known to many of the ED physicians. These data suggest that

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Comparison of All Adult Chemical Burns Pre- and Post-intervention</th>
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<tbody>
<tr>
<td></td>
<td>Narrow-spectrum Testing (pH 4.5–7.5)</td>
</tr>
<tr>
<td>Number of affected patients</td>
<td>22</td>
</tr>
<tr>
<td>Age (years)</td>
<td>40 (±13)</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>11 (50)</td>
</tr>
<tr>
<td>Acid burns</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Alkaline burns</td>
<td>19 (86)</td>
</tr>
<tr>
<td>Unknown burns</td>
<td>1 (5)</td>
</tr>
<tr>
<td>Triage to consultation time (minutes)</td>
<td>83 (±74)</td>
</tr>
<tr>
<td>Irrigation (L)</td>
<td>Before consult</td>
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<td></td>
<td>After consult</td>
</tr>
<tr>
<td>KED (n = 35)</td>
<td>At presentation</td>
</tr>
<tr>
<td></td>
<td>At last follow-up</td>
</tr>
<tr>
<td></td>
<td>Change in KED (n = 35)</td>
</tr>
<tr>
<td>VA (n = 29)</td>
<td>At presentation</td>
</tr>
<tr>
<td></td>
<td>At last follow-up</td>
</tr>
<tr>
<td></td>
<td>Change in VA (n = 29)</td>
</tr>
<tr>
<td>Patients with limbal ischemia (#)</td>
<td>3 (13.64)</td>
</tr>
<tr>
<td>Mean limbal ischemia (n = 54)</td>
<td>4.17% (±19.04%)</td>
</tr>
</tbody>
</table>

Data shown ± SD and/or extent (%).
KED = corneal epithelial defect; n = number of affected eyes; VA = visual acuity (logMAR);
*Significant p-value < 0.05.

Figure 3. Time (minutes) from triage to ophthalmology consultation versus all, alkaline, and acidic eye injuries grouped by pre- and post-intervention. Time decreased significantly after intervention among all chemical eye burns together (*p = 0.0425), as well as for alkaline burns (‡p = 0.0252), but not acid burns (p > 0.05). Data are expressed as mean ± standard error of the mean. *|‡Significant p-value < 0.05.
availability of nitrazine strips and similarly narrow-spectrum pH strips may be dangerous in the clinical setting by falsely reassuring the examiner with inherently inaccurate alkalinity readings.

Protocols for basic management of chemical eye burns are available, although there is scarce literature specifying pH detection aside from instructed measurement with generic “litmus paper.” Given that a major academic and Level I trauma center here would routinely use nitrazine paper until recently, and given that there is scant reference in the literature to the specific type of pH paper required to accurately diagnose and monitor treatment of sight-threatening eye injuries from alkaline exposures, then it is very likely that many EDs still have and use limited-range pH papers without being aware of potentially dangerous consequences. Ophthalmologists covering hospitals (community or tertiary) could be first to inquire or ensure whether respective EDs are equipped with suitable pH strips, although it may be more critical for EDs without ophthalmologist coverage to be aware of the pH strip type that is supplied. If narrow-spectrum pH strips are available anywhere a patient could present with a chemical eye burn (e.g., nitrazine strips at a hospital with both an ED and obstetrics unit), administrative decisions may need to be implemented to avoid inadvertent false measurement of a truly alkaline eye.

Our study supports the idea that greater ocular damage results from alkaline burns. As seen here with larger extent of both corneal epithelial defect and limbal ischemia relative to acid burns. An unexpected finding, however, is the relatively low number of blinding injuries from chemical injury in our study, particularly in the setting of inaccurate pH detection at a high-volume Level I trauma center. It is possible that many patients who present with serious chemical eye injuries who are seen at community hospitals specifically without available ophthalmology consultation (and otherwise systemically stable) are either discharged directly (or initially present) to a nearby ophthalmology clinic rather than transferred to a tertiary care ED. Fortunately, national surveillance data do suggest that severe chemical eye injury rates are normally low at about 0.02 per 100,000, but can be devastating when they do occur.

**LIMITATIONS**

Little to no difference in visual or other clinical outcomes after exclusive pH strip intervention may partially reflect low sample size or inherent weakness of pre-/post-intervention study design, despite the significant differences in time to consultation and post-consult irrigation. More likely, however, long-standing awareness of ED pH strip inaccuracy by the consulted ophthalmologists in our study ended up leading to appropriate management anyway as prompt and accurate measurements on behalf of consultants were made. Although not statistically significant, there was a trend toward greater improvement in VA at follow-up in the post-intervention group, suggesting that delays in irrigation from inadvertent complacency with pre-intervention false pH readings may have led to latent damage and vision loss that would not manifest immediately. Still, it is difficult to quantify success of the intervention as chemical eye injuries may have been missed altogether since these data only reflect those for which ophthalmology consultation was requested. If data were obtained from institutions with practitioners unaware of their own insufficient pH spectrum detection, it may be expected to find significant visual and anatomic improvement of chemically burned eyes after exclusive implementation of broad-spectrum pH strips. There is also potential bias regarding interpretation of results, given ophthalmologist preference for a meaningful impact with broad-spectrum pH strips, despite the possible deleterious consequences. A low sample size and the heterogeneity of chemical eye burns likely precluded effective subanalyses of irrigation quantity among alkaline and acid burn groups specifically, both before and after strip replacement.

**CONCLUSIONS**

The significant decrease in triage to consultation time as well as irrigation following ophthalmology involvement in the setting of exclusive implementation of broad-spectrum pH strips each suggest that awareness of a facility’s default pH detection measures by primary ED physicians may be clinically essential for
optimizing ocular chemical burn management. Future studies may be needed to accurately identify anatomic and visual ophthalmic outcomes, particularly at institutions with ophthalmologists currently unaware of their primary team’s own potential shortcomings in pH measurement or at EDs without any ophthalmology coverage. As many ophthalmologists consider broad-spectrum pH strips essential for accurate diagnosis and management of chemical eye injuries, it is imperative that emergency department physicians are appropriately equipped and approach these traumas in a similar manner with the correct tools.

References

Minding the Gap: A Qualitative Study of Provider Experience to Optimize Care for Critically Ill Children in General Emergency Departments

Lindsey A. Query, MD, Krisjon R. Olson, PhD, Michael T. Meyer, MD, MS, and Amy L. Drendel, DO, MS

Background: Pediatric emergency care provision in the United States is uneven. Institutional barriers to readiness in the general emergency department (GED) are known, but little is understood about the frontline providers. Our objective was to explore the lived experiences of emergency medicine (EM) providers caring for acutely ill children in the GED and identify opportunities to optimize their pediatric practice.

Methods: This grounded theory study used theoretical sampling with snowball recruitment to enroll EM physicians and advanced practice providers from 25 Wisconsin GEDs. Participants completed one-on-one, semistructured interviews. Audio recordings were transcribed and coded by a multi-investigator team drawing on theory produced from comparative analysis.

Results: We reached theoretical saturation with 18 participants. The data suggested that providers felt competent managing routine pediatric care, but critically ill children outstripped their resources and expertise. They recognized environmental constraints on the care they could safely provide, which were intensified by unanticipated knowledge gaps and lack of awareness regarding pediatric practice guidelines. A fragmented medical network to support their pediatric practice was identified as a challenge to their care provision at critical junctures. Due to lack of guidance and feedback, providers internalized their experience with critically ill children with uncertainty, which limited learning and practice change. They benefited from meaningful relationships with pediatricians and pediatric subspecialists, targeted education, timely consults, and looped feedback about care provided and patient outcomes.

Conclusions: General ED providers struggled with critically ill children because they could not anticipate their pediatric-specific knowledge gaps and only realized them at critical junctures. EM providers were isolated and frustrated when seeking help; without guidance and feedback they internalized their experience with uncertainty and were left underprepared for subsequent encounters. The data suggested the need for provider-focused interventions to address gaps in pediatric-specific continuing medical education, just-in-time assistance, and knowledge transfer.

Each year in the United States, approximately 35 million children are evaluated in an emergency department (ED). Secondary to hospital distribution and geographic limitations, the large majority (95%) of these children are seen in a general emergency department (GED), as opposed to a dedicated...
pediatric emergency department (PED). It is estimated that one in five GED visits are by children, but 39% of GEDs see fewer than five children per day and 69% see fewer than 14 children per day. The majority of pediatric visits are low acuity and few (4%) require hospital admission.

In 2006 the Institute of Medicine released a report that described emergency care for children in the United States as “uneven.” Since then, the American College of Emergency Physicians (ACEP), the American Academy of Pediatrics (AAP), and the Emergency Nurses Association (ENA) have jointly published policy statements regarding care of children in the GED. Additionally, the Emergency Medical Services for Children (EMSC) has been active in enhancing GED readiness to care for children through changes in policy and procedure. Despite advances in national pediatric readiness, two-thirds of children cannot readily access an ED that is highly compliant with pediatric emergency care, defined as an ED that has a perfect Pediatric Readiness Score (100). As such, studies have shown uneven care by demonstrating 1) variation in the care of common pediatric illnesses, such as asthma, croup, dehydration, diabetic ketoacidosis (DKA); 2) more aggressive lab testing and increased hospitalization rates; and 3) lower quality of resuscitations in the GED compared to the PED. There are recognized systems-level factors that impact pediatric care in the GED, and survey-based studies have shown that GED physicians are uncomfortable caring for critically ill pediatric patients, with pediatric cardiopulmonary arrests and acutely ill infants being the most problematic.

A recent study by Gangadharan et al. used qualitative methodology to identify GED provider comfort with algorithm-based care, reliance on cognitive aids, and discomfort with pediatric-specific equipment and medications. This was accomplished using a simulated environment to observe the experiences of multidisciplinary GED provider teams during the care of critically ill pediatric cases. Although this work described perceived practice habits and barriers, there is a paucity of research exploring the lived experiences of GED providers with pediatric emergency care as it occurs in the GED setting. Since this environment is subject to resource limitations, competing priorities, care systems, and social interactions, without understanding the patterns of behavior and decision making of GED providers as it occurs there, it is difficult to fully understand the causal process that ultimately leads to “uneven” pediatric emergency care in the United States.

This qualitative study examines the lived experiences of emergency medicine (EM) physicians and advanced practice providers who care for acutely ill children in the GED setting of the United States. The primary goals of this study were to 1) understand how GED providers practice pediatric emergency care and, by explaining patterns of behavior 2) identify opportunities to optimize the care of children in the GED.

METHODS

Study Design

We used a grounded theory research design to explore factors that impact the care of acutely ill pediatric patients in the GED from the perspective and lived experiences of GED providers. Grounded theory methodology was well suited for this study, as it reflects the meaning people make of their own experiences. It moves beyond those individual experiences to obtain answers about specific patterns of behavior that are relevant and problematic for those involved. We recruited board-certified EM physicians, nurse practitioners, and physician assistants who actively work in a GED setting using purposeful sampling with snowball recruitment. Institutional review board approval was obtained from The Medical College of Wisconsin.

Study Setting and Population

We conducted our study in Wisconsin; state population was 5,747,958 and the pediatric population (age 0–17 years) was 1,300,845. There were 128 GEDs; 111 Wisconsin GEDs participated in the 2013 Pediatric Readiness Project. Annually, 59 GEDs see fewer than 1,800 pediatric patients (low), 37 GEDs see 1,800 to 4,999 pediatric patients (medium), 11 GEDs see 5,000 to 9,999 pediatric patients (medium high), and four see more than 10,000 pediatric patients (high). Participants were drawn from GEDs across the state. Based on current referral patterns, there are eight hospitals to which Wisconsin GEDs transfer pediatric patients—five tertiary children’s hospitals with pediatric hospitalists, pediatric intensivists and pediatric subspecialists; two hospitals that have pediatric hospitalists and pediatric intensivists; and one hospital with pediatric hospitalists. These referral hospitals are in Wisconsin and Minnesota.

Study Protocol

A semistructured interview guide (see Data Supplement S1, available as supporting information in
the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13624/full) was developed and tested by performing three mock one-on-one interviews with GED providers; subsequent revisions were made prior to the start of formal data collection. The interview guide consisted of open-ended questions with suggested probes regarding 1) lived experience of GED providers caring for children, 2) facilitators and barriers to optimal care of these patients in the GED, and 3) GED provider beliefs regarding how to optimize their pediatric care.

We used purposeful sampling with snowball recruitment of providers with a diverse representation in age, sex and clinical experience. At the end of each interview, study participants identified additional potential study participants, who were subsequently recruited through e-mail. Enrollment occurred over a 9-month period (May 25, 2017, through December 15, 2017). Data collection stopped based on the principle of thematic saturation, which occurs when no new themes emerge.19,25 There were no dropouts or study refusal.

Data Collection

The primary investigator was a board-certified pediatrician and a fellow of pediatric emergency medicine (PEM) with additional graduate-level training in qualitative research methodology and 2 years of experience in transport medicine. This investigator conducted all one-on-one semistructured interviews; there was no prior relationship with study participants. Interviews were performed at a location of the participant’s choosing to foster a sense of comfort and enable participants to speak candidly. Interviews lasted 60 to 90 minutes and were audio recorded and subsequently transcribed verbatim by professional medical transcriptionists. Field notes were made during and after each interview; these were included in the data analysis.

Data Analysis

The three-member research team independently read, analyzed, and coded three interview transcripts as part of the primary coding. A second team member is a board-certified PEM physician who serves as a medical director of a tertiary care facility ED and has graduate-level training and experience in qualitative research methods. A third team member is a medical anthropologist who conducts research in a tertiary care facility pediatric intensive care unit and is a national expert in qualitative methodology and social change. The research team used an inductive analytic approach to develop a primary coding scheme, which was applied to the remaining transcripts by the primary investigator. Comparative analysis was used to identify new codes that arose and refine existing ones and modify as needed.19 An audit trail was kept, and frequent updates were made to the research team. Participant validation was not performed.

RESULTS

We obtained thematic saturation with 18 study participants (code: GEDP), consisting of 14 board-certified EM physicians and four advanced practice providers, who worked in 25 Wisconsin GEDs (Figure 1). There was representation from GEDs of all four pediatric volume classifications. Basic participant demographics are displayed in Table 1. Four major themes are discussed here (Table 2).

Environmental Constraints on Care Provision

The GED environment presented barriers to optimal pediatric emergency care because of competing priorities due to high acuity across a wide scope of practice and the variable pediatric-specific training of other hospital staff. These led to available resources being quickly outstripped by critically ill children.
General ED providers cared for the full spectrum of adult and pediatric patients. As put by one physician, “As community emergency physicians, you see everything across the gamut. You’re not only dealing with sick kids, you’re dealing with sick adults and major trauma and all sorts of life issues” (GEDP7). When faced with the rare presentation of a critically ill child, providers described a high-stress environment that was quickly overwhelmed due to infrequent exposure and inadequate resources. As described by one physician, “It’s chaos because lack of experience and lack of repetitive appearance of the clinical scenario” (GEDP4). Another provider said, “The sickest of the sick kids we don’t see a lot of and, when we do, everything else stops for the sick kid until the sick kid gets stabilized. Literally, everything stops . . . It’s all hands on deck” (GEDP17). All GED providers prioritized the critically ill child, despite competing priorities and the awareness that other patient care needs were being put on hold. They expressed a need to expedite transfer to better care for all patients. “We needed the kid stabilized, because the most important thing in the ER is the bed, essentially, because you can’t treat your [patient with a heart attack] if he’s in the waiting room” (GEDP17) so, as another physician said, “We would like the patient to move on [and] be somewhere else” (GEDP5).

Other hospital staff members, ranging from GED nurses to radiology techs and subspecialists, had variable training and discomfort with pediatric procedures. Regarding their nurse colleagues, two GED providers described: “The general training in the average ER nurse for sick kids is almost non-existent” (GEDP6), so “the nurses are less comfortable than in [a pediatric hospital] that does this all the time” (GEDP9). Another provider stated, “I don’t have a pharmacist in-house, so often there’s a lag. When you’ve got a sick kid, it’s not what you want” (GEDP12). Additionally, as explained by a physician, “I don’t have all the resources. I don’t have an MRI. I don’t have ultrasonographers who are trained [in pediatrics], so I have a more limited workup” (GEDP10). Without skilled ancillary staff, who were comfortable with pediatrics, optimal medical management and diagnostic evaluation was difficult.

**Limitations in Pediatric Expertise**

Providers had unanticipated knowledge gaps in the care of critically ill children, a factor that developed over time secondary to limits on their pediatric-specific continuing medical education (CME) and the absence of feedback on patient outcomes. These challenges to providers’ capacity to prepare for the arrival of and reflect on the care they provided exacerbated their infrequent clinical exposure and limited their ability to develop expertise in caring for critically ill children.

General ED providers uniformly described being uncomfortable and inadequately prepared for critically ill pediatric patients due to unanticipated knowledge gaps. Due to consistent interaction with common pediatric illnesses—fever, upper respiratory infections, abdominal pain, minor trauma, etc.—providers reported being competent and comfortable managing the most common pediatric illnesses. Accordingly, they reported their unexpected knowledge gaps in the medical management of critically ill pediatric patients stemmed from their highly infrequent exposure to sick children. One physician explained, “when a kid comes in and they’re sick and you know they are sick, if you haven’t seen that over and over again . . . you don’t feel as comfortable” (GEDP8), and another physician clarified that, “sometimes it’s hard to know what you don’t know until you’re there” (GEDP5). A third provider further explained that “those first few steps are universal, it’s the second level, the more nuanced things—‘What labs do I need to get? What are the main pitfalls? What initial imaging do I need to get? Where do I look this up and who do I need to contact’” (GEDP7).

General ED providers described a lack of awareness of pediatric practice guidelines and perceived them to be unavailable for reference at critical junctures. These providers reported that the limited publication of

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**Table 1**

<table>
<thead>
<tr>
<th>Characteristics of ED Staff Participants</th>
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<tbody>
<tr>
<td><strong>Age (years)</strong></td>
</tr>
<tr>
<td>Physicians (n = 14)</td>
</tr>
<tr>
<td>Advanced practice providers (n = 4)</td>
</tr>
<tr>
<td><strong>Female sex</strong></td>
</tr>
<tr>
<td>Physicians</td>
</tr>
<tr>
<td>Advanced practice providers</td>
</tr>
<tr>
<td><strong>Years in practice</strong></td>
</tr>
<tr>
<td>Physicians</td>
</tr>
<tr>
<td>Advanced practice providers</td>
</tr>
<tr>
<td><strong>ED annual pediatric volume†</strong></td>
</tr>
<tr>
<td>High (&gt;10,000)</td>
</tr>
<tr>
<td>Medium high (5,000–9,999)</td>
</tr>
<tr>
<td>Medium (1,800–4,999)</td>
</tr>
<tr>
<td>Low (&lt;1,800)</td>
</tr>
</tbody>
</table>

Data are reported as median (IQR) or n (%). IQR = interquartile range. *Includes clinical training. †Study participants worked in multiple EDs.
Table 2
Summary Themes and Representative Quotations

<table>
<thead>
<tr>
<th>Themes</th>
<th>Representative Quotations</th>
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<tbody>
<tr>
<td><strong>I. Environmental constraints on care provision</strong></td>
<td></td>
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<tr>
<td>Subtheme A: the rare presentation of a critically ill child outstripped resources and led to competing priorities as providers needed to care for the full spectrum of patients</td>
<td>“There’s three groups of children: (1) run-of-the-mill urgent care stuff that is almost one-half of what we see; (2) questionably sick kids with legitimate complaints, like a deformed fracture or a fever and lower quadrant abdominal pain or a respiratory emergency; and (3) the very, very small group of, like, 1% Peds ER critical care patients.” (GEDP17)</td>
</tr>
<tr>
<td></td>
<td>“You’re in a community ED and you’ve got 10, 15, 17, whatever patients – they’re all yours. Then you’ve got this one sick person that is basically taking away from your 12 other patients.” (GEDP12)</td>
</tr>
<tr>
<td></td>
<td>“Well, I am busy taking care of your grandmother when she is septic, and your mother when she is having a heart attack, and I know I am leaving soon, and I know my partner. We have a full shop and he is not going to be comfortable watching a 4-year-old who was just in status [epilepticus].” (GEDP4)</td>
</tr>
<tr>
<td>Subtheme B: variable training and comfort level with pediatric expertise</td>
<td>“Anesthesia is not comfortable with pediatrics.” (GEDP4)</td>
</tr>
<tr>
<td></td>
<td>“Even if I did call our surgeon and [ask] ‘Do you want to do anything about this [11-year-old with an appy]?’ they are like ‘I don’t do children, so transfer.’” (GEDP13)</td>
</tr>
<tr>
<td><strong>II. Limitations in pediatric expertise</strong></td>
<td></td>
</tr>
<tr>
<td>Subtheme A: providers reported unanticipated pediatric-specific knowledge gaps</td>
<td>“I’m comfortable all up until the line that I’m not. Until I have that sick kid in front of me.” (GEDP15)</td>
</tr>
<tr>
<td></td>
<td>“I am comfortable inside of my box of information that I know. Really sick kids, I don’t feel super comfortable with because there’s a lot to know. And kids are good until they’re not and I think that’s terrifying.” (GEDP18)</td>
</tr>
<tr>
<td>Subtheme B: providers lacked awareness of pediatric practice updates due to limitations in CME</td>
<td>“Unless [the new guidelines] were in one of the sources that I already go to, like EM: RAP, I wouldn’t find out about them.” (GEDP14)</td>
</tr>
<tr>
<td></td>
<td>“The hospital requires you to do so much for ACS-related stuff, then my job has the risk management monthly portion of CME, then you add your ACLS and PALS and you’re already at your amount that you need. There’s lot of new requirements, but there’s no consideration for my time, so, yes, it would be nice if I had more pediatric CME, but I would not like that to be at the expense of my own time.” (GEDP15)</td>
</tr>
<tr>
<td>Subtheme C: absence of feedback on patient outcomes inhibited learning</td>
<td>“The culture of healthcare, in general, isn’t so good at learning culture necessarily. It tends to be hierarchical, like more blame culture . . . Then when you approach people within that culture about a certain case, it is immediately taken as blame [when] that’s not the point . . . So then we just don’t get any feedback and it’s frustrating.” (GEDP14)</td>
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<td></td>
<td>“We do not [get feedback] . . . I wish we did . . . then we can adjust our practice depending on what was done down the road.” (GEDP3)</td>
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<tr>
<td><strong>III. Medical support network paradox</strong></td>
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<td>Subtheme A: lack of in-house pediatric services and disconnect from tertiary pediatric facilities left providers with limited access to support</td>
<td>“[My colleagues] don’t know the physicians [and] they don’t know that it’s pretty common practice to call the pediatric hospital for advice rather than kind of struggling with it on their own.” (GEDP10)</td>
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<td>“Sometimes the timeliness of the response can sometimes be a little bit of a barrier [to transfer]. Some of it is just getting the subspecialist to call you back.” (GEDP7)</td>
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<td>“[Pediatric transport] isn’t always available right away, so it takes two hours before they’re ready, then two hours to get to us and two hours back. That’s six hours before the patient sees someone.” (GEDP3)</td>
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<td>Subtheme B: established rapport with in-house pediatric providers and/or tertiary pediatric subspecialists facilitated pediatric care in the GED</td>
<td>“Sometimes NICU will even completely take over. We just call them and they take the entire work-up, which is quickly transported upstairs.” (GEDP3)</td>
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<td>“I had a 12-year-old new-onset diabetic and she was really sick . . . but I called the Peds hospitalists very early with her . . . and then as soon as labs started coming back, it was easy because I already had [them] aware of her in the ED.” (GEDP14)</td>
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<td>“If the peds hospitalist says, ‘I think this kid should probably go to the unit,’ they will make arrangements for that to happen.” (GEDP5)</td>
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<td>“[The pediatric hospital docs and I] have a very good rapport and that definitely helps when I need to call over there and talk to someone and ask for advice, because they know me and they trained me.” (GEDP11)</td>
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<td><strong>IV. Desire for provider-focused interventions</strong></td>
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<td>Subtheme A: multiterraced dissemination of standardized protocols and vetted educational materials</td>
<td>“You are never going to admit that you are probably not where you should be . . . so let’s just give you the stuff that you need to make you feel less anxious or maybe teach you the things that you don’t know.” (GEDP5)</td>
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<td>“After A-B-C I’d love to know what D-E-F is besides disability, exposure and you know . . . [and] if there were 1-2 defined places to go to or 1-2 defined methods to disseminate [that information], that would be great.” (GEDP7)</td>
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(Continued)
pediatric emergency research within the general EM literature and constraints on obtaining pediatric-specific CME were contributing factors. As one provider acknowledged: “I’m not aware of a lot of protocols for kids, except probably the rule-out sepsis protocol. We read the adult literature and they occasionally sprinkle in the peds literature. So, if it is not in the general ER literature, I am not going to see it.” (GEDP4). Additionally, as one physician explained “you don’t have that same academic discussion [as a community doc] and pediatric EM is not as much of a focus, so it’s harder to have those discussions and come up with topics. I don’t have protected time, so it’s hard to attend pediatric CME conferences” (GEDP10). Another said, “Right now, it really falls upon [the provider] to say ‘Well, I’m anxious enough.’ Or, God forbid, ‘I just had a bad outcome, so now I am going to go and get some CME’” (GEDP5).

Specifically, there was an absence of feedback after pediatric resuscitations that left GED providers “isolated” and “forgotten.” A physician explained that, “[tertiary pediatric providers] don’t always view that patient that we sent to them as my patient. Even though we started the care for that event” (BCEM9). The absence of a care continuum culture was thought to inhibit ongoing interfacility communication after an event with a critically ill child. Without feedback, GED providers reported a lack of closure on the case, subsequently internalized their experiences, and described thoughts of uncertainty and self-doubt. “We get no feedback and that’s not good for the community, because you don’t know what happened to the patient. You don’t know ‘Did I do the right thing? Did I give him the right drugs?’ That kind of education feedback is important” (GEDP6). Additionally, the lack of follow-up on care provided and patient outcomes was reported to inhibit learning and practice change for GED providers, as they did not know whether practice modification was even needed and struggled to focus their self-education effectively. “I mean if there’s something that I’m missing, I would be happy to know, because then I would make sure that it’s addressed next time” (GEDP3).

### Medical Support Network Paradox

General ED providers were quick to seek help with their management decisions in pediatric resuscitations. As put by one physician: “I don’t see children often enough to say ‘Oh, I can handle any child that comes in. I will have no problem.’ I would much rather call and be like ‘Help me!’” (GEDP13). Providers, however, were faced with a paradox in their medical support network: “isolation” and “connection.” In each case, provider and patient care experience differed based on the availability of and relationships with pediatric hospitalists and tertiary pediatric subspecialists.

For GED providers, the absence of in-house pediatric services and disconnect from tertiary pediatric facilities, whether geographic or professional, left them with limited access to support for their medical decision making and care provision at critical junctures in the care of pediatric patients. The majority of our study participants (n = 14) worked within institutions without pediatric hospitalists and pediatric surgical specialists. One advanced practice provider described: “In the community hospitals, there’s a lack of pediatric specialists anywhere. There is no PICU, so if you need anything you are stuck transferring.” (GEDP15) However, “pediatric transport is not always available right away” (GEDP3). Therefore, while awaiting the arrival of help, GED providers described drawing on the available resources they had and managing to the best of their ability, for example: “When we have a critical patient arriving, we call our local flight crew of critical care nurses but . . . they still need a

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**Table 2 (continued)**

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<th>Themes</th>
<th>Representative Quotations</th>
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<td><strong>Subtheme B: enhanced availability of supportive and timely consults with tertiary pediatric subspecialists</strong></td>
<td>“Some guidance would be helpful—‘If the child appears well to you and if this looks good to you, then this is what you can do . . .’ If we can do some of that guidance, maybe we would avoid a lot of those unnecessary transports.” (GEDP3)</td>
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<td><strong>Subtheme C: looped feedback on care provided and patient outcomes</strong></td>
<td>“You can learn a ton from a discharge summary. You can learn what the final diagnosis was. That’s probably number one, so ‘Was I thinking the right way or was I missing something?’ That’s really helpful. Then you can see what some of their management was, so maybe you can help set things up for the next time.” (GEDP9) “It should be ‘This is our patient together. This is what you guys did. This is what we did. This is the outcome.’ That’s it. I think that is the best way to collaborate.” (GEDP8)</td>
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GED = general emergency department.
lot of guidance from you during the resuscitation” (GEDP3). During these critical junctures, GED providers (n = 15) identified difficulty finding just-in-time guidance and support from tertiary pediatric subspecialists. The challenge in obtaining assistance was multifactorial. First, subspecialists were described as unwilling to give over-the-phone consultation. One physician explained that, “you cannot just call somewhere and just ask for a consult, because they will be asking you ‘Are you sending them to us or not?’ Over the phone, you cannot really ask for much advice” (GEDP3). Second, even when tertiary pediatric subspecialists provided support, there was often a disconnect between what they recommended and the capabilities of the GED to fulfill their requests. One provider described an encounter with a pediatric neurologist, whom she was calling to direct admit a patient who had presented in status epilepticus: “I knew the pushback I was going to get. He said ‘He is not seizing anymore. You can load him, watch him in your ER for 4 hours and send him home’… I said, ‘We just don’t have the comfort level for that.’ And then you feel like he is thinking ‘Well, you called me for advice and I am the expert’” (GEDP4). GED providers stated these kinds of encounters “might lead to that ‘us versus them’ mentality, as opposed to ‘we’” (GEDP5), which impaired collaboration and patient-centered care.

General ED providers described how established rapport with either in-house pediatric providers or with tertiary pediatric subspecialists, including PEM providers, facilitated pediatric care in the GED. A subset of providers (n = 4) worked in GEDs with in-house pediatric hospitalists and neonatologists. Their availability led to interactions that allowed for the immediate delivery of optimal care provision through shared decision making and care coordination. According to one advanced practice provider, “if you are one the fence and you say, ‘I don’t know, what would you do with this kid?’ they will say ‘I will come down to see them’ and then we will decide together” (GEDP14). Another physician said, “If the child is [sick and] being transferred, they are there to help—to be an extra set of eyes, to recalculate my meds, etc.” (GEDP12). When GED providers (n = 3) either had rapport with tertiary pediatric subspecialists and/or had previous exposure to pediatric tertiary facilities during their residency training, they were more likely to request phone consultations and found that it was easier to obtain guidance. They described their readiness to call stemmed first from knowing that phone consultation was an available option and was bolstered by familiarity with PEM provider practice. One physician explained: “I know that we are allowed to call and talk with the ER doctors [at the pediatric hospital]. It is very similar to how my residency [pediatric hospital] was, in terms of what we did at all the time. [Community doctors] would make a call and double-check things if they wanted to or they would call and tell us about patients they were transferring, which is what we do now… I really liked that system” (GEDP13). GED providers also described how the pediatric providers facilitated their education in the form of just-in-time teaching, as well as by sharing pediatric literature, protocols, guidelines, and updates on patient outcomes afterward. An example of a pediatric hospitalist identifying and addressing GED provider needs was given by a physician: “[Our providers and pediatric hospitalists] have done a lot of intensive pediatric education—SIM lab stuff, more PALS training and … we are working to make it happen every year or every other year” (GEDP5).

Desire for Provider-focused Interventions
Embedded case-based education, timely subspecialty consults, and looped feedback are desired approaches to knowledge sharing that allow for patient-centered care across institutions and organizations with a focus on provider education. GED providers described interest in a multittered approach to the dissemination of vetted, standardized protocols and educational materials that could be widely disseminated in easily accessible formats. One GED physician said: “fostering communication between the Wisconsin ACEP and the Wisconsin AAP to … serve as an information hub … and have good resources in two or three places [would be helpful]” (GEDP7). Another stated, “ideally, it would be something with videos, pathways and articles you can download … and do at your own leisure, on your own time” (GEDP10). Having access to local pediatric hospital guidelines would be useful, according to a third physician: “While I was a resident we had different [pediatric hospital] protocols [and] I used to refer to them pretty regularly, but after I graduated I didn’t have access … so making that public to community docs would be really nice” (GEDP11). Additionally, most providers preferred podcast-based CME due to its easy accessibility and focused topic reviews. They desired more pediatric education embedded within their general EM CME
podcasts, as they found them informative and practice changing. As described by a physician, “[the pediatric expert] will be giving an overview and you are listening to it thinking ‘Wait, I don’t do things that way’ or ‘I don’t think our department does things that way’ or ‘Maybe we should be doing this’” (GEDP5).

General ED providers also identified a need for enhanced availability of supportive and timely consults with tertiary pediatric subspecialists. One GED physician explained, “In residency, even if you are taking care of the patient on your own ... at least you have the comfort of [an attending] behind you. Sometimes in critical care hospitals or [community EDs] you are just not comfortable, and you don’t have somebody sitting over your shoulder ... the pediatric center needs to be the guy on your shoulder” (GEDP8). “It’s knowing that I can pick up a phone and someone on the other line is there to help me, instead of picking up the phone and [wondering] “What grief am I going to get?”” (GEDP9) Another physician described an ideal exchange from a consultant to a GED provider: “[We need to have] a really supportive conversation...almost like a Yes-And—‘Yes, I hear what you have done, and I agree with it and I would like these sorts of things going forward” (GEDP5). The ability to develop rapport with pediatric subspecialists framed by mutual respect was seen as key both to optimal patient care and to the provision of just-in-time teaching for providers.

General ED providers expressed a strong desire for looped feedback from tertiary pediatric facilities to which they transfer patients. They saw this as a significant educational opportunity, which one physician explained as: “We like to know if we did things right or if you guys are like ‘what the heck are they doing’... it helps us learn just from knowing, if this presentation happens again, what would be worth us doing and what’s not worth us doing” (GEDP13). They reported a preference for phone calls, but recognized time constraints for tertiary pediatric subspecialty providers. They also mentioned potential hospital medical–legal concerns due to patient privacy, so they uniformly expressed preference for a deidentified patient discharge summary with detailed medical management and diagnosis. One GED physician described: “I think it should say ‘The child was 6-years-old and ill with DKA. You did A, B, and C. Then we added X, Y, and Z. In case you are unaware, this last step is helpful. We are appreciative of your care. Thank you’” (GEDP4).

**DISCUSSION**

This study is a comprehensive qualitative exploration of the issues encountered during the provision of emergency medical care to critically ill children by front-line providers across the full spectrum of GEDs. We confirmed that while GED providers must effectively identify patients who need life support, monitoring, and critical care, they encounter such children only rarely. This lack of exposure impacts on all aspects of their lived experience. GED providers endorsed that they often cannot anticipate their pediatric-specific knowledge gaps and only realize them once they find themselves at critical junctures in diagnostic evaluation and/or medical management. This resulted in heightened anxiety in the moment, which led them to emergently seek guidance and forced a reactive approach to pediatric emergency care. The desire for a proactive, multifaceted approach to enhancing patient care through provider-focused interventions was identified.

Based on behavior patterns and preferences described by these GED providers, we suggest three strategies for enhanced knowledge translation that are novel within the clinical setting of the United States. These are consistent with Canadian studies that show their GED health care professionals need “synthesized, prefILTERED, vetted sources of evidence” that they access by talking to colleagues (82%), referencing specific medical/health websites (68%) and through professional development (64%).^27^ Embedding and Disseminating PEM Education. Due to their infrequent exposure to critically ill children and competing CME burden, GED providers infrequently seek out and find dedicated PEM-specific CME. Often, providers experienced a problematic or anxiety-provoking case before seeking out PEM education, an approach that is consistent with adult-learning theory. Therefore, updated pediatric evidence does not reach them before it is needed and is therefore not put into practice effectively. While this pattern may suggest the need for enhanced publication of pediatric studies and practice updates in general EM journals, we recommend the robust development, collation, and embedding of targeted PEM education within general EM CME programs. Incorporating PEM CME into already well-utilized learning modalities, such as podcasts, may take advantage of GED provider’s intuitive education-seeking behaviors. Based on current literature regarding effective implementation science,^28^ through
routine and continuous education that involves learning from a discussion with a topic expert, providers should be prompted to reflect on their practice and implement changes. The data also highlight the need for an online repository of up-to-date PEM resources and recommendations. This approach would meet the different learning styles of providers and their preference for easily accessible references at critical junctures in the care of children. It also would be in line with the recent creation of an integrated knowledge translation process in Canada that uses an online “evidence repository and bottom line recommendations.” It is unclear whether these educational materials and repository would be best developed and maintained on a national or local level, and further research is needed to identify specific priority topic areas for GED providers within the scope of care for critically ill children.

**Intensive Local Interprofessional Networking to Facilitate Guidance.** All GED providers seek in-the-moment pediatric consultation. This comes from in-house pediatric hospitalists or tertiary pediatric subspecialists and assists them with case specific decisions. It is known that community-based pediatric hospitalists improve patient triage, increase GED provider comfort through comanagement, provide education, and deliver “secondary care” by linking primary and tertiary care. Here we found that GED providers consider their in-house pediatric hospitalists to be local experts and actively sought their involvement. Given the ongoing expansion of pediatric hospitalist fellowships and a renewed conversation regarding their role in the community hospital, expansion of community-based pediatric hospitalists services may improve pediatric care in the GED. Whether this is best accomplished through the expansion of traditional pediatric inpatient units or combined PED/inpatient units is unclear and deserves further exploration.

Previous studies have shown that consultation by GED providers with tertiary pediatric subspecialists decreases mortality and unnecessary transfers through feedback and validation of their patient care decisions from pediatric consultants. A starting point for enhanced interprofessional collaboration may be for professional organizations, such as ACEP and the AAP, to advocate for interinstitutional cooperation for the sake of improved patient care. Additionally, local tertiary hospital-based PEM leaders may need to reach out to the leadership at surrounding GEDs and vice versa. Doing so should facilitate familiarization with different institutional and provider capabilities, identify specific needs, and address those needs in a manner that is desired and well received. By pediatric providers exchanging specialty education they can develop rapport with local GED providers and may be better equipped to be a readily available reference at critical junctures.

**Looped Feedback About Care Provided and Patient Outcomes.** Follow-up on patient outcomes is wanted and needed. All GED providers considered the provision of standardized feedback as a key opportunity for learning and way to achieve closure in the case of clinical uncertainty. Studies have shown that feedback derived from patient outcomes “carries innate credibility as a cue for learning” and the closure of performance gaps. It also promotes professional development, decreases provider isolation, and improves provider satisfaction. Additionally, academic-community partnerships and outreach projects focused on pediatric trauma care have led to improved patient outcomes, provider comfort communicating with subspecialists, and positive changes in medical practice. Finally, studies have shown the need for educational alliances to “reframe the feedback process from one of information transmission to one of dialogue.” As such, interprofessional teams across institutions should co-create sustainable and effective strategies for looped feedback on care provided and patient outcomes to referring GED providers. Approaches may vary based on local culture, but should ideally be timely, standardized, and focused; use neutral language; and focus on objective facts of the case, such as key interventions and final diagnosis.

**LIMITATIONS**

There are several limitations to our study. Although it encompassed the full spectrum of GEDs in Wisconsin and incorporated the perspectives of both EM physicians and advanced practice providers the description of provider’s lived experience may differ from the actual care provided. Additionally, all study participants were Caucasian. Although 78.3% of all board-certified EM physicians self-identify as white/Caucasian, this may represent a selection bias. Furthermore, the single interviewer was a pediatric EM fellow, which may have introduced interviewer bias, affected the interviewer–interviewee relationship, and shaped the direction of the interviews. Also, since two research team members were pediatric subspecialists in a tertiary pediatric center, our understanding and interpretation of the data may have
been affected by our own clinical practice and potentially introduced researcher bias. Without participant validation, our ability to cocreate conclusions after interviewing was limited. However, we minimized these potential biases with the use of a semistructured interview guide with open-ended questions, reflexivity—an attitude of attending systematically to the context of knowledge construction, especially to the effect of the researcher—at every step of the research process and by incorporating a research team member who is neither a physician nor experienced in EM. Finally, our results may or may not be applicable to all clinical settings and other regions of the country. Regardless, the insights gained from our participants lived experiences provide a meaningful basis for future research in this field.

CONCLUSIONS

In summary, the lived experience of emergency medicine physicians and advanced practice providers caring for critically ill pediatric patients in the general ED is complex with challenges present at the individual, institutional, and system levels. Our results revealed barriers to general ED providers maintaining their pediatric knowledge base and unveiled how a fragmented medical network to support general ED providers medical decision making impacted on care provision of critically ill children through limitations in resources, guidance, and knowledge transfer. The goal of this study was to expand the current, predominantly quantitative literature regarding pediatric readiness and identify critical gaps. Future studies will need to incorporate participant observation and chart review and examine service flows to further understand the causal process of patient care. Additional focus on exploring the generalizability of our findings with multicenter studies that also incorporate additional provider types will be important, so that national interventions can be targeted to relevant and problematic issues for all general ED providers.

References


Supporting Information

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13624/full Data Supplement S1. Semi-structured interview guide.
Financial Conflicts of Interest Among Emergency Medicine Contributors on Free Open Access Medical Education (FOAMed)

Joshua D. Niforatos, MTS, Lucas Lin, Jatin Narang, Anthony James, Andrew Singletary, Emily Rose, Justin A. Yax, DO and Matthew J. Stull, MD

Free open access medical education (FOAMed) is a collection of educational resources that are both free and accessible to health care providers. Platforms used to disseminate FOAMed resources include websites, blogs, Twitter, Facebook, podcasts, and YouTube. Topics published in FOAMed are numerous and include dissemination and/or critique of specialty-specific national guidelines; approaches to differential diagnosis, assessment, and management of myriad diseases; just-in-time procedural training; and critical appraisal of peer-reviewed publications. Over the past decade, there has been a proliferation of emergency medicine/critical care FOAMed resources. A study published in 2014 examined the increase in FOAMed resources from 2002 through 2013 and discovered an increase from two blogs and one podcast to 141 blogs and 42 podcasts over this time period. Another study during this time period revealed that 97.7% of residents surveyed used FOAMed resources at least 1 hour per week as part of "extracurricular education."

While recent research on FOAMed has primarily focused on quality of educational content, there is an absence in the literature concerning financial conflicts of interest (FCOI) in this forum. As part of the Affordable Care Act passed in 2010, the Physician Payments Sunshine Act mandates pharmaceutical and biomedical manufactures to report to Centers for Medicaid and Medicare Services (CMS) any and all financial exchanges made to physicians and hospitals on an annual basis. Given the increasing number of FOAMed resources, as well as the increased use among medical trainees, we sought to characterize the prevalence of FCOI in a select cohort of FOAMed resources recommended by Society for Academic Emergency Medicine (SAEM) and the Emergency Medicine Resident Association (EMRA).

A cross-sectional study of a convenience sample of 31 FOAMed blogs and websites curated from a list of recommended resources on both SAEM and EMRA’s websites. The Open Payments database (OPD), created by the CMS, was used to measure FCOI. The OPD is an online, publicly available repository of financial transactions between industry and physicians and hospital systems, as reported by industry to CMS. Categories of transactions in this database include general payments, research payments, and payments related to...
ownership of companies. An in-depth description of these categories can be found at the OPD website (https://www.cms.gov/openpayments/about/natures-of-payment.html). Data in each category included payments made related to medical devices or pharmaceutical agents.

All blog posts and website entries published between June 1, 2017, and June 1, 2018, were included in the study if the website entry or blog post solely went through a methodologic process of critically appraising a peer-reviewed publication with a summary recommendation regarding whether the conclusions of the publication were clinically relevant to emergency medicine practice. We excluded all entries that did not directly meet the inclusion criteria. Every website entry—blogpost—was reviewed for each website during the inclusion criteria period. Information abstracted from each website entry included name of the posting author(s), sex, provider type, country of practice, and FCOI disclosure. Authors with numerous website entries were only included once in this study.

Using the OPD, we determined financial conflicts of for both general and research payments of all United States–based contributors. Six categories of general payments were recorded in this study, namely: 1) compensation for services other than consulting, including serving as faculty or as a speaker at a venue other than a continuing education program; 2) consulting fee; 3) travel and lodging; 4) honoraria; 5) food and beverage; and (6) education. The primary outcome of this study was prevalence of FCOI among authors of emergency medicine FOAMed content and frequency of disclosures.

The study sample and types of FCOI were described using frequencies and measures of central tendencies. Pearson’s chi-square test was used to assess group differences. An alpha level of 0.05 was used to determine statistical significance for these tests. This study of publicly available information was deemed non-human subjects research by University Hospitals Cleveland Medical Center. All analyses were conducted using Jamovi Project version 0.9.2.1 (https://www.jamovi.org).

We identified 391 unique FOAMed contributors in this study. Table 1 lists characteristics of contributors who were primarily male (68.5%, n = 268), staff physicians (49.6%, n = 194), and practicing within the United States (74.7%, n = 292). Of the 292 United States–based health care providers, 45 (15.4%) had FCOIs in the 2017 Open Payments database. FOAMed contributors on received a median (IQR) of $191 in general payments ($94–$829) with a range of $38,132. Food and beverages (85.8%) comprised the overwhelming number of transactions, followed by travel and lodging (8.6%), other services (1.9%), honoraria (1.9%), consulting (1.2%), and education (0.6%). Chi-square testing indicates that there was marginal significance in difference between males and females with FCOI (18% vs. 10.5%, p = 0.06). Twelve of 45 contributors also had research FCOIs and received a median (IQR) of $15,703 ($10,262–$72,916) in research payments.

A “significant financial conflict of interest” is an aggregate of greater than or equal to $5,000 from a single company over a 12-month period. Of the 45 bloggers with FCOI, 12 (26.6%) had financial conflicts greater than $5,000 from a single company. None of the 12 bloggers (0%) disclosed these significant FCOI in their FOAMed content.

Finally, approximately 25% (n = 99) of FOAMed contributors practice medicine outside the United States. Since there exists no foreign Open Payments equivalent that tracks clinician FCOI, we were unable to assess FCOI for these 99 international FOAMed contributors.

One limitation of our study is our use of a convenience sample of both website and blog posts. The sample was taken from two widely utilized resources.
with explicit missions to educate broad swathes of emergency medicine providers. Further, while conflicts of interest may exist for more core content social media posts, we felt that restricting our search to critical appraisal of literature might enable a clearer link between posts and FCOI. An entire survey of the emergency medicine FOAMed content may reveal a lower prevalence of FCOIs than in this unique population. Additionally, our study does not trend FCOIs over time since the beginning of Open Payments data collection from 2013, which may additionally alter the prevalence and amount of FCOIs.

Based on the current specialty guidelines for FCOI discovery and our investigation findings, we recommend that all FOAMed contributors explicitly declare FCOIs on FOAMed content—or use #FCOI on Twitter⁷—or provide a link to their OPD profile. In this study of emergency medicine FOAMed websites and blogs, we discovered that 15% of FOAMed contributors had FCOIs in 2017 in the OPD compared to 25% of all emergency physicians with FCOIs in 2015.⁸ These results suggest that emergency medicine providers involved in FOAMed are less likely to have FCOIs; however, the total dollar amount of FCOIs in our study is greater than the average total dollar amount of conflicts in a national emergency medicine provider cohort.⁸ The greater dollar amount of financial conflicts received by FOAMed emergency medicine contributors may influence the material they create.

The majority of financial transactions in this study were for food and beverages. Other studies have similarly shown that food and beverages are the most frequent payment to emergency physicians,⁹ as well as to physicians across medical specialties.⁸ While the dollar value of individual meals may not be high, physicians who receive even a single industry sponsored meal increase their prescribing of the brand name drug that is promoted.¹⁰ While our study is the first to examine FCOIs of emergency medicine contributors on social media, it does not directly address the impact of FCOI on the content of these posts. However, a study similar to ours of United States–based hematologists-oncologist on Twitter revealed that approximately 80% who use Twitter have an FCOI with a median nonresearch general payment of over $1,600.⁷ Of those with an FCOI of at least $1,000, 81% mentioned a drug from a company where they have a FCOI, and tweets about conflicted drugs were more “positive” compared to tweets about nonconflicted drugs.¹¹ In this cohort, approximately 1% of physicians included disclosures in their social media post.¹¹ While these rates of FCOI in hematology-oncology were considerably higher compared to our study, both highlight the necessity of reporting for FCOI in FOAMed.

Finally, in our study 25% of FOAMed contributors practice outside of the United States and do not have FCOI data that is publicly available in the OPD or a foreign equivalent. Concomitantly, although almost 27% of emergency medicine contributors on FOAMed with FCOI had general or research payments greater than $5,000, none of the providers in this study disclosed these conflicts with industry on their FOAMed content. The absence of public disclosure, along with a significant proportion of FOAMed contributors practicing in countries without mandated public reporting of financial conflicts, raises concern related to possible industry bias influencing the educational content in FOAMed and warrants further investigation.

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Emergency Department Patients With a Prolonged Corrected QT Interval Do Not Have Increased Thirty-day Mortality

Frank X. Scheuermeyer, MD, MHSc, Grant Innes, MD, Eric Grafstein, MD, Ryan Chard, MD, Stephanie Vandenbarg, MD, MSc, Jay Cheyne, MD, Rob Cheyne, MD, Jim Christenson, MD, Brian Grunau, MD, MHSc, David Barbic, MD, MSc, and Stephen W. Smith, MD

Prolonged QT interval (long QTc) predisposes to torsades de pointes, which can present with seizures, syncope, and sudden death. While one-third of emergency department (ED) patients may have a prolonged corrected QT (QTc) interval, often discovered incidentally, clinical significance is uncertain. In hospitalized patients or long-term community studies, long QTc is associated with increased mortality. The only ED-based study estimating mortality found that 5% of admitted patients died, although discharged patients—nearly half the cohort—were not evaluated. Our study purpose was to compare the 30-day mortality rate of ED patients with long and normal QTc, including those discharged from the ED.

We conducted a retrospective review at two Canadian university-affiliated EDs, an inner-city and cardiology referral center and a community hospital, comparing patients with normal QTc to those with both moderately and severely prolonged QTc. The Providence Health Care ethics board approved this study. At both sites, the MUSE system (GE Healthcare) records electrocardiogram (ECGs) and estimates QTc interval via Bazett. From April 1, 2011, to March 31, 2012, we selected consecutive ED patients > 18 years with prolonged QTc, defined as > 460 milliseconds (female) and > 450 milliseconds (male) based on the 98th percentile of normal. We used only the first ECG with long QTc during an ED visit. We followed patients for 30 days after the index ED visit; an additional visit during that time frame was counted as a return visit, and a subsequent visit past 30 days was counted as another index visit. To identify a comparison group of non-long QTc patients, we interrogated the ECG database during the same period to identify ECGs with normal QTc.

Based on a prior study, we estimated a 5% mortality rate for long QTc patients. To generate 95% confidence intervals (CIs) for a between-group mortality difference of ±1.5%, we required at least 800 patients. We estimated approximately 15,000 ECGs over the study period and assumed one-third would have long QTc; we used a random-number generator to select patients.
20% of these patients. For the comparison group, we sequentially evaluated a list of patients with a normal QTc-ECG and matched these patients 1:2 with long QTc patients on the basis of sex, age (within 5 years), and status as admitted or discharged from the ED.

Our electronic database records patient demographics, all ED investigations and results, and all records to 1999, including ED and hospital discharge summaries. We adhered to accepted criteria for chart review. Four residents, all blinded to study hypothesis, independently abstracted data onto standardized electronic spreadsheets to document vital signs, comorbidities, and outcomes. We described relevant comorbidities (Data Supplement S1, Appendix S1a, available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13702/full) and medications (Data Supplement S1, Appendix S1b). We reviewed old charts to clarify missing or discrepant information and resolved by consensus. A second blinded abstractor reviewed a random 10% of all charts and we estimated inter-rater reliability for the QTc value, as recorded by the reviewer.

We calculated all outcomes for both long and normal QTc groups. Primary outcome was 30-day mortality, which we obtained by linking with the provincial vital statistics database. Via chart review as above, we attempted to ascertain if any death was initiated by ventricular tachycardia. Since long QTc can predispose to cardiac arrest, syncope, and seizures, the secondary outcome was the proportion of patients with these conditions within 30 days: we reviewed hospital records for admitted patients and referenced the regional ED database for discharged patients. Finally, to assess severe QTc prolongation, we obtained all outcomes for patients with QTc > 500 milliseconds.

We used Microsoft Excel 2011 for data entry and analysis and reported discrete variables as percentages; we presented continuous variables as means with standard deviations if normally distributed or medians with interquartile ranges (IQRs) otherwise.

During the study period, 22,986 ECGs were collected from 14,011 unique patients with 4,170 (29.8%) having long QTc. We randomly selected 834 long QTc patients and matched 417 non-long QTc patients. The kappa value was 0.90 (95% CI = 0.86 to 0.94).

Half were female, median age was 65 years, and few patients had documented congenital long QTc. In both groups, 58% were discharged home (Table 1). At 30 days, 40 (4.8%, 95% CI = 3.5% to 6.5%) long QTc patients died, with 39 admitted at the index ED visit. Data Supplement S1, Appendix S2, describes clinical vignettes: 25 (62.5%) were male, median age was 78 years (IQR = 72 to 86 years), and all patients had multiple serious acute and chronic comorbidities; mortality appeared due to emphysema, advanced malignancies, and sepsis. No deaths appeared due to a primary arrhythmia. No patients had a seizure, syncope, or nonfatal cardiac arrest within 30 days. (0/834, 0%, 95% CI = 0% to 0.4%) Among normal QTc patients, 21 of 417 (5.0%, 95% CI = 3.2% to 7.7%) died within 30 days; the main causes were advanced malignancies, emphysema, and sepsis. No patients in this group had a seizure, syncope, or nonfatal cardiac arrest within 30 days. (0/417, 0%, 95% CI = 0% to 0.8%) The difference in mortality rates between long and normal QTc was 0.2%. (95% CI = −2.3% to 3.2%)

For the 167 patients (20.0%) with QTc > 500 milliseconds, eight patients died within 30 days, all in hospital during the index admission (4.8%, 95% CI = 2.4% to 9.2%; Data Supplement S1, Appendix S2) and none appeared due to a ventricular arrhythmia. No patients had a seizure, syncope, or nonfatal cardiac arrest. (0%, 95% CI = 0% to 2.8% for all; mortality difference between long and severe QTc = 0.9%, 95% CI = 4.2% to 4.9%.)

We identified 834 ED patients with prolonged QTc and determined the 30-day mortality rate at 4.8%, similar to a prior ED-based study. Deaths did not appear to have been initiated by ventricular dysrhythmia; furthermore, no patients—even those discharged home—suffered seizure, syncope, or nonfatal cardiac arrest. Importantly, the mortality rate of patients with long QTc was similar to a matched cohort of patients with normal QTc. This may imply that the traditional benchmarks of a Bazett-corrected QTc > 460 milliseconds (women) and 450 milliseconds (men) may not be appropriate for mortality risk stratification in an unselected ED population.

Seftchick et al. assessed 544 ED patients and followed the admitted 45% to estimate a mortality rate of 5.0%, but did not evaluate discharged patients. We extend these findings by providing a comparison group of normal QTc patients and obtaining outcomes on all patients. Furthermore, we ascertained a very low rate of seizures, syncope, and nonfatal cardiac arrest.
Table 1
Baseline Variables and Outcomes of Patients With and Without Prolonged QTc

<table>
<thead>
<tr>
<th></th>
<th>Long QT (n = 834)</th>
<th>Normal QT (n = 417)</th>
<th>Difference (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>65 (56–75)</td>
<td>65 (56–75)</td>
<td>0 (0 to 0)</td>
</tr>
<tr>
<td>Female</td>
<td>410 (49.2)</td>
<td>205 (49.2)</td>
<td>0 (-6.0 to 6.0)</td>
</tr>
<tr>
<td>EMS arrival</td>
<td>366 (43.9)</td>
<td>171 (41.1)</td>
<td>2.8 (-3.1 to 8.7)</td>
</tr>
<tr>
<td><strong>Initial vital signs on ED arrival</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>89 (80–97)</td>
<td>86 (78–95)</td>
<td>3 (0 to 5)</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>134 (120–149)</td>
<td>135 (123–150)</td>
<td>-1 (-3 to 1)</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>74 (68–84)</td>
<td>77 (70–88)</td>
<td>-3 (-5 to 1)</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)</td>
<td>18 (18–20)</td>
<td>18 (16–20)</td>
<td>0 (0 to 0)</td>
</tr>
<tr>
<td>Oxygen level (% on room air)</td>
<td>97 (96–99)</td>
<td>97 (96–99)</td>
<td>0 (-1 to 0)</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>36.6 (36.5–36.7)</td>
<td>36.6 (36.5–36.8)</td>
<td>0 (0 to 0)</td>
</tr>
<tr>
<td><strong>Chronic comorbidities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congenital long QTc</td>
<td>1 (0.1)</td>
<td>0 (0)</td>
<td>0.1 (-1.0 to 0.8)</td>
</tr>
<tr>
<td>Structural heart disease</td>
<td>451 (54.1)</td>
<td>202 (48.1)</td>
<td>5.6 (-0.4 to 11.6)</td>
</tr>
<tr>
<td>Stroke or TIA</td>
<td>40 (4.8)</td>
<td>10 (2.4)</td>
<td>2.4 (-0.08 to 4.5)</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>73 (8.8)</td>
<td>28 (6.7)</td>
<td>2.0 (-1.4 to 5.1)</td>
</tr>
<tr>
<td>HIV</td>
<td>32 (3.9)</td>
<td>12 (2.9)</td>
<td>1.0 (-1.6 to 3.0)</td>
</tr>
<tr>
<td>Hepatitis</td>
<td>57 (6.6)</td>
<td>24 (5.7)</td>
<td>0.8 (-2.4 to 3.6)</td>
</tr>
<tr>
<td>Sympathomimetic use</td>
<td>27 (3.2)</td>
<td>16 (3.8)</td>
<td>-0.6 (-3.2 to 1.6)</td>
</tr>
<tr>
<td>Alcohol use disorder</td>
<td>121 (15.0)</td>
<td>73 (17.5)</td>
<td>-2.5 (-7.2 to 1.8)</td>
</tr>
<tr>
<td>Eating disorder</td>
<td>6 (0.7)</td>
<td>1 (0.2)</td>
<td>0.5 (-0.9 to 1.4)</td>
</tr>
<tr>
<td><strong>Medications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antiarrhythmics</td>
<td>28 (3.4)</td>
<td>8 (1.9)</td>
<td>1.6 (-0.8 to 3.2)</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>27 (3.2)</td>
<td>19 (4.6)</td>
<td>-1.3 (-4.1 to 1.0)</td>
</tr>
<tr>
<td>Antineoplastics</td>
<td>2 (0.2)</td>
<td>0 (0)</td>
<td>0.2 (-0.9 to 1.0)</td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td>7 (0.8)</td>
<td>2 (0.5)</td>
<td>0.3 (-1.2 to 1.4)</td>
</tr>
<tr>
<td>Antidepressants</td>
<td>124 (14.9)</td>
<td>74 (17.8)</td>
<td>-2.9 (-7.6 to 1.5)</td>
</tr>
<tr>
<td>Antifungals</td>
<td>2 (0.2)</td>
<td>0 (0)</td>
<td>0.2 (-0.9 to 1.0)</td>
</tr>
<tr>
<td>Antimania</td>
<td>3 (0.4)</td>
<td>3 (0.7)</td>
<td>-0.3 (-1.9 to 0.3)</td>
</tr>
<tr>
<td>Antiemetic</td>
<td>2 (0.2)</td>
<td>2 (0.5)</td>
<td>-0.2 (-1.7 to 0.6)</td>
</tr>
<tr>
<td>Antipsychotics</td>
<td>23 (2.8)</td>
<td>16 (3.8)</td>
<td>-1.0 (-3.7 to 1.0)</td>
</tr>
<tr>
<td>Antiviral</td>
<td>30 (3.6)</td>
<td>11 (2.6)</td>
<td>1.0 (-1.5 to 3.0)</td>
</tr>
<tr>
<td>Bronchodilators</td>
<td>99 (11.9)</td>
<td>41 (9.8)</td>
<td>2.0 (-1.9 to 5.6)</td>
</tr>
<tr>
<td>H2 blockers</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (-1.2 to 0.6)</td>
</tr>
<tr>
<td>Opiate agonists</td>
<td>11 (1.3)</td>
<td>8 (1.9)</td>
<td>-0.6 (-2.7 to 0.9)</td>
</tr>
<tr>
<td>Stimulants</td>
<td>7 (0.8)</td>
<td>8 (1.9)</td>
<td>-1.1 (-3.1 to 0.3)</td>
</tr>
<tr>
<td>≥1 QTc-prolonging medication</td>
<td>297 (35.6)</td>
<td>142 (34.1)</td>
<td>1.5 (-4.3 to 7.2)</td>
</tr>
<tr>
<td><strong>Acute comorbidities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothermia</td>
<td>5 (0.6)</td>
<td>3 (0.7)</td>
<td>-0.1 (-1.7 to 0.9)</td>
</tr>
<tr>
<td>Hypokalemia</td>
<td>58 (7.0)</td>
<td>40 (9.6)</td>
<td>2.6 (-6.3 to 0.6)</td>
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<tr>
<td>Hypomagnesemia</td>
<td>11 (1.3)</td>
<td>4 (1.0)</td>
<td>0.3 (-1.4 to 1.6)</td>
</tr>
<tr>
<td>Hypocalcemia</td>
<td>9 (1.1)</td>
<td>5 (1.2)</td>
<td>-0.1 (-2.0 to 1.2)</td>
</tr>
<tr>
<td>Sympathomimetic misuse</td>
<td>17 (2.0)</td>
<td>13 (3.1)</td>
<td>-1.1 (-3.5 to 0.8)</td>
</tr>
<tr>
<td>Acute coronary syndrome</td>
<td>14 (1.7)</td>
<td>5 (1.2)</td>
<td>0.5 (-1.4 to 1.8)</td>
</tr>
<tr>
<td>Intracranial hemorrhage</td>
<td>1 (0.1)</td>
<td>1 (0.2)</td>
<td>-0.1 (-1.4 to 0.6)</td>
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<tr>
<td>Heart failure</td>
<td>68 (8.2)</td>
<td>27 (6.5)</td>
<td>1.7 (-1.7 to 4.7)</td>
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<tr>
<td>Sepsis (including pneumonia)</td>
<td>74 (8.9)</td>
<td>43 (10.3)</td>
<td>-1.4 (-5.3 to 2.0)</td>
</tr>
<tr>
<td>Pulmonary embolus</td>
<td>8 (1.0)</td>
<td>3 (0.7)</td>
<td>0.3 (-1.4 to 1.4)</td>
</tr>
</tbody>
</table>

(Continued)
The 30-day mortality of unselected ED patients with QTc > 500 milliseconds was 4.9%, not apparently different from “regular” long QTc, although these results may not apply to ED patients who present with syncope or near syncope, both higher-risk groups. Our results differ from a study of over 41,000 hospitalized patients where 293 (0.7%) had QTc > 500 milliseconds; all-cause mortality was double, and malignant arrhythmia and syncope were 10-fold. Anderson et al. determined that admitted inpatients with QT > 500 milliseconds had a higher 30-day mortality but no deaths appeared due to arrhythmia. It is critical to note that the evidence of elevated mortality risk in patients with prolonged QTc < 500 milliseconds—in contrast to QT > 500 milliseconds—arises from longitudinal community-based studies. As both cardiology inpatient and community-based populations are very likely different from an undifferentiated ED cohort, future investigators may wish to use QTc as a continuous variable, or in conjunction with other variables, to stratify ED patients for mortality risk.

We note some limitations. We did not confirm each QTc interval by hand, but it is unlikely that most emergency physicians would do so clinically. Bazett’s formula may be inferior to others including Hodges, Fridericia, Framingham, and Rautarhaju. Vandenberk suggests Bazett’s formula overcorrects by a mean of 24 milliseconds compared with the Fridericia formula; had we used this cutoff broadly, we would have collected 578 long QTc patients with 28 deaths (4.8%). QTc is affected by QRS duration, and we did not correct for bundle branch blocks or paced rhythm, but these are infrequent findings affecting a very small proportion of ECGs. QTc intervals may be dynamic. Most patients likely had acquired long QTc and our results cannot be extrapolated to patients with known congenital illness, although the latter is rare. Despite our matching attempts, unmeasured confounders may influence both normal and long QTc groups. With only 40 deaths our study was not powered to find a small mortality difference; similarly, there are likely a large number of variables potentially affecting long QTc, which limits mortality conclusions in our cohort. Some admitted patients might not have had occult seizures, syncope, or torsades-initiated arrest recorded in hospital summaries. Nevertheless, our study questions whether, in an undifferentiated ED population with prolonged QTc, there is any significant short-term increased risk of ventricular dysrhythmia or death, especially if QTc is only moderately prolonged (<500 ms) and illustrates the need for larger studies.

### References


Supporting Information

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13702/full

Data Supplement S1. Supplemental material.
BACKGROUND

Child sex trafficking (CST) is a global human rights violation and occurs when a minor is engaged in any sex act that involves an exchange of something of perceived value, whether monetary or nonmonetary. Examples of CST include prostitution of children by others, “survival sex” (runaway/homeless children having sex in exchange for shelter or something else needed to survive), working in sex-oriented businesses, or production of child sexual abuse materials. Statistics from the United States Human Trafficking Reporting System indicate that 85% of identified sex trafficking victims were U.S. citizens/legal residents and 55% were minors. Risk factors associated with CST include a history of abuse, substance use, juvenile justice system involvement, a history of running away from home, and LGBTQ status.

Victims of CST are at risk for a myriad of health-related consequences, including physical injury; chronic pain; sexually transmitted infection (STIs); substance use disorders; and psychiatric disorders such as PTSD, depression, and suicide. Most of these victims seek medical attention at some point, with 88% having seen a physician during their exploitation.

ARTICLE SUMMARY

This study evaluates a screening tool for CST among pediatric patients who present to a large inner-city emergency department (ED). Children aged 10 to 18 presenting with high-risk chief complaints including many gynecologic and psychiatric complaints or high-risk sexual or social behavior were screened for CST. This was done using a screening tool previously developed from a comparison of CST victims to patients presenting with complaints of acute sexual assault without a commercial component.

QUALITY ASSESSMENT

Overall this was a well-done prospective, observational study performed in the pediatric ED (PED) of a major U.S. city. The sample of patients may not be representative, because it was based on a convenience sample of participants selected during times when the CST investigative team was available in the PED. In addition to this, non–English-speaking patients were excluded and both of these factors did introduce some selection bias. The study attempted to mitigate the selection bias created by convenience sampling through inclusion of a representative sampling of day, evening, night, and weekend shifts.

Despite focusing on child trafficking, this study included 18-year-old patients. The authors noted that they were included because they still present to this particular PED and, upon a positive screen, the CST team would be searching for evidence of CST prior to age 18.
A major issue with any study examining sex trafficking is the criterion standard being used. The authors used a federal, legal definition of CST, which is standardized and reproducible. However, it is primarily based on self-report, which means the definition could both overcall and (more likely) undercall cases of CST, which would impact the reported sensitivity and specificity. That being said, self-report is likely the best criterion standard available for this diagnosis.

External validity is also a limitation of this study, as this was done in an urban inner-city PED, so we are unable to generalize to community EDs. Thankfully, CST is relatively rare. However, small numbers do result in large confidence intervals (CIs) that must be considered when assessing this screening tool.

**KEY RESULTS**

The primary outcome was the diagnostic accuracy of the CST screening tool, which had a sensitivity of 90.9% (95% CI = 58.7%–99.8%), specificity of 53.1% (95% CI = 45.6%–60.4%), positive predictive value of 10.0% (95% CI = 5.0%–17.6%), and negative predictive value of 99.0% (95% CI = 94.7%–99.9%). Other findings revealed that the mean (range) age of CST victims was 15.9 (13–18) years, with nine females and two males. CST victims presented in a variety of social circumstances, including alone, with a parent/guardian, with a friend, with a police officer, and with a social services case manager. A total of 55% of CST victims had seen a medical provider within the past 6 months.

History items strongly associated with CST were more likely to have run away from home, have used drugs/alcohol in the past 12 months, have had more than 10 sexual partners, and have had a prior STI. There was no chief complaint among the inclusion criteria that correlated significantly with CST presentation.

**AUTHORS’ COMMENTS**

Although there are some methodologic issues that make us uncertain of the accuracy of this screening tool, CST is an incredibly important topic. This tool is unlikely to be 100% sensitive based on the results presented. However, we expect that CST is frequently missed in current clinical practice, and therefore this screening tool, even if imperfect, may represent a significant improvement for many clinicians.

**TOP SOCIAL MEDIA COMMENTARY**

There was very limited social media discussion on this topic, which may be due to its sensitive nature. However, as emergency physicians, we need to be aware of CST and how to screen for it as these patients often present to EDs. We welcome ongoing discussion on The SGEM website.

**Comments From Twitter**

Paper-in-a-pic from Kirsty Challen, @KirstyChallen

**Meme Contest**

**TAKE-TO-WORK POINTS**

Child sex trafficking is a high-risk condition with a myriad of health consequences. Emergency physicians are in a unique position to identify victims. The use of a CST screening tool for adolescents presenting to the ED with high-risk complaints might help us identify more at-risk children.

**References**

7. Reid JA. Risk and resiliency factors influencing onset and adolescence-limited commercial sexual exploitation of
disadvantaged girls. Crim Behav Mental Health 2014;24:332–44.


High-flow Oxygen Therapy for Treating Bronchiolitis in Infants

Isaac Gordon, MD, and Ambreen S. Khan, MD

<table>
<thead>
<tr>
<th>Color recommendation</th>
<th>Yellow (unclear benefit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary heading</td>
<td>Decreases the risk of treatment failure and requiring escalation to higher level of care</td>
</tr>
<tr>
<td>Benefits in NNT</td>
<td>NNT of 9 for preventing escalation of care</td>
</tr>
<tr>
<td>Benefits in percentage</td>
<td>11% lower risk of escalation of care for patients treated with high-flow oxygen No benefit in terms of duration of hospitalization or oxygen therapy</td>
</tr>
<tr>
<td>Harms in NNT</td>
<td>No difference between the groups for adverse events</td>
</tr>
<tr>
<td>Harms in percentage</td>
<td>No difference between the groups for adverse events</td>
</tr>
<tr>
<td>Efficacy endpoint(s)</td>
<td>Treatment failure (requiring escalation of care), admission to intensive care unit, duration of hospital stay, the duration of intensive care unit stay, duration of oxygen therapy, intubation rates</td>
</tr>
<tr>
<td>Harm endpoint(s)</td>
<td>Serious adverse events including pneumothorax, respiratory arrest, cardiac arrest, apnea, emergency intubation</td>
</tr>
<tr>
<td>Who was in the studies?</td>
<td>1,472 infants younger than 12 months with signs of bronchiolitis with oxygen requirement</td>
</tr>
</tbody>
</table>

NARRATIVE

Bronchiolitis is the most common reason for hospitalization in infants worldwide. Current recommendations by the American Academy of Pediatrics are for supportive care including maintenance of hydration and oxygen support for hypoxemia. Other interventions such as the use of bronchodilators have failed to show any benefit when compared to supportive care alone. However, it has been proposed that the obstructive process of bronchiolitis that causes increased work of breathing, hypoxia, and hypercapnea might respond to the moderate positive pressure provided by high-flow oxygen therapy.

The randomized control trial referenced here was conducted in Australia and New Zealand across multiple institutions on otherwise healthy infants (less than 12 months old) with bronchiolitis with an oxygen requirement. For the purposes of the study, oxygen requirement was defined as the need for supplemental oxygen to maintain oxygen levels between 92% and 98% (11 institutions used site-specific standard of 94%–98%). Patients were randomized to heated and humidified high-flow oxygen at a rate of 2 L/kilogram body weight/min delivered by the Optiflow system with the use of an age-appropriate Optiflow Junior cannula and the Airvo 2 high-flow system (intervention group) or supplemental oxygen through a nasal cannula, up to a maximum of 2 L/min, to maintain an oxygen-saturation level in the range of 92% to 98% (control group).

Treatment failure was defined as the need for escalation of care based on standardized clinical criteria: persistent or worsening tachycardia, tachypnea, worsening of hypoxemia requiring > 40% FiO2 in the high-flow oxygen group and > 2 L/min flow rate of nasal cannula in the standard therapy group. Each hospital was allowed to use its own escalation protocol to be used as the criteria for treatment failure. Each episode of escalation of care was reviewed to ensure that it met study criteria. Escalation of care in the standard oxygen group was recommended to switch each patient to high-flow therapy.
The trial showed a 11% absolute risk reduction in the need for escalation of care in patients receiving high-flow oxygen therapy (relative risk = 0.52, 95% confidence interval = 0.40–0.66; NNT = 9). This trial did not show any significant difference between the groups for other outcomes such as duration of hospital or ICU stay and intubation rates (although a very small percentage of patients [12/1,472] required intubation).3

High-flow oxygen therapy did not result in any significant increase in the risk of adverse events, although the rate of adverse events was very low in both groups and no patients in any of the groups required emergency intubation and cardiopulmonary resuscitation. One child in each group was diagnosed with pneumothorax but none required thoracostomy.3

Similar results were found by another recent smaller trial that reported an absolute risk reduction of 9% in treatment failure rate (NNT = 11) in patients allocated to high-flow oxygen therapy but no statistically significant difference between the groups for time to oxygen weaning or length of stay. The rates of adverse events were similar between the two groups in this trial as well.4

CAVEATS

This is the largest randomized trial to date addressing this important research question.3 The major limitation of this trial was the absence of blinding, which was not possible due to difference between the equipment. To reduce the risk of bias, the investigators remained blinded to the trial outcome until the trial was completed.

The primary outcome of this trial was treatment failure defined as requiring escalation of care. This was a composite outcome which reflected admission to a higher level of care or changing from low-flow oxygen to high-flow oxygen therapy (control group) and may not be considered a patient-centered outcome. In addition, determining this outcome was somewhat subjective. Analyzing individual patient-centered outcomes such as length of hospital or ICU stay and intubation rate did not show any benefits from using high-flow oxygen therapy. It must be noted that according to the Australian New Zealand Clinical Trials Registry, the initial primary outcome of the trial was reduction in transfer rate from regional hospital to tertiary center. This outcome was changed after inclusion of tertiary centers since this outcome would not be applicable anymore for patients who present directly to a tertiary emergency department (ED).5

While the overall rate of treatment failure and the need for escalation of care was lower in patients allocated to high-flow oxygen therapy, when the high-flow group was divided by hospital with an on-site pediatric intensive care unit (PICU) versus no PICU, the escalation rate was significantly higher in hospitals with an on-site PICU (14% vs. 7%). Therefore, availability of an on-site PICU could be an important factor in escalation of care by treating physicians.3

It is notable to mention that 61% of the patients in the standard therapy group who experienced treatment failure were transitioned to high-flow oxygen therapy and responded positively.3 High-flow oxygen therapy may potentially have the highest overall benefit in hospitals without an intensive care unit as it may decrease the need for interfacility transfers.

Another limitation of the reported data is that 34% of all patients that had escalation of care did not meet the criteria for escalation of care based on the study criteria but met the individual hospitals escalation criteria. This can present some confounding when looking at treatment failure between the groups.3

It must be noted that the trial did not control for the effect of high-flow oxygen therapy itself as a main factor for the need for higher level of care. Assignment to high-flow oxygen above 2 L/kg might have prompted certain physicians to escalate the level of care for closer observation and higher demands for nursing care.

The trial discussed in this review did not exclusively enroll patients in the ED.3 Patient enrollment occurred both in the ED and on the pediatric wards. Therefore, a trial originated exclusively in the ED might produce different results. Er et al.6 explored the characteristics of ED patients with bronchiolitis who respond poorly to high-flow oxygen therapy. These investigators concluded that low initial oxygen saturation, respiratory acidosis, and an oxygen saturation/fraction of inspired oxygen ratio less than 195 at the first hours of treatment were related to unresponsiveness to high-flow oxygen therapy in the pediatric ED.5

Unfortunately, this trial does not evaluate the cost effectiveness of high-flow oxygen therapy. Other published trials have suggested cost saving benefits from using high-flow oxygen therapy.4,7 Kepreotes et al.4 discussed the estimated cost savings with the use of high-flow oxygen therapy and concluded that high-flow oxygen therapy might have a role as a rescue therapy to reduce the proportion of children requiring high-cost intensive care. Heikkilä et al.,7 performed a cost
analysis of high-flow oxygen therapy versus standard oxygen therapy and found that using high-flow oxygen therapy was associated with a $441 saving per patient due to decreases in ICU admission and hospital transfers. Finally, this trial used pulse oximetry levels of 92% to 98% (94%–98% in specific institutions) to evaluate response to therapy while the American Academy of Pediatrics recommends initiation of oxygen therapy at pulse oximetry levels of 90% or below.10

In conclusion, high-flow oxygen therapy in infants with bronchiolitis reduces the risk of treatment failure and the need for escalation of care. However, it does not offer any benefit as far as direct patient-centered outcomes are concerned. Therefore, we assign a color recommendation of yellow (unclear benefits) to this intervention. However, this trial still has clinical implications. It appears that for patients with bronchiolitis who do not respond to low-flow oxygen therapy (first line of therapy) based on criteria used in this trial or other institutional criteria, high-flow oxygen therapy should be considered as the next logical step before employing other more aggressive measures.

Editor’s Note: Brass Tacks are concise reviews of published evidence. This series is a result of collaboration between Academic Emergency Medicine and the evidence-based medicine website, www.TheNNT.com. For inquiries please contact the section editor, Shahriar Zehtabchi, MD (Shahriar.zehtabchi@downstate.edu).

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Point-of-care Ultrasound for the Diagnosis of Thoracoabdominal Injuries After Blunt Trauma

Michael Gottlieb, MD¹, Alex Koyfman, MD², and Brit Long, MD³

NARRATIVE

Trauma is a major cause of morbidity and mortality, representing one of the top 10 causes of both death and disability-adjusted life-years by the World Health Organization.¹,² Point-of-care ultrasound (POCUS) is commonly performed during or after the primary survey to identify whether significant thoracic injuries or abdominal free fluid are present, particularly when patients are unstable or cannot receive a computed tomography (CT).³ However, it is important to determine the accuracy of this modality to ensure proper application in trauma patients.

The Cochrane Review discussed here⁴ included retrospective and prospective studies assessing the diagnostic accuracy of POCUS for thoracoabdominal injuries in patients with blunt trauma (defined as any nonpenetrating force). The reference standard included CT scan, magnetic resonance imaging, laparotomy or laparoscopy, thoracotomy, or autopsy. The primary outcome was the diagnosis of any thoracoabdominal injury, which was defined as free fluid in the thoracic or abdominal cavity, retroperitoneum, pericardium, or mediastinum; organ injury (e.g., splenic, other solid organ, hollow viscer, or other organ laceration); a vascular lesion (e.g., dissection of rupture of aorta or other vessels); and other injuries (e.g., pneumothorax). Subgroup analyses were performed for pediatric patients versus adult patients as well as abdominal versus thoracic injury.⁴ Approximately half of the trials were conducted in the United States, and half of the study subjects were enrolled in Level I trauma centers.

The authors of the Cochrane review identified 2,872 records, of which 34 studies (n = 8,635...
patients) met inclusion criteria. Overall, POCUS was 74% sensitive (95% confidence interval [CI] = 65% to 81%) and 96% specific (95% CI = 94% to 98%) with a positive likelihood ratio of 18.5 (95% CI = 10.8 to 40.5) and a negative likelihood ratio of 0.27 (95% CI = 0.19 to 0.37). Among pediatric patients, POCUS was 63% sensitive (95% CI = 46% to 77%) and 91% specific (95% CI = 81% to 96%). In adults alone, POCUS was 78% sensitive (95% CI = 69% to 84%) and 97% specific (95% CI = 96% to 99%). POCUS was 68% sensitive (95% CI = 59% to 75%) and 95% specific (95% CI = 92% to 97%) for diagnosing abdominal injuries specifically. For thoracic injuries, POCUS was 96% sensitive (95% CI = 88% to 99%) and 99% specific (95% CI = 97% to 100%).

Assuming an overall baseline pretest probability of thoracoabdominal injury of approximately 28% (based on the median prevalence of such injuries in all of the included studies), POCUS would hypothetically miss injuries in 7.3% of patients and falsely suggest the presence of injuries in 2.9% of the patients. Assuming a pretest probability of thoracoabdominal injury of approximately 31% in pediatric patients (based on the median prevalence of such injuries in the included studies), the miss rate (false negative) would increase to 11.8%, and the false-positive rate would be 6.2%.

**CAVEATS**

The overall quality of the trials included in this meta-analysis was unclear due to limited reporting of the selection of participants and choice of diagnostic testing used for the reference standard. The most important limitation of the original review was the inclusion of all organ injuries (rather than free fluid) in the outcome assessment. The American College of Emergency Physicians guidelines states that the primary indication of the FAST examination is to “identify pathologic collections of free fluid or air released from injured organs or structures.” Consequently, assessing for the presence of any organ injury is beyond the scope of the FAST examination. Additionally, it is unclear how many injuries were significant enough to require an intervention. In this case, while a solid organ injury may have been missed with the FAST examination, it may not have been clinically significant. Therefore, it may have been preferable to focus on the identification of intraperitoneal free fluid and clinically significant organ injuries.

Furthermore, a number of different criterion standards were used, which can lead to differential verification bias. There was also significant heterogeneity with regard to both the patient and the study characteristics. Training protocols also varied and were not explicitly defined in most studies. Additionally, provider experience and specialty as well as the POCUS machine utilized differed significantly between studies. These factors may have further contributed to the heterogeneity between the trials. Moreover, most studies assessed abdominal injury and only four studies assessed thoracic injury. Finally, there was limited reporting of multiple methodologic parameters, including how studies accounted for inconclusive results.

While the trials included in the meta-analysis do not report the harms associated with using POCUS for identifying thoracoabdominal injuries, false-positive findings might subject the patients to unnecessary diagnostic or therapeutic procedures. False-negative findings might falsely reassure the providers and cause them to miss injuries. The level of training and the experience of the operators might reduce the risk of such harms. Future trials are needed to assess the risk of such harms and identify the methods by which they could be reduced.

Based on the existing evidence, POCUS appears to be highly sensitive and specific for identifying significant thoracic injury. Additionally, POCUS appears to be highly specific but insufficiently sensitive to exclude abdominal injury. This suggests that a positive POCUS is strongly suggestive of an abdominal injury and should prompt subsequent targeted intervention, particularly in unstable patients. However, a negative POCUS examination does not exclude significant injury and should be followed by advanced imaging (e.g., CT), especially in pediatric patients. Keeping the limitation of this diagnostic modality in mind, this noninvasive and rapid test could provide useful information to the clinician and guide the proper diagnosis and treatment. Therefore, we have assigned a color recommendation of green (benefit > harm) to the use of POCUS for identifying thoracoabdominal injuries after blunt trauma.

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Almost a quarter of a century has passed since the National Institute of Neurological Disorders and Stroke (NINDS) t-PA trial began to transform the emergency treatment of acute ischemic stroke (AIS), based on a rigid 3-hour window from the patient’s last known well (LKW) time. Twenty years later, the mechanical thrombectomy era was ushered in by compelling outcome data from trials of large-vessel occlusion (LVO) AIS patients selected for mechanical thrombectomy within 4.5 hours from LKW, based on CT perfusion (CTP) and magnetic resonance imaging mismatch criteria. More recently, it was reported that similar mismatch criteria can identify patients who can benefit from endovascular reperfusion therapy as far out as 24 hours from LKW. Indeed, advanced imaging selection criteria threaten to make any acute time-based window for treatment obsolete, including that for systemic thrombolysis. This evolution of AIS treatment, and the challenges it poses for developing regionalized systems of acute stroke care, are discussed in a review published in this month’s issue of Academic Emergency Medicine.

While the imperative to create such regionalized acute stroke care systems has never been more apparent, whether or not we succeed with stroke, as we have with ST-elevation myocardial infarction (STEMI), remains to be seen.

It has been often stated that the Holy Grail of regionalized acute stroke care is finding the “STEMI 12-lead ECG equivalent for stroke,” which would not only identify AIS in the field, but also accurately distinguish LVO AIS from non-LVO AIS. This effort has yielded an acronym soup of derived LVO screens (LAMS, RACE, C-STAT, VAN, FANG-D, LEGS, PASS, FAST-ED) that, as Miller et al suggest, all lack rigorous study of reproducibility and validity. However, this lack of evidence has not hindered several states from enacting statewide policies mandating the use of a prehospital LVO screen to inform “routing protocols.” That the term “routing” has replaced “bypass” as the preferred vernacular for referring to such protocols is not coincidental. It undeniably reflects the threat that such protocols can pose in regions where several stroke centers of varying capabilities compete as the preferred destination for EMS patients. Market competition aside, more concerning may be the impact of undertriage and overtriage that such policies may create. Since the 15% overtriage rate deemed acceptable for suspected STEMI routing to a percutaneous coronary intervention center is unlikely to be achieved for stroke, it appears likely that regions adopting these policies may need to tolerate overtriage rates closer to the 50% rate judged acceptable for major trauma patients. This is largely due to the low prevalence of LVO stroke in the EMS population screened, which, when coupled with nonspecific screens, becomes a recipe for overtriage. This concern was pointed out in a recently conducted systematic review commissioned by the American Heart Association/American Stroke Association, which was intended to support the recommendations of their updated stroke guidelines originally published in January 2018. Interestingly, a “corrected” version of these guidelines emerged 4 months later, which notably seemed to ignore the findings of their commissioned study. How and why this correction came about remains unclear, but it disregards the recognition that work remains until severity-based stroke routing can be widely endorsed. Such work should include simulation modeling, which has the potential to quantify the likely impact of specific routing schemes before implementation, so that protocols can be tailored for the local characteristics of specific regions. For example, such modeling found that Mecklenburg County North Carolina could nearly double the

The author receives research support from Penumbra, Inc., and serves as consultant for Stryker Neurovascular. The author has no potential conflicts of interest to disclose.
number of LVO patients routed to a thrombectomy capable center by adjusting the permissible increased EMS transport time from 10 to 20 minutes but would only marginally benefit from increasing the allowable time beyond 20 minutes. However, simulations in King County Washington suggested that increasing from 20 to 30 minutes of permitted additional transport time corresponded to a 28% increase of patients with LVO directly transported to an ESC.\(^{18}\) Furthermore, it must be acknowledged that routing may not be best for all LVO patients, as recent data demonstrate IV t-PA recanalizes 30% of all LVOs and is more likely to be successful with more distal thrombus location, greater thrombus permeability, and longer time to recanalization assessment.\(^{19}\) Such patients, it would seem, would benefit more from timely systemic thrombolysis, than from treatment delays associated with direct routing to a thrombectomy center. Importantly, a prospective, multicenter, cluster randomized trial comparing the strategy of transferring suspected acute LVO AIS patients to the closest local stroke center versus direct transfer to an endovascular stroke center is ongoing (RACECAT, NCT02795962).\(^{20}\) This study, which is targeted to be completed in 2020, is likely to provide important insight into the hazard of misclassification of non-LVO patients and the possibility of early recanalization after thrombolysis.

Coupled with the aforementioned challenges of field to facility triage are the challenges and work needed to improve interfacility triage and transport of LVO AIS patients who will inevitably initially present to nonendovascular centers, regardless of how successful routing becomes. This is perhaps best reflected in recent data reporting that 54% to 73% of interfacility transfers for intended mechanical thrombectomy did not go on to receive endovascular intervention on arrival at the thrombectomy center.\(^{21,22}\) Even more concerning is that 44% to 48% of these false-positive thrombectomy transfers were transported by helicopter. This demonstrates the need for better methods of triage and patient selection to identify those likely to benefit from emergent transfer for endovascular intervention. At a minimum, CT angiography (CTA) should be required to confirm the presence of a target LVO. Additionally, it is becoming increasingly apparent that CTP capability is highly beneficial for nonthrombectomy centers to select patients with a favorable tissue mismatch, as was done in all of the CT-based extended window trials and two of the early window trials demonstrating the efficacy of mechanical thrombectomy.\(^2-4,23\) Utilization of advanced imaging at nonthrombectomy centers is further supported by quantitative estimates demonstrating that its deployment would result in significantly fewer futile transfers for endovascular therapy.\(^{24}\) Additionally, emerging data suggest that CTP may help predict which transferred patients may proceed rapidly to the angiography suite, without repeat imaging on arrival to the endovascular center, based on parameters such as a low hypoperfusion index and high relative cerebral blood volume in the hypoperfused region, which are strong indicators of good collateral circulation and slow infarct growth.\(^{25,26}\) Nonetheless, even with prompt identification of LVO patients, it is recognized that delay in hospital-to-hospital transfer is a common reason that many patients are excluded from interventional therapy.\(^{27}\) To prevent such delays, it is essential that thrombectomy centers work closely with their referral hospitals to develop protocols leveraging the early identification of thrombectomy eligible LVO patients now possible though advanced imaging. Even with CTA alone, it has been shown that a strategy consisting of timely CTA performance at nonthrombectomy sites, early communication to the referral thrombectomy center, and efficient electronic image sharing between hospitals can improve efficiency and outcomes.\(^{28}\)

While the treatment options for LVO AIS patients have never been more promising, responsibly applying recent advancements over an increasingly expanding time window since patients were LKW represents a challenge. Especially considering that over the next 40 years, the number of incident strokes is expected to more than double (with the majority of the increase likely to occur among those aged ≥ 75 years),\(^{29}\) it will be essential that regional systems of acute stroke care are thoughtfully designed. Stakeholders in these regional systems must resist premature implementation of policies and protocols that have been insufficiently studied and have the potential to overwhelm current emergency care resources. Instead, we need to all work together to study, create, and then deliver the next generation of regionalized acute stroke care.

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So the Doctor Is Burned Out: What Does It Mean for Patient Care?

The current state of physician burnout has become an increasingly popular topic of discussion and concern. Depending on how it is defined and measured by researchers, the prevalence of physician burnout ranges anywhere from 0% to 80%.

Emergency medicine is often cited as the specialty with some of the highest reported levels of physician burnout. Regardless of what the “true” prevalence of physician burnout may be, most of these studies suggest the presence of a crisis. The detrimental impact of burnout on physicians is certainly of interest to physicians. What is missing from these discussions is the impact of burnout on patients and their families and objective clinical outcomes.

Many studies have demonstrated the significant relationships between physician burnout and the “softer,” but no less important, sides of patient care. For example, physician burnout has been shown to be inversely related to patients’ satisfaction with their care as well as their ratings of their physicians’ empathy and communication skills. Lower patients’ satisfaction with their care may in turn lead to poorer patient compliance with recommended treatment, although the links between patient satisfaction and patient outcomes remain unsettled.

Burnout has also been tied to lower physician productivity and shorter career longevity, which may ultimately impact patient care by respectively raising costs and decreasing access to medical care. Indeed these findings have formed the basis for the burgeoning business case for addressing physician burnout.

While decreasing burnout may lead to more satisfied physicians and patients, does it lead to healthier patients? Do patients treated by physicians with lower levels of burnout and more resilience experience fewer medical errors or experience less morbidity and mortality? It remains unclear if burnout has an objective and quantifiable impact on objective measures of patient care. The vast majority of burnout studies that point to such a link rely on the self-reports of physicians responding to a survey. These data are limited by response, reporting, and hindsight biases, among others, and they do not reveal if burned out physicians’ self-reports of worse care actually translate to poor outcomes. Studies that rely on more objective measurements of how burnout may influence patient care are rare, and these studies have yielded mixed results.

There are likely a small number of such studies because it is difficult to link provider-specific burnout with provider-specific outcomes. Medicine is a team sport and few aspects of patient care can be cleanly attributed to the actions of a single provider. If burnout does indeed influence patient outcomes, can the impact of one health care provider’s burnout on a patient’s care be offset by the lack of burnout—or engagement—in another provider caring for the same patient? It is also unclear which outcomes of patient care are most at risk from physician burnout. Does burnout impact patient care in obvious ways like differences in sepsis outcomes and serious medical errors? Or does burnout influence patient care more subtly via variations in communication and resource utilization? For example, do burned out physicians communicate less well with colleagues and patients or order more laboratory tests, CT imaging, and specialist consultations?

Despite these unknowns, many studies have detailed provider-centered and systems-wide interventions to mitigate physician burnout. Although some of these efforts have resulted in improved burnout scores or physician work satisfaction, presumably these improvements are meaningful because they in turn improve the delivery of patient care. Unfortunately in the fervor to address...
burnout and promote wellness, the important step of demonstrating such a link is a glaring omission.

The argument for investing in efforts to mitigate physician burnout and promote professional fulfillment can be bolstered if researchers are able to demonstrate an objective impact on real-world patient care. Such a link may also inform interventions to address burnout that will yield the most benefit for physicians and patients alike. The case for addressing physician burnout would no longer just be a business case focusing on relative value units and staff turnover. Rather it would be an ethical, public health, and patient safety case centered on the appropriate use of medical resources, preventing patient harm, and delivering the best possible care to patients. Before the medical community becomes burned out from reading studies on burnout, a shift in focus on how burnout ultimately matters to patient care is necessary.

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Climate Change and Health: An Urgent Call to Academic Emergency Medicine

There is consensus among 97% of scientists that anthropogenic climate change is occurring and international agreement of the grave threat it poses.1,2 A Lancet Commission declared climate change “the biggest global health threat of the 21st century” with “potentially catastrophic risk to human health.”3,4 Emergency medicine (EM) is already on the frontlines as climate change directly affects our patients, clinical practice, and emergency departments (EDs). This presents EM with a profound leadership opportunity to join our colleagues in the house of medicine to improve health and save lives.

Climate change, driven by increased greenhouse gas (e.g., carbon dioxide) emissions from activities like fossil fuel combustion for electricity generation, has led to rising temperatures, more extreme weather, and rising sea levels. The United States has warmed 0.15°F per decade since 1895, with 2016 the warmest year on record, and the first year scientists definitively identified extreme weather events that would not have occurred without climate change.5–7 Almost as hot, 2017 had a record-setting number of large-scale disasters with these 16 events alone causing over $313 billion in damages and an official death toll of 3,278.8,9 Sea level rise is also well documented with significant implications for coastal regions.10 While these are the most tangible exposure pathways of climate change, others include exacerbation of air pollution, increased allergen production, alterations in vector ecology, and decreased water and food quality.11

While new impacts on health are continually being discovered, climate change is already causing a broad range of human disease in the United States like injuries from severe weather and interpersonal violence, heat stroke and heat-related cardiac disease, reactive airway disease exacerbations from smog and allergens, gastrointestinal illnesses from water supply contamination, vector-borne diseases, and mental health crises.11 These harms disproportionately affect children and elders, the poor, and those with chronic diseases—the patients we see in our EDs.3 Globally, those most affected are the least responsible.12 Thus, there are practical and ethical imperatives for academic emergency physicians to become climate and health champions.

The health risks of climate change are complex and challenging to communicate.13 Yet, as with many other complex health issues, emergency physicians are in a unique position to help as we practice at the front door of the health care system. We are natural educators and caregivers, routinely communicating abstract scientific concepts and presenting digestible treatment plans to our patients, all in an incredibly high-stakes environment. The public, even those who are dismissive of climate change, trusts physicians’ assessments regarding climate and health.14

Literature on physician views shows a clear consensus: climate change is happening and affecting our patients.15–17 Most physicians also feel that it is important for them to inform patients of the threat and that medical associations should play an advocacy role. Other specialties have responded.18 Twenty-one medical societies, including the American Medical Association, have joined the Medical Society Consortium on Climate and Health. Until California’s chapter of the American College of Emergency Physicians joined, EM had been absent despite early consideration of the issue as a priority.19

Our specialty was born of a societal need, not a unique scientific scope, and we continue to respond to the needs of those we serve. EDs are the safety net of our health care system, and climate change will...
challenge our already-stretched EDs. In addition to increased utilization of emergency services, we will treat more patients displaced by extreme weather events. In fact, it could be predicted that all of the 20 leading diagnoses for both ED visits and hospital admissions will increase as the climate crisis swells.

The most affected patients are those for whom we already provide care. In 2014, 18% of ED patients were over 65 and 19% were under 18. The impoverished visit the ED at twice the rate of those with incomes over 400% of the poverty line. We already see a steady increase in ED patients with chronic diseases. This is particularly true in disasters, when EDs are often the only source of care for acute or chronic conditions. No profession exceeds our dedication to, and proficiency for, disaster response and indefatigable care for the most vulnerable.

The house of medicine is fatigued and strained, and our practitioners are burning out from a host of stressors, but that does not have to be. While there are contributing factors physicians cannot change, taking leadership on climate and health could help us reconnect with our altruistic calling. Academic EM can add to our legacy by leading the charge, embracing the Society for Academic Emergency Medicine’s vision of “creating and disseminating content with the greatest impact on emergency care.” In the face of this challenge, academic EM’s unique contribution should focus on education, research, and advocacy, so we are better prepared, informed, and aligned with those we serve.

Education is perhaps the most central for our colleagues, students, and patients. While most physicians have minimal understanding of climate change and health linkages, approximately three-fourths want relevant continuing medical education. Columbia University’s Global Consortium on Climate and Health Education has pledges from over 115 health profession schools to include climate and health in their curricula. These educational efforts need a clinical focus for acute care practitioners, which will translate to education of our patients and the public.

There are also a host of EM climate and health research needs, from epidemiologic analyses to consideration of how climate-related migrations are likely to impact health system operations and service delivery. Analyses of health system failures in disasters and infrastructure vulnerabilities to flooding and sea level rise are sorely needed, as are strategies for improving resilience to issues such as medication shortages from disasters. With health care contributing at least 10% of U.S. greenhouse gas emissions, we need research to help us reduce our footprint. Finally, research evaluating educational interventions for medical and patient communities is required.

Advocacy is needed, at a minimum, to bridge the gap between research and policy. One of the most critical steps is unifying physicians and the larger health community to advocate for our current and future patients against the negative health impacts of climate change. We have the ability and expertise to put a human face on climate change in a way no other group can.

Climate change has moved beyond a fight over fossil fuels and causality. As impacts mount, level-headed engagement and risk assessment are needed, and physicians are in a unique position to reframe climate change as a public health issue to mobilize action. The battle is not already lost, and the fact that significant further warming and sea level rise are now inevitable only reinforces the need to aggressively attack preventable dangers to and minimize the harms.

Emergency medicine joined the house of medicine in 1979, and its practitioners now span three generations. While young, EM is mature enough to consider its legacy. If current trends continue, when we celebrate our first centennial the world will be several degrees warmer and seas almost a meter higher. The impacts on EM will be incontrovertible. How will trainees then view the choices we make now? Hopefully, they will say we acted with foresight, courage, and haste.

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Hey, Doctor!

I’m midway through my third year of medical school, and today is the first day of my emergency medicine rotation. The emergency department (ED) is crowded; I snake through staff and stretchers as I try to find my resident in Resus. I’m sidetracked by an anxious-looking man. “Hey, Doctor! My wife is still having back pain; can she have some Percocets?” I’ve gotten used to people calling me doctor, and I’ve stopped correcting them. I kind of like the feeling. “Sorry, sir, I’m not taking care of your wife.”

I finally find my resident, and he assigns me my first patient—MQ. 70-year-old Hispanic female complaining of shortness of breath. History of asthma, strokes, and AML. AML…that’s acute…myelogenous…no,…myeloid leukemia. That’s the one with the Philadelphia thing right? Or the 15:17 translocation? My medicine rotation feels like so long ago.

MQ is accompanied by her two daughters. I’m excited to put my medical Spanish to use. “Hola, me llamo Benjamín, soy estudiante de medicina.” “Nice to meet you doctor, but we speak English.” Already an awkward start.

I gather some history. She recently finished a course of chemo for her leukemia. She’s been having fevers and leg swelling. This morning she became short of breath, and her asthma inhalers haven’t been helping.

We run some tests. EKG, troponins, and chest x-ray are within normal limits. I notice her white count is elevated and surmise a possible underlying infection. My resident points out that it actually reflects an exacerbation of her leukemia—she was in blast crisis. We take her for a CT angiogram, showing diffuse pulmonary emboli in both lungs. That’ll explain the shortness of breath. MQ’s management continues but alas my shift comes to an end.

I return to the ED the next morning eager to do some chart checking. MQ was admitted to the ICU. According to the last note in her chart, she’s being ventilated. I decide to pay her a visit before my shift.

I waddle into the ICU with my short white coat, passing by rows of mechanically ventilated patients. huu-tssssss… huu-tssssss.

I get to MQ’s room and note her two daughters. “Hey, Doctor,” one of the daughters say. I’m happy she recognizes me. I smile and ask how her mother is doing. “Why don’t you look for yourself,” she says.

I see MQ resting calmly on the hospital bed. I inch toward her and notice she doesn’t have a breathing tube. Wait—the note I read said she had one. Maybe she was weaned off? I keep looking. I don’t see any chest rise and fall. Oh god.

Within seconds, a warm wave of shock and guilt courses through my body. I’m paralyzed. I notice a visitor at the bedside sobbing, tissues in hand.

Little do I know that a new note was just entered into her chart. MQ coded and was receiving ACLS and chest compressions for three hours before she was pronounced dead just moments ago.

What do I say? Should I say anything at all? I just stand by the bed, my thoughts racing but with no clear destination.
MQ’s daughter breaks the silence. “Have none of your patients died before?” I feel embarrassed. My patients? “They have, it’s just …” I stop myself. They don’t want to hear this right now. I stand there thinking for another painful minute. I finally muster together some words. “I’m sorry for your loss.” They voice their appreciation.

I scamper away, numb, shell-shocked, trying to digest what just occurred. As I snake across the crowded ED trying to find my resident, I get stopped by a visibly frustrated young man. “Hey, Doctor! I’ve been here for 2 hours and no one has seen me yet!” “Sorry, sir, I’m just a medical student.”

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