EDITOR’S PICK

The Effect of Financial Incentives on Patient Decisions to Undergo Low-value Head Computed Tomography Scans
Rahul Iyengar, Jessica L. Winkels, Chelsea Morrow Smith et al. 1117

ORIGINAL CONTRIBUTIONS

The Introduction and Development of the H-index for Imaging Utilizers: A Novel Metric for Quantifying Utilization of Emergency Department Imaging
Terek N. Hanna, Richard Duszak Jr., Amanda Chahine et al. 1125

Risk Factors for Sedation-related Events During Acute Agitation Management in the Emergency Department
Celene Y. L. Yap, David McD. Taylor, David C. M. Kong et al. 1135

Multicenter Comparison of Nonsupine Versus Supine Positioning During Intubation in the Emergency Department: A National Emergency Airway Registry (NEAR) Study
H. Hill Stoecklein, Christopher Kelly, Amy H. Kaji et al. 1144

Study Monitoring in Emergency Care Trials: Lessons from the Resuscitation Outcomes Consortium Continuous Chest Compressions Trial
Robert H. Schmicker, Graham Nichol, Clifton W. Callaway et al. 1152

Public Deliberation as a Novel Method for an Exception From Informed Consent Community Consultation
Patricia E. Powers, Karen K. Shore, Susan Perez et al. 1158

RESEARCH LETTERS

Pain Scores Are Not Predictive of Radiographically Evident Intraabdominal Pathology in Patients With Abdominal Pain
Tony Zitek, Lauren Pellman, Jessica Uribe et al. 1169

Contents continued inside cover.
### Oriented 3D Ultrasound for Central Venous Cannulation Using an Augmented 2D Ultrasound System
Joshua S. Broder, Matthew R. Morgan, Elias J. Jaffa et al.

### HOT OFF THE PRESS
Hot Off the Press: She Works Hard for the Money—Time’s Up in Health Care
Christopher Bond, Justin Morgenstern, Corey Heitz et al.

### THE BRASS TACKS: CONCISE REVIEWS OF PUBLISHED EVIDENCE
- Tranexamic Acid for Upper Gastrointestinal Bleeding
  Raymond Beyda, Davood Johari
- Retinal Pathology in Patients With Acute-onset Flashes and Floaters
  Brit Long, Alex Koyfman, Michael Gottlieb

### SPECIAL CONTRIBUTION
Global Emergency Medicine: A Review of the Literature from 2018
Indi Trehan, Maxwell Osei-Ampofo, Kamna S. Balhara et al.

### COMMENTARY-INVITED
Skin in the Game, Black Swans, and Minor Head Injury: Exploring Asymmetries in Emergency Department Decisions
Jesse M. Pines

### CORRESPONDENCE - UNSOLICITED LETTERS TO THE EDITOR
HOUR Prediction Rule
Andrew Koons, Robert Cannon, Gillian Beauchamp et al.

### CORRESPONDENCE - RESPONSE TO LETTERS TO THE EDITOR
Pharmacokinetics and Pharmacodynamics of Naloxone
Brian M. Clemency, William Eggleston, Heather A. Lindstrom

### REFLECTIONS
Drowning
Edward K. Lew
Copyright and Copying (in any format)
Copyright © 2019 Society for Academic Emergency Medicine. All rights reserved. No part of this publication may be reproduced, stored or transmitted in any form or by any means without the prior permission in writing from the copyright holder. Authorization to copy items for internal and personal use is granted by the copyright holder for libraries and other users registered with their local Reproduction Rights Organization (RRO), e.g. Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923, USA, www.copyright.com, provided the appropriate fee is paid directly to the RRO. This consent does not extend to other kinds of copying such as copying for general distribution, for advertising or promotional purposes, for republication, for creating new collective works or for resale. Permissions for such reuse can be obtained using the RightsLink “Request Permissions” link on Wiley Online Library. Special requests should be addressed to permissions@wiley.com

Disclaimer
The Publisher, the Society for Academic Emergency Medicine (SAEM) and Editors cannot be held responsible for errors or any consequences arising from the use of information contained in this journal; the views and opinions expressed do not necessarily reflect those of the Publisher, the Society for Academic Emergency Medicine (SAEM) and Editors, neither does the publication of advertisements constitute any endorsement by the Publisher, the Society for Academic Emergency Medicine (SAEM) and Editors of the products advertised.

For submission instructions, subscription and all other information visit http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1553-2712
CME Information: The Effect of Financial Incentives on Patient Decisions to Undergo Low-Value Head CT Scans

CME Editor: Corey Heitz, MD

Authors: Rahul Iyengar, Jessica L. Winkels, Chelsea Morrow Smith, Arjun P. Meka, MD, Jonathan D. Porath, MD, and William J. Meurer, MD, MS

If you wish to receive credit for this activity, please refer to the website: www.wileyhealthlearning.com/aem

Educational Objectives
After reading the article, participants should be able to discuss the influence of financial incentives, accompanied with information regarding risk and benefit, on patient preferences for diagnostic testing.

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.

Accreditation
John Wiley and Sons, Inc. is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

John Wiley and Sons, Inc. designates this journal-based CME activity for a maximum of 1.0 AMA PRA Category 1 Credit™. Physicians should only claim credit commensurate with the extent of their participation in the activity.

For information on applicability and acceptance of continuing medical education credit for this activity, please consult your professional licensing board.

This activity is designed to be completed within 1 hour. To successfully earn credit, participants must complete the activity during the valid credit period, which is up to two years from initial publication. Additionally, up to 3 attempts and a score of 70% or better is needed to pass the post test.
The Effect of Financial Incentives on Patient Decisions to Undergo Low-value Head Computed Tomography Scans

Rahul Iyengar, Jessica L. Winkels, Chelsea Morrow Smith, Arjun P. Meka, MD, Jonathan D. Porath, MD, and William J. Meurer, MD, MS

ABSTRACT

Background: Excessive diagnostic testing and defensive medicine contribute to billions of dollars in avoidable costs in the United States annually. Our objective was to determine the influence of financial incentives, accompanied with information regarding test risk and benefit, on patient preference for diagnostic testing.

Methods: We conducted a cross-sectional survey of patients at the University of Michigan emergency department (ED). Each participant was presented with a hypothetical scenario involving an ED visit following minor traumatic brain injury. Participants were given information regarding potential benefit (detecting brain hemorrhage) and risk (developing cancer) of head computed tomography scan, as well as an incentive of $0 or $100 to forego testing. We used 0.1 and 1% for test benefit and risk, and values for risk, benefit, and financial incentive varied across participants. Our primary outcome was patient preference to undergo testing. We also collected demographic and numeracy information. We then used logistic regression to estimate odds ratios (ORs), which were adjusted for multiple potential confounders. Our sample size was designed to find at least 300 events (preference for testing) to allow for inclusion of up to 30 covariates in fully adjusted models. We had 85% to 90% power to detect a 10% absolute difference in testing rate across groups, assuming a 95% significance level.

Results: We surveyed 913 patients. Increasing test benefit from 0.1% to 1% significantly increased test acceptance (adjusted OR [AOR] = 1.6, 95% confidence interval [CI] = 1.2 to 2.1) and increasing test risk from 0.1% to 1% significantly decreased test acceptance (AOR = 0.70, 95% CI = 0.52 to 0.93). Finally, a $100 incentive to forego low-value testing significantly reduced test acceptance (AOR = 0.6; 95% CI = 0.4 to 0.8).

Conclusions: Providing financial incentives to forego testing significantly decreased patient preference for testing, even when accounting for test benefit and risk. This work is preliminary and hypothetical and requires confirmation in larger patient cohorts facing these actual decisions.

Excessive unnecessary diagnostic testing incurs tremendous costs to the health care system. With estimated total defensive medicine costs reaching $46 billion in the United States in 2008 alone, reducing the amount of unnecessary diagnostic tests is critical to mitigating rising health care costs. Head computed...
tomography (CT) scans are diagnostic tests that provide significant clinical utility when indicated, but they are often used against established clinical guidelines in situations of minor injury. Previous reports suggest that one-third of head CT scans are avoidable by applying the Canadian CT Head Rule. Furthermore, head CT scans expose patients to harmful radiation that is linked to an increased cancer risk.

An evidence-based medicine approach is useful for avoiding diagnostic testing that is unlikely to benefit patients; however, determining what constitutes a low-value test is challenging, as the value of a given test can vary across individual patients. Factors such as low health literacy, cultural power imbalances, or detachment from the medical decision-making process can all contribute to patients’ hesitancy to make their concerns about testing known. Nevertheless, it is important to engage patients to consider the benefits and risks of diagnostic testing, particularly when a test may be of low clinical value. Previous work performed by the authors of this study suggests that, when presented with a hypothetical scenario of minor traumatic brain injury (mTBI) and asked for their preferences regarding pursuing a diagnostic head CT scan, patients were most strongly deterred by increasing personal financial test cost.

This study seeks to examine the effect, if any, that a direct financial incentive to forego a low-value diagnostic head CT scan has on patients’ preferences to undergo testing in a hypothetical mTBI scenario where numerical information regarding test benefit and risk is also provided. Each participant was randomly assigned a value for benefit (0.1% or 1%), risk (0.1% or 1%), and incentive ($0 or $100) associated with a head CT scan. Participants were provided with percentages (0.1% or 1%), ratios (one in 100 or one in 1000), and visual depictions (Data Supplement S1) of risk and benefit values to improve comprehension. These values were previously used in an earlier study performed by the authors and were originally selected based on a separate preliminary study performed by the authors, as these values for risk, benefit, and cost were thought to represent the most interesting zone of variation in patients’ preferences for diagnostic testing. Additionally, values of 0.1 and 1% represent plausible benefit and risk probabilities associated with diagnostic head CT scans following situations of minor head trauma.

**METHODS**

**Overview**

This is a cross-sectional survey of a convenience sample of patients from the University of Michigan emergency department (ED) exploring the effect that varying levels of benefit, risk, and financial incentives associated with diagnostic testing have on patients’ willingness to undergo testing.

**Study Design**

We presented participants with a hypothetical clinical scenario in which they presented to the ED following mTBI. The full scenario can be found in 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.13823/full). The scenarios represented low-risk injury that would not indicate obtaining a head CT scan on the basis of the Canadian CT Head Rule. Each participant also was presented with a chest pain scenario, which will be reported in a separate scientific report. The order of receiving the chest pain or mTBI scenario was randomized, and the participants received a distinct random set of benefits, risks, and incentives for each scenario.

After consent was obtained, a script of the scenario was read aloud to all participants to limit possible issues they might have with reading, seeing, or comprehending the scenario. Participants were then asked if they would elect to receive a diagnostic head CT scan, given different levels of benefit (the chance that the head CT scan accurately detects a life-threatening brain hemorrhage), risk (the chance of developing cancer within 10 years due to ionizing radiation from the head CT scan), and incentive (a cash payment from their insurance company to forego low-value testing).

Each participant was randomly assigned a value for benefit (0.1% or 1%), risk (0.1% or 1%), and incentive ($0 or $100) associated with a head CT scan. Participants were provided with percentages (0.1% or 1%), ratios (one in 100 or one in 1000), and visual depictions (Data Supplement S1) of risk and benefit values to improve comprehension. These values were previously used in an earlier study performed by the authors and were originally selected based on a separate preliminary study performed by the authors, as these values for risk, benefit, and cost were thought to represent the most interesting zone of variation in patients’ preferences for diagnostic testing. Additionally, values of 0.1 and 1% represent plausible benefit and risk probabilities associated with diagnostic head CT scans following situations of minor head trauma.
recruited 913 total patients age 18 or older between May and July 2016. Patients who were presenting with chest pain, recent head trauma, or altered mental status were not approached. We did not approach patients with contact precautions or in resuscitation bays. Participants were not offered any compensation for participating in our study, and participation was completely voluntary.

**Human Subjects Protection**
The University of Michigan Institutional Review Board reviewed this study and determined it to be exempt survey research.

**Primary Outcomes and Variables**
The primary outcome for this study was the percentage of patients electing to receive a head CT scan given three major predictive variables: benefit, risk, and financial incentive. There were eight total subgroups of respondents, given that each of these three variables had two possible values.

We collected the following deidentified demographic and medical information to assess for potential confounders: age; sex; marital status; educational status; race; ethnicity; prior medical training or employment; self-reported overall health; income; and a past medical history of cancer, hypertension, diabetes, atrial fibrillation, myocardial infarction, or head trauma requiring a hospital visit. In addition, we administered a previously validated numeracy assessment to classify participants as having low, medium, or high numeracy.14

**Data Collection**
Qualtrics was used for survey administration and data collection, and SPSS (Version 25) was used for data analysis. We included any participant response in which the primary outcome was collected. We compared the unadjusted proportion of respondents electing to receive a head CT scan for each combination of values for benefit, risk, and financial incentive.

**Sample Size**
We followed the methodology we previously reported in 2018 in the work focusing on an additional copayment for a diagnostic test.7 Briefly, our sample size of 913 was feasible for our workforce (medical students conducting summer research) to recruit, and it conferred approximately 85% to 90% power to detect a 10% absolute change in the proportion of subjects desiring testing from a baseline test acceptance rate of 50% at a 95% level of significance.8

**Data Analysis**
We next performed a series of nested multivariable logistic regression models to obtain the odds that participants would agree to receive a head CT scan, given these variable combinations. We selected four sets of variables to adjust for in the models, and all variables were specified in advance so that they would be included regardless of their significance. Sets of variables were ordered based on what we hypothesized would be most influential, with potentially more influential variables incorporated into earlier models. The fully adjusted model was limited to at most 30 variables, using a guideline of 10 outcome events per predictor. Model 1 adjusts for the benefit, risk, and financial incentive associated with testing. Model 2 additionally adjusts for income, education level, and numeracy. Model 3 additionally adjusts for age, sex, race, ethnicity, and previous health care training/employment. Finally, Model 4 additionally adjusts for self-reported overall health and a medical history of cancer, hypertension, diabetes, atrial fibrillation, myocardial infarction, or head trauma requiring a hospital visit.

We evaluated model fit by examining the Hosmer and Lemeshow goodness-of-fit statistic with a p-value of >0.05 indicating adequate fit. In accordance with the instructions for SPSS, we fit linear regression models with indicator variables to assess for multicollinearity, with a variance inflation factor below 10 indicating a lack of meaningful multicollinearity. The deidentified data set, along with the model output (which includes all parameter estimates for the fully adjusted models, goodness of fit statistics, and multicollinearity diagnostics) is posted in the University of Michigan Institutional Data Repository (https://doi.org/10.7302/pnmm-4v40).

**RESULTS**
In total, 913 patients met inclusion criteria and completed the primary outcome portion of the survey. All of these participants’ results were included in the analysis. Demographic and medical participant characteristics are displayed in Table 1. The median participant age for this study was 45 years (interquartile range = 30–60 years), with an absolute range of 18 to 92 years. Patient preferences by group—representing the eight possible combinations of risk, benefit, and incentive—are shown in Table 2.

Patients elected to receive a head CT scan in 54.2% of scenarios (495 of 913 surveyed). In the unadjusted
analysis, decreased benefit, increased risk, and a financial incentive were all associated with a statistically significant decrease in odds of test acceptance (Table 3). Furthermore, the overall pattern of test acceptance in each of the adjusted regression models was similar to the unadjusted analysis in that decreased benefit, increased risk, and offering a $100 financial incentive deterred participants from accepting a head CT scan (Table 4). This similarity suggests that none of the variables present in model 2, 3, or 4 acted as confounders influencing the observed effect of the major predictive variables on test acceptance.

Fully adjusted models (Table 4) demonstrated that patients’ odds of accepting a head CT scan was significantly lower when offered a $100 incentive to forego testing versus when there was no incentive (adjusted OR [AOR] = 0.59, 95% confidence interval [CI] = 0.44–0.79). There was a statistically significant increase in odds of test acceptance with increasing test benefit

Table 1
Characteristics of Study Participants (N = 913)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>18–25</td>
<td>16 (146)</td>
</tr>
<tr>
<td>26–40</td>
<td>23.1 (211)</td>
</tr>
<tr>
<td>41–55</td>
<td>25.6 (234)</td>
</tr>
<tr>
<td>56–65</td>
<td>15.0 (137)</td>
</tr>
<tr>
<td>66–75</td>
<td>10.7 (98)</td>
</tr>
<tr>
<td>&gt;76</td>
<td>5.1 (47)</td>
</tr>
<tr>
<td>Unreported</td>
<td>4.4 (40)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sex</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>39.6 (362)</td>
</tr>
<tr>
<td>Female</td>
<td>56.1 (512)</td>
</tr>
<tr>
<td>Other/transgender</td>
<td>0.1 (1)</td>
</tr>
<tr>
<td>Unreported</td>
<td>4.1 (38)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marital status</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Married</td>
<td>49.8 (455)</td>
</tr>
<tr>
<td>Divorced</td>
<td>7.6 (69)</td>
</tr>
<tr>
<td>Single/never married</td>
<td>32.0 (292)</td>
</tr>
<tr>
<td>Separated</td>
<td>1.2 (11)</td>
</tr>
<tr>
<td>Widowed</td>
<td>5.0 (46)</td>
</tr>
<tr>
<td>Unreported</td>
<td>4.1 (38)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highest level of education</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Some high school</td>
<td>3.9 (36)</td>
</tr>
<tr>
<td>High school graduate</td>
<td>15.4 (141)</td>
</tr>
<tr>
<td>Some college</td>
<td>31.5 (288)</td>
</tr>
<tr>
<td>College graduate</td>
<td>26.4 (241)</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>16.1 (147)</td>
</tr>
<tr>
<td>Unreported</td>
<td>6.6 (60)</td>
</tr>
<tr>
<td>Works in health care</td>
<td>24.5 (224)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5.3 (48)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>American Indian/Alaska Native</td>
<td>0.5 (5)</td>
</tr>
<tr>
<td>African American</td>
<td>12.0 (110)</td>
</tr>
<tr>
<td>Caucasian</td>
<td>77.1 (704)</td>
</tr>
<tr>
<td>Asian</td>
<td>2.1 (19)</td>
</tr>
<tr>
<td>Native Hawaiian/Pacific Islander</td>
<td>0.2 (2)</td>
</tr>
<tr>
<td>Other</td>
<td>2.0 (18)</td>
</tr>
<tr>
<td>Prefer not to disclose/unreported</td>
<td>6.0 (55)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>History of cancer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>History of diabetes</td>
<td>13.2 (120)</td>
</tr>
<tr>
<td>History of hypertension</td>
<td>15.1 (137)</td>
</tr>
<tr>
<td>History of atrial fibrillation</td>
<td>7.7 (70)</td>
</tr>
<tr>
<td>History of heart attack</td>
<td>5.0 (45)</td>
</tr>
<tr>
<td>History of head injury requiring ED visit</td>
<td>20.5 (184)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-reported overall health</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>10.6 (97)</td>
</tr>
<tr>
<td>Very good</td>
<td>26.2 (239)</td>
</tr>
<tr>
<td>Good</td>
<td>28.3 (258)</td>
</tr>
<tr>
<td>Fair</td>
<td>18.4 (168)</td>
</tr>
<tr>
<td>Poor</td>
<td>9.1 (83)</td>
</tr>
<tr>
<td>Unreported</td>
<td>7.5 (68)</td>
</tr>
</tbody>
</table>

(Continued)

Table 2
Patient Preferences by Subgroup

<table>
<thead>
<tr>
<th>Benefit</th>
<th>0.1%</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentive = $0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1%</td>
<td>Accept test: 59.7% (71 of 119)</td>
<td>Accept test: 48.5% (50 of 103)</td>
</tr>
<tr>
<td>1%</td>
<td>Accept test: 70% (84 of 120)</td>
<td>Accept test: 60.3% (70 of 116)</td>
</tr>
</tbody>
</table>

| Incentive = $100 | |  |
| 0.1% | Accept test: 46.2% (54 of 117) | Accept test: 43.6% (51 of 117) |
| 1% | Accept test: 61.4% (62 of 101) | Accept test: 44.2% (53 of 120) |

Data are reported as percent (n).
DISCUSSION

Our study examined the effect of test benefit, test risk, and financial incentives on patient preferences regarding pursuing low-value diagnostic testing with head CT scan in the ED. In this cross-sectional convenience sample, we found that decreased benefit, increased risk, and offering a financial incentive all significantly deterred participants from accepting low-value diagnostic testing. These findings are applicable to both healthcare providers and payers. For example, these results indicate that discussing benefits and risks of low-value diagnostic testing via head CT scan with patients, even when absolute benefit or risk is very low, may impact patients’ decision-making. Furthermore, implementation of a cash incentive to forego unnecessary diagnostic testing may prove to be a successful method to decrease health care costs for ED patients. Future studies involving other diagnostic tests may shed light on the generalizability of this effect across a variety of clinical situations.

This research was a follow-up to a similar published study in which we evaluated the influence of benefit, risk, and out-of-pocket cost on patient preference for low-value diagnostic testing in the context of mTBI. Both of these studies have shown a trend of decreased test acceptance with decreased test benefit and increased test risk. Furthermore, both approaches to financial intervention—increasing cost to patients versus offering an incentive—were effective in decreasing test acceptance. In this study, there was a 9.3% drop in test acceptance (58.9% to 49.6%) with decreased test benefit, a 10.2% drop (59.3% to 49.1%) with increased risk, and a 11.7% drop (60.0% to 48.3%) with a financial incentive. In the 2018 work, a subset of parents with children received a modified scenario where they were asked to decide on testing for a child with mTBI. From this study, in the cohort of adults deciding on testing for themselves, there was a 6.2% drop (67.0% to 60.8%) in head CT scan acceptance with decreased benefit, a 3.0% drop (65.5% to 62.5%) with increased risk, and a 17.4% drop (72.9% to 55.5%) with increased cost to the patient. However, in contrast with our current study, the effects of variable test risk and benefit failed to reach statistical significance in the prior study, which may be attributable to variation between the data sets and about a 12% smaller sample size in the prior work. Examination of the findings of both studies in parallel suggests that financial measures may serve as a more effective deterrent against patient preference for diagnostic testing than discussing risks and benefits of testing, although further investigation is required to better characterize these effects.

### Table 3

Unadjusted Patient Preferences* ($N = 913$)

<table>
<thead>
<tr>
<th>Benefit</th>
<th>0.1% (ref)</th>
<th>49.6 (226)</th>
<th>1%</th>
<th>58.9 (269)</th>
<th>OR (95% CI)</th>
<th>1.471 (1.128–1.917)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>0.1% (ref)</td>
<td>59.3 (271)</td>
<td>1%</td>
<td>49.1 (224)</td>
<td>OR (95% CI)</td>
<td>0.661 (0.507–0.861)</td>
</tr>
<tr>
<td>Incentive</td>
<td>$0 (ref)</td>
<td>60.0 (275)</td>
<td>$100</td>
<td>48.3 (220)</td>
<td>OR (95% CI)</td>
<td>0.636 (0.488–0.828)</td>
</tr>
</tbody>
</table>

All ORs are unadjusted. Data are reported as percent (n) accepting test.

### Table 4

Nested Logistic Regression Model*

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>1.47 (1.13–1.91)</td>
<td>1.46 (1.10–1.94)</td>
<td>1.48 (1.11–1.98)</td>
<td>1.58 (1.18–2.13)</td>
</tr>
<tr>
<td>Risk</td>
<td>0.66 (0.51–0.86)</td>
<td>0.71 (0.53–0.94)</td>
<td>0.70 (0.53–0.93)</td>
<td>0.70 (0.52–0.93)</td>
</tr>
<tr>
<td>Incentive</td>
<td>0.64 (0.49–0.82)</td>
<td>0.61 (0.46–0.82)</td>
<td>0.61 (0.46–0.81)</td>
<td>0.59 (0.44–0.79)</td>
</tr>
</tbody>
</table>

Data are reported as AOR (95% CI). Model 1 adjusts for benefit, risk, and incentive associated with testing. Model 2 additionally adjusts for income, education level, and numeracy. Model 3 additionally adjusts for age, sex, race, ethnicity, and previous health care training or employment. Model 4 additionally adjusts for self-reported overall health and a medical history of cancer, hypertension, diabetes, atrial fibrillation, myocardial infarction, and head trauma requiring hospital visit. Hosmer and Lemeshow goodness-of-fit p-value ranged from 0.8 to 0.2, indicating that model fit was adequate. Variance inflation factors for each included variable ranged from 1 to 1.4 (with values less than 10 indicating a lack of meaningful multicollinearity). AOR = adjusted odds ratio.
LIMITATIONS

Our study has several limitations that should be taken into consideration while interpreting our results. Importantly, although participants were patients in the ED, the survey consisted of hypothetical scenarios—patients presenting with an acute medical problem may make decisions differently. Also, the true benefit and risk of a diagnostic test varies substantially across patients based on their individual traits and clinical presentations, and it would be unlikely that patients could be provided with an exact numeric representation of their individual test risk and benefit. Participants in our study may also have incorporated their own perception of risk for brain hemorrhage in the context of mTBI, although our study instructions clearly indicated that participants should disregard their known medical comorbidities and that the numeric benefit and risk provided in the scenario accounted for their specific risk factors. For example, patients on anticoagulation therapy may have been told in the past that they should always receive a diagnostic head CT scan, even in the event of minor trauma, whereas in our study such patients could be assigned a 0.1% expected chance of a serious intracranial injury. Furthermore, in our study we contrasted the benefit of detecting an immediate medical condition (brain hemorrhage) against the risk of acquiring another medical condition (cancer) several years in the future. The difference in time of onset for benefit and risk may have affected participants’ preferences. In addition, the true risks of CT scans are likely lower than the 0.1 and 1% assigned in these scenarios; however, had we used much smaller risks, we would not have had symmetry with the values for potential benefit. Another potential limitation of our study is that 25% of participants reported working in a healthcare environment. While this encompassed many professions (full list in Data Supplement S1) and was not unexpected for our usual ED population, it is possible that increased medical knowledge or experience could have influenced survey responses for some of these participants. Finally, the role of a financial incentive as a deterrent against diagnostic testing described in this study is restricted to the survey scenario—a low-risk, low-value test. Patients may respond differently to a financial incentive applied to another diagnostic test. Factors such as familiarity with the diagnostic test, perception of the importance of potential medical conditions that could be detected, and understanding the implications of future risk may all influence patient preference.

CONCLUSIONS

This cross-sectional survey of patients in the ED suggests that a direct financial incentive is an effective deterrent against patient preference for low-value diagnostic testing in the context of minor traumatic brain injury. While we also found that decreased potential benefit and increased risk associated with testing reduced patient preference for head CT scan, consideration of our results in conjunction with findings in a previous published work by the authors suggests that financial factors may be more influential to patients than estimates of test benefit and risk in scenarios where testing is considered to be of low value. Further study of the impact of financial incentives on patient decision making across other clinical scenarios and in nonhypothetical patient situations is needed to better describe this relationship.

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.13823/full

Data Supplement S1. Supplemental material.
The Introduction and Development of the H-index for Imaging Utilizers: A Novel Metric for Quantifying Utilization of Emergency Department Imaging

Tarek N. Hanna, MD,1 Richard Duszak Jr, MD,1 Amanda Chahine, MPH,1 Matthew E. Zygmont, MD,1 Keith D. Herr, MD,1 and Michal Horný, PhD, MSc1,2

ABSTRACT

Objective: The objective was to develop a novel metric for quantifying patient-level utilization of emergency department (ED) imaging.

Methods: Using 2009 to 2015 Truven Health MarketScan commercial claims and encounters database, all ED visits and associated imaging services were identified. To measure imaging resource intensity, total imaging relative value units (RVUs) were calculated for each patient per ED visit. An individual’s annual imaging h-index is defined as the largest number, h, such that h ED visits by that individual in a given year is associated with total medical imaging RVUs of a value of at least h.

Results: Over 7 years, in a sample of 86,506,362 privately insured individuals (232,919,808 person-years) in all 50 states and the District of Columbia, 38,973,716 ED visits were identified. A total of 9.5% of person-years had one ED visit and 2.7% had two or more (the remainder had none). From 2009 to 2015, the percentage of ED patients undergoing imaging increased from 25.1% to 34.6%. Individuals with two or more ED visits each associated with two or more imaging RVUs (ED imaging h-index ≥ 2) comprised 0.2% of the sample and 1.4% of ED visitors; however, they accounted for 4.0% of ED visits and the use of 18.6% of imaging resources. From 2009 to 2015, imaging resource allocation for such patients increased from 16.5% to 21.0%.

Conclusions: The ED imaging h-index allows identification of patients who undergo significant ED imaging, based on a single-digit patient-specific metric that incorporates both annual ED visit number and medical imaging resource intensity per visit. While ED patients with an ED imaging h-index ≥ 2 represented a minuscule fraction of privately insured individuals, they were associated with one-fifth of all ED imaging resources.

From the 1Department of Radiology and Imaging Sciences and the 2Department of Health Policy and Management, Rollins School of Public Health, Emory University, Atlanta, GA.

Received February 11, 2019; revision received April 5, 2019; accepted April 10, 2019.

Preliminary data originating from this study was presented at the Annual Meeting of the American Society of Emergency Radiology in McLean, VA, 2018. This presentation received the Magna Cum Laude Award (2nd Place Scientific Presentation) for the conference.

The authors believe that there are no conflicts of interest relevant to this work; however, in the interest of full disclosure have included research support below per the journal guidelines: RH received research support from Harvey L. Neiman Health Policy Institute (Reston, VA) to Emory University to conduct research conceived and written by Dr. Richard Duszak Jr.; MH received research support from Harvey L. Neiman Health Policy Institute (Reston, VA) to Emory University to conduct research conceived and written by Dr. Michal Horný; TH received research support from the American Society of Emergency Radiology to Emory University to conduct research conceived and written by Dr. Tarek Hanna (funding was not targeted to this project and expired December 31, 2018); and KH received research support from the American Society of Emergency Radiology to Emory University to conduct research conceived and written by Dr. Keith Herr (funding was not targeted to this project and expired December 31, 2018). AC and MZ have disclosed no conflicts of interest.

Author Contributions: TNH, MH, and RD conceived of and designed the study; MH managed the database, cleaned the data, and conducted the analysis; TNH, MH, AC, MEZ, and KDH drafted the manuscript; all authors contributed to editing and revising the manuscript; and TNH and MH take responsibility for the paper as a whole.

Supervising Editor: Alice M. Mitchell, MD, MS.

Address for correspondence and reprints: Tarek N. Hanna, MD; e-mail: tarek.hanna@emory.edu.


© 2019 by the Society for Academic Emergency Medicine
doi: 10.1111/acem.13765
A pproximately 5% of emergency department (ED) patients in the United States account for one-quarter of all annual ED visits. Others have observed that this small group also accounts for disproportionate overall per-visit ED resource utilization. If such patients, on average, seek frequent ED care as an alternative to routine nonemergent physician follow-up, these actions could result in poorly coordinated care with adverse effects on outcomes. Most authors define frequent ED users as those accruing four or more annual ED visits and specifically recognize a subgroup of clinical “superusers,” who each accumulate more than 10 ED visits per year. With ED resources in high demand due to overall growing patient volumes, a better understanding of resource consumption by frequent ED users is timely, particularly in the current environment of health care–related cost awareness. The use of national insurance claims data sets allows researchers to better understand what factors inherent in this population are associated with their relatively frequent use of ED resources, particularly if less costly, but nonetheless appropriate, alternatives are available. Medical imaging is a frequently deployed and costly resource in the U.S. health care system. Its use in the ED has increased dramatically over the past two decades, far outpacing increases in patient volumes. Between 1994 and 2015, ED imaging utilization rates increased overall by 660%, with some modalities experiencing increases as large as 17,000%. Of note, imaging utilization growth in the ED has eclipsed temporal increases in patient volumes, indicating an increased intensity of imaging per-visit (higher number of individual examinations and/or higher relative value units [RVUs] per examination). Prior work has suggested that various patient demographic characteristics, such as insurance status, may predict increased intensity of ED imaging. Overall, however, the characteristics and distribution of disproportionate ED imaging utilizers is not well described, and the methods employed are variable.

Frequent users of ED imaging are at increased risk for repeated exposure to ionizing radiation (with its attendant health implications, such as increased risk of carcinogenesis) and increase overall health care costs and incum bent financial toxicity. Studies investigating the growth of ED imaging indicate the need for detailed characterization of patients who undergo substantial ED imaging, which necessitates first defining and then identifying this patient cohort in a consistent and reproducible manner. Prior studies of ED imaging employ various utilization metrics such as total number of annual ED imaging examinations or average per-visit ED imaging; yet, such metrics do not differentiate between patients with a single visit with a large volume of imaging or multiple ED visits with smaller amounts of imaging and ignore differences in imaging resource intensity (e.g., radiograph vs. magnetic resonance imaging).

The purpose of this study was to develop a novel metric that can assist in quantifying ED patients who disproportionately utilize imaging using national claims data of individuals who receive insurance from their employer, the largest insured segment of the U.S. population.

METHODS

Study Participants
Data originated from the Truven Health MarketScan commercial claims and encounters database, a large set of health care claims collected from private, employer-sponsored health plans across the United States, for years 2009 to 2015. Analysis of these data was determined by our institutional review board to be exempt from its oversight.

Study Design and Analysis
For each year within the study period, the sample was limited to individuals continuously enrolled from January 1 to December 31. Study subjects’ visits to the ED were identified using professional claims submitted for ED encounters with Current Procedural Terminology (CPT) evaluation and management codes 99281–99285. Critical care CPT codes 99291 and 99292 were not included, as these codes are more commonly used in the intensive care unit, and the appearance of these codes in isolation in the MarketScan database did not reliably reflect an ED visit. For each ED visit, the following variables were recorded: major diagnosis, ED clinical encounter complexity level 1 to 5 (based on the last digit in CPT code range 99281–99285), whether the visit was trauma-related (using the Barell Injury Diagnosis Matrix), and whether it resulted in an admission.

Imaging services associated with each ED visit were identified as claims that satisfied three conditions. First, they contained a CPT code listed in the Neiman Imaging Types of Service (NITOS) classification system, version 1.01. Second, the service category indicated that the procedure was performed in the ED.
Third, the claim was billed on the same day as the index ED visit. Additionally, for patients with no other ED visit on the day before or the day after each index visit, we considered imaging services performed in the ED and billed on those days to be also associated with the index ED visit. Such discrepancies in dates can appear, for example, if an ED visit spans midnight. For patients with ED visits on consecutive days, imaging services were mapped to the nearest ED visit; for example, if a patient had ED visits logged on Tuesday and Wednesday, ED imaging on Monday mapped to the Tuesday visit, and ED imaging on Thursday mapped to the Wednesday visit. The NITOS classification system was used to indicate the modality and body region of each imaging procedure.

Because changes to several imaging CPT codes were made during the study period, we made relevant adjustments to avoid double-counting imaging procedures. Computed tomography (CT) of the abdomen and pelvis, for example, was billed using two separate CPT codes through 2011, after which new single codes were introduced to report the bundled procedure.

**Measurements**

To quantify the utilization of ED imaging services, we employed two main measures. First, we used simple counts of procedures and calculated various statistics, such as the number of annual ED imaging procedures per person, the number of imaging procedures per ED visit, and the number of annual ED visits that involved imaging. Second, because there is considerable variation in the amount of resources required for imaging of different body parts and by different modalities, we approximated the resource intensity of each imaging procedure using its total RVUs designated for facility payments without geographic adjustment. The RVU is a resource-based relative value scale measure used by Medicare and many private payers to determine code-level provider reimbursement. For all CPT codes of imaging procedures, we identified the most recent assigned total RVUs in the Centers for Medicare & Medicaid Services Physician Fee Schedules between 2009 and 2015 (the most recent RVU for each CPT code was used to ensure consistency of resource intensity measurement across years).

We then devised a novel individual-specific resource intensity metric to calculate the main outcome measure of our analysis: the annual ED imaging h-index. First proposed in 2005 by Jorge Hirsch, the Hirsch index, or h-index, is widely used to measure the publication productivity and citation impact of researchers. In that context, an author’s h-index is defined as the largest number, h, such that h publications by that author have at least h citations. We adapted the h-index to classify individuals based on both the number of annual ED visits by that individual and the resource intensity of imaging utilization associated with each visit. In this context, an individual’s annual imaging h-index is defined as the largest number, h, such that h ED visits by that individual in a given year is associated with a total number of RVUs of at least h (Figure 1). In other words, an ED Imaging h-index of 0 indicates that an individual had either no ED visit per year or none of their ED visits involved one or more imaging RVU. An ED imaging h-index of 1 indicated one or more annual ED visits, one of which had at least one RVU of ED imaging. Since RVUs can be fractional numbers, we rounded down cumulative RVUs per visit to the nearest whole number to arrive at h RVUs. For example, an individual receiving ED care on two separate occasions in one year and undergoing CT of the abdomen and pelvis with

![Figure 1. Graphical illustration of the imaging h-index for a hypothetical patient with five annual ED visits (x-axis): one visit involved 7.39 RVUs of imaging (y-axis), one visit involved 4.00 RVUs of imaging, one visit involved 0.72 RVUs of imaging, and two visits involved no imaging. Although the patient had a total of five annual ED visits, three of which involved imaging, the h-index = 2 as only two visits involved two or more imaging RVUs. The use of RVUs instead of number of imaging examinations allows this index to capture resource utilization in technical imaging acquisition and interpretation.](image-url)
intravenous contrast (1.82 RVUs) at each visit would be assigned an imaging h-index of 1 for that year. The justification for using this person-level metric is based on the position that a patient with only one ED visit in any given year involving a substantial amount of imaging resources (imaging h-index of 1) does not present as much a burden on ED imaging resources as a patient with multiple ED visits in that year, each involving imaging of two or more RVUs (imaging h-index > 1).

Finally, to characterize distinct groups of utilizers of ED imaging services, patient age, sex, imaging modality type, and imaged body region were stratified by annual ED imaging h-index. Analysis of variance was used for comparison of age across groups, while chi-square tests were used for comparison of the distribution of categorical variables. The analysis was conducted using SAS software, version 9.4.

RESULTS

Characteristics of Subjects and ED Visits
Our study sample consisted of 86,506,362 distinct individuals from all 50 states and the District of Columbia. Over the 7-year study period, it comprised 232,919,808 person-years. Most person-years (87.8%) had no ED visits within a year. A total of 9.5% had one visit, and the remaining 2.7% had two or more annual ED visits (Table 1). Of the total of 38,973,716 ED visits, 94.9% were classified as medium-to-high complexity, 23.6% were trauma-related, 25.0% involved imaging, and 6.0% resulted in a hospital admission (Table 2).

ED Imaging Among Subjects
The most commonly used modality was radiography/fluoroscopy (performed in 17.2% of ED visits), followed by CT (performed in 8.6% of ED visits). The most commonly imaged body regions were the chest (9.4% of visits), abdomen/pelvis (7.1% of visits), and extremities (6.7% of visits). Figure 2 shows the relative amount of ED imaging resources used by ED visitors by year. In 2009, 25.1% of ED visitors received imaging as part of their ED care. That proportion grew steadily to 34.6% in 2015.

Table 3 demonstrates the disproportionate use of ED imaging by groups of individuals stratified by the annual ED imaging h-index. The h-index for the vast majority of the sample (99.8%) was equal to 0 or 1. That group also comprised 98.6% of ED visitors and accounted for 96.0% of ED visits and 81.5% of ED imaging resources. In contrast, individuals with an annual ED imaging h-index ≥ 2 comprised only 0.17% of the sample and 1.4% of ED visitors and accounted for 4.0% of ED visits, 12.9% of ED imaging procedures, and 18.6% of ED imaging resources.

On average, individuals with an annual ED imaging h-index ≥ 2 were older and more likely to be female compared to ED patients who consumed fewer imaging resources (h-index of 0 or 1) or individuals who had no ED visits per year (h-index of 0; Table 4). Compared to ED visitors with an h-index of 0 or 1, visits by individuals with an annual ED imaging h-index ≥ 2 were more likely to be classified as high-complexity clinical encounters (86.0% vs. 61.3%; p < 0.001), less likely to be trauma-related (10.5% vs. 24.1%; p < 0.001), more likely to result in an admission (13.8% vs. 5.7%; p < 0.001), and less likely to occur on a weekend (27.3% vs. 31.1%; p < 0.001).

Table 1
Demographics and Overall ED utilization

<table>
<thead>
<tr>
<th>Variable</th>
<th>N or Mean</th>
<th>% or SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distinct individuals</td>
<td>86,506,362</td>
<td>—</td>
</tr>
<tr>
<td>Person-years</td>
<td>232,919,808</td>
<td>—</td>
</tr>
<tr>
<td>Age (years)</td>
<td>34.0</td>
<td>18.4</td>
</tr>
<tr>
<td>Females</td>
<td>120,290,075</td>
<td>51.6%</td>
</tr>
<tr>
<td>Health plan type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preferred provider organization</td>
<td>142,919,907</td>
<td>61.4%</td>
</tr>
<tr>
<td>Health maintenance organization</td>
<td>28,109,039</td>
<td>12.1%</td>
</tr>
<tr>
<td>Consumer-driven/high-deductible health plan</td>
<td>22,351,576</td>
<td>9.6%</td>
</tr>
<tr>
<td>Point of service</td>
<td>16,255,094</td>
<td>7.0%</td>
</tr>
<tr>
<td>Exclusive provider organization</td>
<td>4,382,920</td>
<td>1.9%</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>3,632,306</td>
<td>1.6%</td>
</tr>
<tr>
<td>Unknown</td>
<td>15,268,966</td>
<td>6.6%</td>
</tr>
<tr>
<td>Resides in a metropolitan statistical area (~urban)</td>
<td>190,221,563</td>
<td>81.7%</td>
</tr>
<tr>
<td>Annual ED visits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>204,585,415</td>
<td>87.8%</td>
</tr>
<tr>
<td>1</td>
<td>22,069,428</td>
<td>9.5%</td>
</tr>
<tr>
<td>2</td>
<td>4,214,032</td>
<td>1.8%</td>
</tr>
<tr>
<td>3</td>
<td>1,173,400</td>
<td>0.5%</td>
</tr>
<tr>
<td>4+</td>
<td>877,533</td>
<td>0.4%</td>
</tr>
<tr>
<td>Annual ED imaging studies (of those with 1+ annual ED visits)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>20,166,822</td>
<td>71.2%</td>
</tr>
<tr>
<td>1</td>
<td>5,009,493</td>
<td>17.7%</td>
</tr>
<tr>
<td>2</td>
<td>1,878,537</td>
<td>6.6%</td>
</tr>
<tr>
<td>3</td>
<td>650,348</td>
<td>2.3%</td>
</tr>
<tr>
<td>4</td>
<td>298,527</td>
<td>1.1%</td>
</tr>
<tr>
<td>5–10</td>
<td>303,996</td>
<td>1.1%</td>
</tr>
<tr>
<td>11+</td>
<td>26,670</td>
<td>0.1%</td>
</tr>
</tbody>
</table>
Not surprisingly, individuals with an annual ED imaging h-index ≥ 2 consumed a greater proportion of imaging based on both modality and body region. These individuals underwent imaging by most modalities at a rate exceeding 500% when compared to other ED visitors, except for radiography/fluoroscopy, for which the rate was only 1.9 times higher.

Individuals with an annual ED imaging h-index ≥ 2 accounted for 16.5% of total imaging resources in 2009, and that percentage incrementally increased to 21.0% in 2015. The most pronounced differences by body part were found in abdomen/pelvis (6.1 times higher rate) and brain (5.2 times higher rate). Overall, this class of individuals accounted for on average 16.2 imaging RVUs per year in 2009 and 17.4 imaging RVUs in 2015, representing a 7.8% increase. The five most common diagnoses recorded as the major diagnosis for ED visits among individuals with an annual ED imaging h-index ≥ 2: abdominal pain (ICD-9 code 789.0x, 14.3% of visits), headache/migraine (784.0, 4.5%; 346.90, 1.9%), chest pain (786.5x, 5.3%), calculus of kidney (592.0, 1.5%), and syncope and collapse (780.2, 1.5%). Of note, individuals with an annual ED imaging h-index ≥ 2 typically did not maintain this status from year to year. Of individuals with an annual ED imaging h-index ≥ 2 in a given year, T, only an average of 11.7% persisted as such in year $T + 1$. The specific imaging persistence rate for this group was fairly constant across years (10.5% in 2009/2010, 10.4% in 2010/2011, 12.0% in 2011/2012, 11.6% in 2012/2013, 13.0% in 2013/2014, and 12.7% in 2014/2015). This finding suggests that a large proportion of these individuals present to the ED with episodic, high-complexity illnesses that either resolve within the period of a year or result in death.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Characteristics of ED Visits and ED imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>N or Mean</td>
</tr>
<tr>
<td>Total number of ED visits</td>
<td>38,973,716</td>
</tr>
<tr>
<td>ED clinical encounter complexity level</td>
<td></td>
</tr>
<tr>
<td>1 (low complexity)</td>
<td>233,117</td>
</tr>
<tr>
<td>2</td>
<td>1,765,598</td>
</tr>
<tr>
<td>3</td>
<td>12,704,147</td>
</tr>
<tr>
<td>4</td>
<td>12,951,690</td>
</tr>
<tr>
<td>5 (high complexity)</td>
<td>11,319,164</td>
</tr>
<tr>
<td>Trauma/injury</td>
<td>9,183,301</td>
</tr>
<tr>
<td>Resulted in an admission</td>
<td>2,339,674</td>
</tr>
<tr>
<td>Payment per visit</td>
<td>$1,407</td>
</tr>
<tr>
<td>Imaging studies per ED visit</td>
<td>0.36</td>
</tr>
<tr>
<td>0</td>
<td>29,238,611</td>
</tr>
<tr>
<td>1</td>
<td>6,867,774</td>
</tr>
<tr>
<td>2</td>
<td>2,023,347</td>
</tr>
<tr>
<td>3</td>
<td>499,770</td>
</tr>
<tr>
<td>4+</td>
<td>344,214</td>
</tr>
<tr>
<td>Imaging total RVUs per ED visit</td>
<td>0.91</td>
</tr>
<tr>
<td>0</td>
<td>29,240,569</td>
</tr>
<tr>
<td>0.01–0.99</td>
<td>4,159,766</td>
</tr>
<tr>
<td>1.00–1.99</td>
<td>1,073,119</td>
</tr>
<tr>
<td>2.00–2.99</td>
<td>360,308</td>
</tr>
<tr>
<td>3.00–3.99</td>
<td>1,133,654</td>
</tr>
<tr>
<td>4.00+</td>
<td>3,006,300</td>
</tr>
<tr>
<td>Involved imaging by modality</td>
<td></td>
</tr>
<tr>
<td>Radiography/fluoroscopy</td>
<td>6,687,733</td>
</tr>
<tr>
<td>CT</td>
<td>3,354,586</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>1,071,666</td>
</tr>
<tr>
<td>Magnetic resonance imaging</td>
<td>121,603</td>
</tr>
<tr>
<td>Nuclear medicine</td>
<td>47,380</td>
</tr>
<tr>
<td>Involved imaging of body region</td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td>3,671,968</td>
</tr>
<tr>
<td>Abdomen/pelvis</td>
<td>2,766,625</td>
</tr>
<tr>
<td>Extremity</td>
<td>2,594,800</td>
</tr>
<tr>
<td>Brain</td>
<td>1,358,381</td>
</tr>
<tr>
<td>Spine</td>
<td>701,132</td>
</tr>
<tr>
<td>Head/neck</td>
<td>373,140</td>
</tr>
<tr>
<td>Cardiac</td>
<td>66,905</td>
</tr>
<tr>
<td>Breast</td>
<td>2,760</td>
</tr>
<tr>
<td>None</td>
<td>49,590</td>
</tr>
</tbody>
</table>

Figure 2. Between 2009 and 2015, 100% of annual ED imaging resources were used by 25.1% to 34.6% of ED visitors as indicated by the vertical dashed lines in the plot above. Each year is represented by a line in the above plot, with a general movement to increased imaging use in progressive years.
DISCUSSION

Using targeted variables from an insurance claims database including 86 million individuals in the United States, we found that a miniscule fraction of patients with an annual h-index $\geq 2$ consumed nearly one-fifth of all ED imaging resources. Moreover, the fraction of ED imaging resources consumed by this group increased annually during the 7-year study period. These patients underwent advanced imaging at a rate 500% higher than other ED patients. Based on their ED imaging use compared to the total population of employer-provided privately insured individuals, we believe that this unique subgroup of ED patients deserves further attention from health policy researchers investigating trends in ED imaging volumes, overcrowding, and overall resource expenditures.

The introduction and development of the ED imaging h-index allows for a unique stratification of patient-level imaging use within the ED that accounts for both the number of ED visits and the resource intensity in imaging examinations per visit. Resource intensity in medical imaging, as measured by total per-visit RVU, is directly related to the billing amount—both in terms of patient and insurance expense and in resulting hospital revenue. Further investigation of high utilizers of ED imaging can be facilitated by adopting a standard h-index threshold for this group of ED patients (e.g., $\geq 2$). Prior studies have shown that certain interventions targeting frequent ED users tend to reduce their rates of ED use. Electronic medical record red-flagging has been used to identify heavy ED imaging users. 

Case management as an interventional method has been supported in the literature as the most favorable and effective strategy to significantly reducing use of ED services. Other interventional approaches described in the literature have included individualized care plans, diversion strategies for redirecting patients to more appropriate services areas, and information sharing. Some investigations have explored the impact of case management on health care costs and diagnostic testing in the ED; overall, there was a significant reduction in these rates. Nonetheless, it is unclear whether any traditional patient-centered interventions would translate to effectiveness in reducing the h-index of the cohort of patients who both frequently visit the ED and for whom high-intensity imaging is obtained, as emergency providers are responsible for the imaging-order cascade. In other words, once such a patient arrives at the ED to establish an encounter (one component of the h-index), whether and what imaging that patient receives is then typically at the discretion of an ED provider (the second component of the h-index). Moreover, on the basis of the data available for this analysis, we can draw no conclusions regarding the extent to which high h-index patients can be converted to a lower h-index through any set of interventions since we did not assess the appropriateness or effectiveness of the ED visit in general or the imaging received during that visit in this population.

Computed tomography, magnetic resonance imaging, nuclear medicine, and ultrasound all showed on average a sixfold increased rate of utilization in patients with an ED imaging h-index $\geq 2$. The disproportionately increased use of advanced imaging modalities in this patient group is presumed to reflect a higher severity of disease. ED providers may order advanced imaging in patients with more severe disease for a number of reasons, including one of appropriate medical necessity, but also including reasons unrelated to disease severity, such as suboptimal staffing resources, attempts to increase throughput in the ED, and perceived risk of delayed diagnosis expected with less costly interventions, such as observation. Systematic evaluation of advanced imaging in this population may assist in identifying

<table>
<thead>
<tr>
<th>Annual ED Imaging h-index</th>
<th>No. of Person-years</th>
<th>% of Sample</th>
<th>% of ED Patients</th>
<th>% of ED Visits</th>
<th>% of ED Imaging Procedures</th>
<th>% of ED Imaging Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>228,052,946</td>
<td>97.9%</td>
<td>82.8%</td>
<td>79.2%</td>
<td>26.2%</td>
<td>7.8%</td>
</tr>
<tr>
<td>1</td>
<td>4,473,750</td>
<td>1.9%</td>
<td>15.8%</td>
<td>16.8%</td>
<td>60.9%</td>
<td>73.7%</td>
</tr>
<tr>
<td>2*</td>
<td>324,561</td>
<td>0.14%</td>
<td>1.15%</td>
<td>2.70%</td>
<td>9.10%</td>
<td>13.09%</td>
</tr>
<tr>
<td>3*</td>
<td>55,851</td>
<td>0.02%</td>
<td>0.20%</td>
<td>0.87%</td>
<td>2.63%</td>
<td>3.75%</td>
</tr>
<tr>
<td>4*+</td>
<td>12,700</td>
<td>0.01%</td>
<td>0.04%</td>
<td>0.42%</td>
<td>1.16%</td>
<td>1.71%</td>
</tr>
</tbody>
</table>

The annual ED imaging h-index is a resource measure where h is the largest number such that h annual ED visits have at least h total relative value units of imaging examinations.

*ED superusers are defined as h-index $\geq 2$. 

<table>
<thead>
<tr>
<th>Table 3</th>
<th>The Use of ED Imaging Resources by Annual ED Imaging h-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual ED Imaging h-index</td>
<td>No. of Person-years</td>
</tr>
<tr>
<td>0</td>
<td>228,052,946</td>
</tr>
<tr>
<td>1</td>
<td>4,473,750</td>
</tr>
<tr>
<td>2*</td>
<td>324,561</td>
</tr>
<tr>
<td>3*</td>
<td>55,851</td>
</tr>
<tr>
<td>4*+</td>
<td>12,700</td>
</tr>
</tbody>
</table>
potentially inappropriate imaging in this special cohort, potentially resulting in substantial resource savings to the U.S. health care system overall. Additionally, advanced imaging resource congestion can increase ED lengths of stay and decrease patient throughput; accordingly, mitigating the advanced imaging resources consumed by these individuals, if appropriate and feasible, could have a substantial effect on improving overall ED operations.

Recent work on the utilization of the ED and its resources has focused on Medicare beneficiaries.\textsuperscript{47} Our study population, in contrast, included only employer-

| Table 4 Comparison of Disproportionate Utilizers of ED Imaging to the Rest of the Population |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| **Person-level measures**                        | **Disproportionate Utilizers of ED Imaging (Annual ED Imaging h-index = 2+)**                     | **Individuals With ED Encounter(s) Who Are Not Disproportionate Utilizers of ED Imaging (Annual ED Imaging h-index = 0 or 1)** |
| Age (years)                                       | 39.37 (39.32–39.43)                                                                             | 33.08 (33.071–33.085)                                                                             |
| Females                                          | 67.9%                                                                                            | 54.2%                                                                                            |
| Resides in metropolitan statistical area        | 82.4%                                                                                            | 78.8%                                                                                            |
| **ED-visit-level measures**                      |                                                                                                 |                                                                                                 |
| **ED clinical encounter complexity level**       |                                                                                                 |                                                                                                 |
| 1 (low complexity)                               | 0.2%                                                                                             | 0.6%                                                                                             |
| 2                                                | 1.3%                                                                                             | 4.7%                                                                                             |
| 3                                                | 12.5%                                                                                           | 33.4%                                                                                           |
| 4                                                | 36.1%                                                                                           | 33.1%                                                                                           |
| 5 (high complexity)                              | 49.9%                                                                                           | 28.2%                                                                                           |
| **Trauma/injury**                                | 10.5%                                                                                           | 24.1%                                                                                           |
| **Resulted in an admission**                     | 13.8%                                                                                           | 5.7%                                                                                             |
| **Weekday**                                      |                                                                                                 |                                                   |
| Monday                                           | 15.6%                                                                                           | 14.9%                                                                                           |
| Tuesday                                          | 14.7%                                                                                           | 13.7%                                                                                           |
| Wednesday                                        | 14.4%                                                                                           | 13.5%                                                                                           |
| Thursday                                         | 14.0%                                                                                           | 13.3%                                                                                           |
| Friday                                           | 13.9%                                                                                           | 13.6%                                                                                           |
| Saturday                                         | 13.2%                                                                                           | 15.1%                                                                                           |
| Sunday                                           | 14.1%                                                                                           | 16.0%                                                                                           |
| **Involved imaging by modality**                 |                                                                                                 |                                                   |
| CT                                               | 43.3%                                                                                           | 7.2%                                                                                             |
| Radiography/fluoroscopy                          | 30.9%                                                                                           | 16.6%                                                                                           |
| Ultrasound                                       | 15.4%                                                                                           | 2.2%                                                                                             |
| Magnetic resonance imaging                       | 1.8%                                                                                             | 0.3%                                                                                             |
| Nuclear medicine                                 | 0.7%                                                                                             | 0.1%                                                                                             |
| **Involved imaging of body region**              |                                                                                                 |                                                   |
| Abdomen/pelvis                                   | 36.2%                                                                                           | 5.9%                                                                                             |
| Chest                                            | 21.5%                                                                                           | 8.9%                                                                                             |
| Brain                                            | 15.6%                                                                                           | 3.0%                                                                                             |
| Extremity                                        | 9.1%                                                                                             | 6.6%                                                                                             |
| Spine                                            | 5.8%                                                                                             | 1.6%                                                                                             |
| Head/neck                                        | 2.9%                                                                                             | 0.9%                                                                                             |
| Cardiac                                          | 0.6%                                                                                             | 0.2%                                                                                             |
| Breast                                           | 0.03%                                                                                            | 0.01%                                                                                            |
| None                                             | 0.4%                                                                                             | 0.1%                                                                                             |

Data are reported as estimate (95% CI) or %.

*We did not calculate p-values for the differences in the proportion of ED visits that involved imaging by modality and body part because disproportionate utilizers of ED imaging services, by definition, had more ED visits and higher rates of imaging compared to nonheavy utilizers of ED imaging services.
provided private health plan beneficiaries, providing insight into this less studied group that nonetheless comprises 56% of the U.S. population. This group may be distinct from the U.S. population without health insurance or with Medicare or Medicaid benefits, for whom ED clinical and imaging utilization patterns differ. Medicare beneficiaries are older and likely sicker and are twice as likely to be frequent ED users than those with private health insurance.

LIMITATIONS

Our analysis has limitations. First, due to the lack of time stamps in billing data, we could not distinguish whether multiple claims with emergency evaluation and management CPT codes per day represented multiple ED visits or billing corrections. Thus, we measured the use of ED resources on the patient-day level. Consequently, our measures of the annual number of ED visits may be underestimated. Second, we did not include critical care codes 99291 and 99292, primarily because such codes are also frequently used in the intensive care unit and, without additional treatment location-specific information, these codes could not confirm an ED encounter. The significance of our excluding of these codes is that ED patients for whom only a critical care code of 99291 to 99292 was billed were excluded from analysis, resulting in an undersampling of sicker ED patients. Had these patients been included in the analysis, we would expect a greater overall proportion of individuals with an h-index of ≥2. Third, our study sample consisted of privately insured individuals within the United States: therefore, the results may not be generalizable to other populations (from other geographic regions, different insured populations, and the uninsured). Fourth, we did not evaluate the appropriateness of the ED imaging performed in this special population, which has bearing on the presumption of cost savings in prospectively identifying such patients. Finally, we eliminated those patients who were in the database for less than one calendar year, potentially excluding individuals with short-term employment from analysis.

CONCLUSION

Among 86.5 million individuals with employer-sponsored private insurance, a miniscule fraction (0.17%) accounted for nearly one-fifth of ED imaging resources over a 7-year period, with an incremental fractional increase year on year. We introduce the concept of the ED imaging h-index, a patient-level measure of imaging resource consumption in the ED, which incorporates both the annual number of ED visits and the intensity of medical imaging resource consumption for any given patient. Application of the ED imaging h-index in the health policy research domain can assist in stratifying populations of ED patients based on patient-level image utilization, permitting an analysis of imaging use in any stratum, in particular those with disproportionately frequent visits to the ED that are associated with resource-intense imaging (h-index ≥ 2, as in our study). The potential value in studying this specific cohort particularly concerns the identification of inefficient or inappropriate image ordering as an effort to mitigate imaging-related costs and improve throughput in the ED.

References

Risk Factors for Sedation-related Events During Acute Agitation Management in the Emergency Department

Celene Y. L. Yap, BPharm, PhD¹,²,³,⁴, David McD. Taylor, MBBS, MD¹,²,⁵, David C. M. Kong, GCHE, BPharm, MPharm, PhD¹,⁴,⁶, Jonathan C. Knott, MBBS, PhD¹,²,³,⁷, and Simone E. Taylor, PharmD⁷ on behalf of the Sedation for Acute Agitation in Emergency Department Patients: Targeting Adverse Events (SIESTA) Collaborative Study Group

ABSTRACT

Objective: The objective was to describe the incidence, nature, and risk factors for adverse events (AEs) among patients who received parenteral sedation for acute agitation in an emergency department (ED) setting.

Methods: We undertook a prospective observational study and a clinical trial of parenteral sedation for the management of acute agitation. We included agitated adult patients who required parenteral sedation from 2014 to 2017 in 12 Australian EDs, excluding those with incomplete information or aged under 18 years. The primary outcome was the number of patients who experienced at least one AE. Multivariable logistic regression was used to determine factors associated with AEs.

Results: A total of 904 patients were included in the analyses (62.3% male; median age = 34 years, range = 18 to 95 years). Of these, 144 (15.9%) patients experienced at least one AE. The most common AEs were oxygen desaturation (7.4%), airway obstruction (3.6%), bradycardia (1.9%), hypotension (1.7%), and prolonged QTc interval (1.3%). No deaths or serious AEs were reported. The following factors had an increased adjusted odds ratio (OR) for experiencing an AE: age 65 years and older (OR = 2.8, 95% confidence interval [CI] = 1.2 to 7.2), more than one type of parenteral sedation administered within 60 minutes (OR = 2.1, 95% CI = 1.4 to 3.1), and alcohol intoxication (OR = 1.8, 95% CI = 1.2 to 2.6).

Conclusions: Sedation-related AEs are common, especially respiratory events. Elderly patients, sedation with multiple sedatives within 60 minutes, and alcohol intoxication increased the risk.

Patients with acute agitation are a common presentation to emergency departments (EDs). A recent study reported that approximately 3% of ED patients presented with acute agitation, and the majority of them required parenteral sedation.¹ Care for these patients comes with safety risks for both ED staff and the patients themselves.² As patients presenting with acute agitation can be highly complex with comorbid medical and substance use issues, there is an increased risk of adverse events (AEs) following parenteral

From the ¹Faculty of Medicine, Dentistry and Health Sciences; and the ²Centre for Integrated Critical Care, Department of Medicine and Radiology, Melbourne Medical School, The University of Melbourne, Parkville, Victoria; the ³Emergency Department, The Royal Melbourne Hospital, Parkville, Victoria; the ⁴Centre for Medicine Use and Safety, Monash University, Parkville, Victoria; the ⁵Emergency Department; and the ⁶Pharmacy Department, Austin Health, Heidelberg, Victoria; and the ⁷Pharmacy Department, Ballarat Health Services, Ballarat, Victoria, Australia.

Received March 10, 2019; revision received June 4, 2019; accepted June 25, 2019.

Additional authors and members of the SIESTA Collaborative Study Group are listed in Appendix A.

Presented at the 34th Annual Scientific Meeting of the Australasian College for Emergency Medicine, Sydney, Australia, November 2017.

The study was supported by SHPA Emergency Medicine Grant 2014 (EME 1402); Emergency Medicine Foundation (EMTR-101R23-2015). The funding organizations did not have any role in the design or execution of the study, data analysis, or interpretation. The authors have no relevant financial information or potential conflicts to disclose.

Supervising Editor: Steven B. Bird, MD.

Address for correspondence and reprints: Professor David Taylor; e-mail: David.Taylor@austin.org.au.

ACADEMIC EMERGENCY MEDICINE 2019;26:1135–1143.

© 2019 by the Society for Academic Emergency Medicine
doi: 10.1111/acem.13826

ISSN 1553-2712

1135
s彦edation. Nonetheless, few studies have investigated factors that potentially place these patients at greater risk for AEs.

Sedative medications such as benzodiazepines (e.g., midazolam), typical antipsychotics (e.g., haloperidol, droperidol), and atypical antipsychotics (e.g., olanzapine) are commonly prescribed to manage acute agitation in the ED setting. Previous clinical trials have assessed the efficacy and safety of parenteral sedation for the management of agitation in this ED setting. The need to administer additional study medications or any sedative medications within 60 minutes of the initial dose has been commonly reported. However, it is unknown whether the addition of different sedative medications increases the risk of AEs.

In addition, the incidence of AEs reported in these trials varies considerably, depending on the prespecified definitions and the methods for monitoring and documentation. For example, in comparable patient populations, the AE rate for intramuscular droperidol has been reported to range from 6.0% to 40.0%. As there is lack of uniformity in reporting AEs in these trials, it is difficult to compare the AE rates directly. Importantly, none of these efficacy focused trials have sufficient statistical power to identify factors associated specifically with AEs among the patients.

While previous research has demonstrated that intoxication with illicit substances or alcohol are associated with the majority of acute agitation presentations, the impact of these ingested substances on the occurrence of sedation-related AEs remains understudied. There is limited evidence regarding other factors that may predispose a patient who has received parenteral sedation for acute agitation to AEs. Further investigation into which patient characteristics and treatment-specific variables are associated with the occurrence of AEs may improve patient safety and prevent serious complications in managing acute agitation in EDs. This study aimed to describe the incidence and nature of AEs among patients who received parenteral sedation for acute agitation in the ED and to identify risk factors associated with AEs in this patient population.

METHODS

Study Design and Setting

We analyzed data from a randomized controlled trial (RCT) of parenteral sedation for the management of acute agitation and a prospective observational study of patients in 12 Australian EDs. The annual patient census of these EDs ranged from 50,000 to 100,000 patients. Each ED is supported by 24-hour colocated psychiatric services. Ethics approval for both studies was obtained from the individual governance offices and human research ethics committees.

The RCT compared intravenous (IV) midazolam-droperidol combination, IV droperidol alone, and IV olanzapine alone for the management of undifferentiated acute agitation in two EDs in Melbourne, Australia. Patients were enrolled between October 2014 and August 2015, inclusive. These two EDs did not participate in the observational study to avoid overlapping between the samples. The observational study was undertaken in the EDs of 10 other public tertiary-referral hospitals across three Australian states (Victoria, Queensland, and New South Wales) between March 2015 and April 2017, inclusive. The observational study was designed to complement AE data obtained from the RCT, to increase the sample size for multivariable risk factor analysis.

Selection of Participants

Patients aged 18 years or older who required parenteral sedation for undifferentiated acute agitation in the participating EDs were enrolled. Cases enrolled more than once into the RCT or with incomplete information were excluded from the analyses. In the RCT, three patients were enrolled twice (about 3–4 hours apart) during the same presentation. Only the initial encounter was included in this analysis of the RCT and observational study patients to avoid double counting of the AE incidence and to improve the accuracy of the logistic regression model. Consecutive patient enrollment was undertaken by assigning patients to the next sequential study pack at their site for the RCT; however, convenience sampling was used for the observational study.

Methods of Measurements

It is the routine clinical practice in the participating EDs to have one-on-one nursing implemented postsedation to monitor the patient’s vital signs, airway patency, and level of sedation. Adverse events were recorded immediately after the administration of parenteral sedation and throughout the ED length of stay. Adverse event data and the time of first parenteral sedation administration were prospectively collected by clinical staff using a designated case report form. To ensure that data were collected in a consistent way across all sites by different nurses, definitions of both
respiratory and hemodynamic AEs were stated on the case report form, and all data were reassessed by the site investigators after the ED presentation, by reviewing the medical record and seeking clarification of any details from the clinicians who cared for the patient in the ED.

Both studies used the same definitions for the following AEs: respiratory AEs (i.e., hypoventilation [respiratory rate < 10 breaths/min], oxygen desaturation [oxygen saturation < 90% mmHg], partial or complete airway obstruction); cardiovascular AEs (i.e., prolonged QTc [corrected QT > 500 milliseconds], tachycardia [heart rate > 100 beats/min], bradycardia [heart rate < 60 beats/min]); and other AEs (i.e., extrapyramidal side effects [EPSE], vomiting, anticholinergic side effects [e.g., urinary retention, dry mouth], falls, and anaphylaxis). Clinical events such as oxygen desaturation, airway obstruction, hypotension, and borderline prolonged QTc occur during the sedation will only be detected by nursing staff providing bedside routine care. If other AEs occurred following the sedation (e.g., EPSE), they would have been detected by the attending nursing staff or reported by the patient. Patients were only discharged home after any identified AEs were managed and after being medically cleared. Therefore, clinical events observed and documented by staff on the case report form are considered a reliable source of reported events detected in the ED. Causality of each AE was assessed by the site investigators using the World Health Organization definitions.

Site investigators are ED physicians responsible for the conduct of the study at the participating sites. Most participating sites have two site investigators and they have contributed their time in kind for this study. The role and responsibilities of site investigators including study promotion prior to the study commencement (e.g., conduct training sessions for both nurses and doctors in the ED about the inclusion criteria, AE documentation), data collection (i.e., collecting demographics data from medical records, assessing AEs reported on the case report form), site support (e.g., answering queries from local staff and the coordinating principal investigators), and assist in the preparation of progress reports and the manuscript. They were not blinded to the study aim.

Site investigators extracted data on patient demographics and treatment from medical records. Variables extracted retrospectively included sex, age, triage date and time, medication history (i.e., regular psychotropic medications and medications given by paramedics), first dose of parenteral sedation regimen, further parenteral sedation prescribed in the ED within 60 minutes of the first dose, need for mechanical restraint, illicit drugs and alcohol use immediately prior to presentation, final diagnosis, and disposition.

**Data Analysis**

Sample size calculations were determined a priori for both the RCT and the observational study. For the observational study, our initial sample size was calculated to be at least 1,944 patients to be 95% certain that the AE rate would range between 11% and 14% (level of significance = 0.05). However, after 547 patients were recruited, the incidence of AE observed was 13.5% (74/547 [95% confidence interval {CI} = 10.9%–16.7%]), within the expected range. While higher sample numbers will lead to smaller CIs and may increase the chance of detecting rare AEs, we believe that the current sample size which afforded 13.5% AEs appears to have captured the most common types of AE related to the parenteral sedation in this setting.

Patient characteristics, treatment received, and incidence and nature of AEs were analyzed descriptively and are reported as frequencies and percentages. For AE data, we calculated differences in proportions with associated 95% CIs for patients who received single or multiple types of parenteral sedation within 60 minutes and for agitation with or without alcohol intoxication.

Adjusted odds ratios (ORs) and 95% CIs were determined using multiple logistic regression. The independent variables were selected according to clinical plausibility. All variables were entered simultaneously into the model to determine the OR for any AE. As previous work has reported high rates of respiratory AEs postsedation, we created a second model using the same set of independent variables to determine the OR for any respiratory AE (oxygen desaturation, airway obstruction, or hypventilation). The independent variables selected for both models included age, sex, regular psychotropic medications, alcohol intoxication, drug intoxication, need for mechanical restraint, sedatives were administered prior to parenteral sedation, and whether multiple types of parenteral sedation were administered within 60 minutes. All variables included in the model are categorical and the outcomes are dichotomous (i.e., yes vs no); hence the assumptions related to extreme values,
influential values, and assumption of linearity are not applicable for this model. Collinearity diagnostics were conducted, all variables have tolerance values more than 0.1, which indicated low intercorrelations among the independent variables included in the logistic regression model. Model fit was assessed for each model with the Hosmer-Lemeshow fit statistic. All analyses were performed using IBM SPSS Statistics Version 25 and the level of significance was 0.05.

RESULTS

Characteristics of Study Subjects

Of the 925 cases (361 from the RCT and 564 from the observational study) entered into the study database, 21 cases were excluded (one aged less than 18 years, three repeated enrollment, and 17 incomplete information). The remaining 904 cases (357 from the RCT and 547 from the observational study) had complete data and were included in these analyses.

Patient characteristics, type of parenteral sedation administered, and disposition are reported in Table 1. The median age was 34 years (range = 18 to 95). Among the 388 (42.9%) patients identified to have ingested alcohol prior to the ED presentation, approximately one-half (46%) had blood alcohol levels documented. The mean (±SD) alcohol level among these patients was 0.21 (±0.10) g/dL.

Main Results

Adverse events following parenteral sedation were observed in 144 (15.9%) patients (Table 2). Respiratory AEs including oxygen desaturation, airway obstruction, and hypoventilation were observed in 11.3% of patients. All patients who experienced a respiratory AE were managed with the administration of oxygen, airway positioning, or bag-mask ventilation. No patient required endotracheal intubation. Cardiovascular AEs including hypotension, QTc prolongation, and bradycardia were observed in 4.8% of patients. However, significantly more patients receiving only olanzapine experienced at least one cardiovascular AEs (8.5% vs. 4.2%, p = 0.04). Bradycardia was the most commonly reported cardiovascular AE (17/43, 40%), and more than one-third (35%) of these patients were managed with olanzapine alone. All reported AEs were transient and resolved without adverse clinical outcomes. No deaths were reported.

We found no significant differences in ED length of stay and disposition destination between patients who experienced an AE and those who did not (Table 1). Although a higher proportion of patients who experienced an AE were admitted to the medical ward, all patients were admitted for their underlying medical conditions. No patients were admitted to the medical ward secondary to AEs associated with the management of their acute agitation.

After adjustment for other variables, multiple types of parenteral sedation administered within 60 minutes (OR = 2.1, 95% CI = 1.4 to 3.1) and alcohol intoxication (OR = 1.8, 95% CI = 1.2 to 2.6) were independently associated with the occurrence of any AEs and with any respiratory AEs (Table 3).

DISCUSSION

To our knowledge, this study is the first to investigate the risk of the occurrence of any AEs in patients who received multiple types of parenteral sedation within 60 minutes of the initial parenteral sedation. To date, most studies related to the management of acute agitation have focused on the efficacy and safety of the initial dose of sedative medication.10,11 As most of the sedative medications used in the ED setting for acute agitation have elimination half-lives longer than 60 minutes, any additional sedative medications administered within 60 minutes would likely have additive sedative and respiratory or hemodynamic depression effects.10 Hence, in comparison to patients who received only one type of parenteral sedation, agitated patients who received more than one type of parenteral sedation within 60 minutes are at higher risk of experiencing sedation-related AEs. When a different type of parenteral sedation is required to manage an episode of agitation, experienced staff and resuscitation equipment should be immediately available for prompt management of any sedation-related AEs.

Adverse events following parenteral sedation for acute agitation are common. Consistent with previous studies,4-7 respiratory-related AEs were the most common complications following parenteral sedation in this study. Although previous reviews highlight the potential for serious sedation-related AEs (e.g., Torsades de Pointes [TdP], respiratory depression),11,12 it is important to note that, in this study, no patient experienced more than transient morbidity associated with sedation. Regular clinical monitoring with early detection of AEs may have avoided life-threatening events such as respiratory arrest. This finding serves to emphasize that all patients must receive close
## Table 1
Characteristics of the Study Population

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total Population (N = 904)</th>
<th>Any AE (n = 144)</th>
<th>Respiratory AE (n = 92)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–30</td>
<td>321</td>
<td>47 (14.6)</td>
<td>32 (10.0)</td>
</tr>
<tr>
<td>31–64</td>
<td>549</td>
<td>89 (16.2)</td>
<td>57 (10.4)</td>
</tr>
<tr>
<td>≥65</td>
<td>34</td>
<td>8 (23.5)</td>
<td>3 (8.8)</td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>563</td>
<td>100 (17.8)</td>
<td>69 (12.3)</td>
</tr>
<tr>
<td><strong>ICD-10 category</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental illness</td>
<td>347</td>
<td>49 (14.1)</td>
<td>26 (7.5)</td>
</tr>
<tr>
<td>Intoxication (drugs and/or alcohol)</td>
<td>472</td>
<td>80 (17.0)</td>
<td>56 (11.9)</td>
</tr>
<tr>
<td>Organic illness</td>
<td>85</td>
<td>15 (17.6)</td>
<td>10 (11.8)</td>
</tr>
<tr>
<td><strong>Regular psychotropic medications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>91</td>
<td>13 (14.3)</td>
<td>6 (6.6)</td>
</tr>
<tr>
<td>SSRI or SNRI</td>
<td>84</td>
<td>17 (20.2)</td>
<td>10 (11.9)</td>
</tr>
<tr>
<td>Atypical antipsychotics</td>
<td>153</td>
<td>22 (14.4)</td>
<td>13 (8.5)</td>
</tr>
<tr>
<td>Typical antipsychotics</td>
<td>33</td>
<td>2 (6.1)</td>
<td>1 (3.0)</td>
</tr>
<tr>
<td>Prescription opioidsa</td>
<td>70</td>
<td>5 (7.1)</td>
<td>2 (2.9)</td>
</tr>
<tr>
<td>Alcohol intoxication</td>
<td>388</td>
<td>77 (19.9)</td>
<td>55 (14.2)</td>
</tr>
<tr>
<td>Illicit drug intoxication</td>
<td>391</td>
<td>61 (15.6)</td>
<td>37 (9.5)</td>
</tr>
<tr>
<td>Need for mechanical restraint</td>
<td>494</td>
<td>89 (18.0)</td>
<td>63 (12.8)</td>
</tr>
<tr>
<td><strong>Sedatives administered prior the initial parenteral sedation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intramuscular midazolam^d</td>
<td>32</td>
<td>9 (25.7)</td>
<td>6 (18.8)</td>
</tr>
<tr>
<td>Oral diazepam</td>
<td>43</td>
<td>7 (16.3)</td>
<td>5 (11.6)</td>
</tr>
<tr>
<td>Oral olanzapine</td>
<td>25</td>
<td>2 (8.0)</td>
<td>1 (4.0)</td>
</tr>
<tr>
<td>Oral risperidone</td>
<td>4</td>
<td>2 (50.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Oral diazepam and olanzapine</td>
<td>26</td>
<td>4 (15.4)</td>
<td>3 (11.5)</td>
</tr>
<tr>
<td><strong>Type of parenteral sedation administered within 60 minutes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single sedative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Droperidol</td>
<td>473</td>
<td>54 (11.4)</td>
<td>32 (6.8)</td>
</tr>
<tr>
<td>Olanzapine</td>
<td>118</td>
<td>22 (18.6)</td>
<td>10 (8.5)</td>
</tr>
<tr>
<td>Midazolam</td>
<td>48</td>
<td>6 (12.5)</td>
<td>5 (10.4)</td>
</tr>
<tr>
<td>Othersd</td>
<td>10</td>
<td>2 (20.0)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td>Multiple sedatives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midazolam + antipsychotics^e</td>
<td>217</td>
<td>54 (24.9)</td>
<td>41 (18.9)</td>
</tr>
<tr>
<td>Typical antipsychotics + atypical antipsychotics^f</td>
<td>19</td>
<td>3 (15.8)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Ketamine + other sedatives^g</td>
<td>10</td>
<td>3 (30.0)</td>
<td>3 (30.0)</td>
</tr>
<tr>
<td>Other combinations^i</td>
<td>9</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td><strong>ED length of stay (hours)</strong></td>
<td>10.1 (6.0–15.2)</td>
<td>9.2 (6.4–14.3)</td>
<td>8.9 (5.6–12.3)</td>
</tr>
<tr>
<td><strong>Disposition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>474</td>
<td>71 (15.0)</td>
<td>52 (11.0)</td>
</tr>
<tr>
<td>Psychiatric ward</td>
<td>282</td>
<td>40 (14.2)</td>
<td>22 (7.8)</td>
</tr>
<tr>
<td>Medical ward</td>
<td>79</td>
<td>17 (21.5)</td>
<td>8 (10.1)</td>
</tr>
<tr>
<td>ED observational ward</td>
<td>44</td>
<td>12 (27.3)</td>
<td>7 (15.9)</td>
</tr>
<tr>
<td>Other facilities^j</td>
<td>25</td>
<td>4 (16.0)</td>
<td>3 (12.0)</td>
</tr>
</tbody>
</table>

Data are reported as n (%) or median (IQR).

ICD-10 = International Classification of Diseases; IQR = Interquartile range; SSRI = selective serotonin reuptake inhibitor; SNRI = serotonin noradrenalin-reuptake inhibitor

^aPatients could have been administered more than one type of regular psychotropic medications prior to the presentation.

^bPrescription opioids included buprenorphine, codeine, fentanyl, methadone, morphine, oxycodone, or tramadol.

^cIntramuscular midazolam administered by paramedics before arriving EDs.

^dOther sedative medications included haloperidol, diazepam, lorazepam, and propofol.

^eAntipsychotics that had been administered within 1 hour before or after sedation with midazolam included droperidol, olanzapine, and haloperidol.

^fCombination of antipsychotics included droperidol-olanzapine and haloperidol-risperidone.

^gSedatives that had been administered within 1 hour before or after sedation with ketamine included midazolam, droperidol, clonazepam, and morphine.

^hOther combinations of sedatives included droperidol-diazepam, droperidol-clonazepam, and droperidol-lorazepam.

^iOther facilities included correctional facilities, assisted accommodation, and police.
monitoring of their vital signs and be attended by personnel skilled in airway management when parenteral sedation is administered.

Droperidol is widely used in the management of acute agitation due to its effectiveness in treating all subsets of acute agitation, including those resulting from stimulant abuse, alcohol intoxication, head injury, mania, or psychosis and in both elderly and pediatric patients. However, the use of droperidol decreased considerably in the United States after

Table 2
Frequency and Nature of Sedation-related AEs

<table>
<thead>
<tr>
<th></th>
<th>Total (n = 904)</th>
<th>Multiple Sedatives (n = 255)</th>
<th>Single sedative (n = 649)</th>
<th>Difference in Proportions (95% CI)</th>
<th>Alcohol (n = 388)</th>
<th>No Alcohol (n = 516)</th>
<th>Difference in Proportions (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients with reported events</td>
<td>144 (15.9)</td>
<td>60 (23.5)</td>
<td>84 (12.9)</td>
<td>10.6 (4.8 to 16.9)</td>
<td>77 (19.8)</td>
<td>67 (13.0)</td>
<td>6.9 (1.9 to 12.0)</td>
</tr>
<tr>
<td>Respiratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen desaturation (SaO₂ &lt; 90%)</td>
<td>67 (7.4)</td>
<td>32 (12.6)</td>
<td>35 (5.4)</td>
<td>7.2 (2.9 to 12.3)</td>
<td>42 (10.8)</td>
<td>25 (4.8)</td>
<td>6.0 (2.3 to 10.0)</td>
</tr>
<tr>
<td>Airway obstruction (partial or complete)</td>
<td>33 (3.6)</td>
<td>17 (6.7)</td>
<td>16 (2.5)</td>
<td>4.2 (1.1 to 8.3)</td>
<td>20 (5.2)</td>
<td>13 (2.5)</td>
<td>2.7 (-0.02 to 5.7)</td>
</tr>
<tr>
<td>Hypoventilation (RR &lt; 10 breaths/min)</td>
<td>6 (0.7)</td>
<td>1 (0.4)</td>
<td>5 (0.8)</td>
<td>-0.4 (-1.8 to 1.6)</td>
<td>3 (0.8)</td>
<td>3 (0.6)</td>
<td>0.2 (-1.2 to 1.9)</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bradycardia (HR &lt; 60 beats/min)</td>
<td>17 (1.9)</td>
<td>1 (0.4)</td>
<td>16 (2.5)</td>
<td>-2.1 (-0.3 to 3.7)</td>
<td>7 (1.8)</td>
<td>10 (1.9)</td>
<td>-0.1 (-2.1 to 2.1)</td>
</tr>
<tr>
<td>Hypotension (SBP &lt; 80 mm Hg)</td>
<td>15 (1.7)</td>
<td>7 (2.8)</td>
<td>8 (1.2)</td>
<td>1.6 (-0.5 to 4.7)</td>
<td>10 (2.6)</td>
<td>5 (1.0)</td>
<td>1.6 (-0.3 to 3.9)</td>
</tr>
<tr>
<td>Prolonged QTc (QTc interval &gt; 500 ms)</td>
<td>12 (1.3)</td>
<td>4 (1.6)</td>
<td>8 (1.2)</td>
<td>0.4 (-1.3 to 3.1)</td>
<td>7 (1.8)</td>
<td>5 (1.0)</td>
<td>0.8 (-0.9 to 3.0)</td>
</tr>
<tr>
<td>Tachycardia (HR &gt; 100 beats/min)</td>
<td>1 (0.1)</td>
<td>0 (0.0)</td>
<td>1 (0.2)</td>
<td>-0.2 (-1.7 to 1.0)</td>
<td>0 (0.0)</td>
<td>1 (0.2)</td>
<td>-0.2 (-1.0 to 1.3)</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPSE</td>
<td>8 (0.9)</td>
<td>5 (2.0)</td>
<td>3 (0.5)</td>
<td>1.5 (-0.09 to 4.3)</td>
<td>1 (0.3)</td>
<td>7 (1.4)</td>
<td>-1.1 (-0.5 to 2.7)</td>
</tr>
<tr>
<td>Vomiting</td>
<td>2 (0.2)</td>
<td>1 (0.4)</td>
<td>1 (0.2)</td>
<td>0.2 (-0.7 to 2.4)</td>
<td>1 (0.3)</td>
<td>1 (0.2)</td>
<td>0.1 (-0.1 to 1.5)</td>
</tr>
<tr>
<td>Urinary retention</td>
<td>2 (0.2)</td>
<td>1 (0.4)</td>
<td>1 (0.2)</td>
<td>0.2 (-0.7 to 2.4)</td>
<td>0 (0.0)</td>
<td>2 (0.4)</td>
<td>-0.4 (-0.9 to 1.5)</td>
</tr>
<tr>
<td>Dry mouth</td>
<td>1 (0.1)</td>
<td>0 (0.0)</td>
<td>1 (0.2)</td>
<td>-0.2 (-1.7 to 1.0)</td>
<td>0 (0.0)</td>
<td>1 (0.2)</td>
<td>-0.2 (-1.0 to 1.3)</td>
</tr>
<tr>
<td>Fall</td>
<td>1 (0.1)</td>
<td>1 (0.4)</td>
<td>0 (0.0)</td>
<td>0.4 (-0.4 to 2.5)</td>
<td>1 (0.3)</td>
<td>0 (0.0)</td>
<td>0.3 (-0.7 to 1.7)</td>
</tr>
<tr>
<td>Anaphylaxis</td>
<td>1 (0.1)</td>
<td>0 (0.0)</td>
<td>1 (0.2)</td>
<td>-0.2 (-1.7 to 1.0)</td>
<td>0 (0.0)</td>
<td>1 (0.2)</td>
<td>-0.2 (-1.0 to 1.3)</td>
</tr>
<tr>
<td>Total cases of AEs</td>
<td>166 (18.3)</td>
<td>70 (27.5)</td>
<td>96 (14.8)</td>
<td>12.7 (6.6 to 19.2)</td>
<td>92 (23.7)</td>
<td>74 (14.3)</td>
<td>9.4 (4.1 to 14.8)</td>
</tr>
</tbody>
</table>

*Data are reported as n (%).
AE = adverse event; EPSE = extrapyramidal side effects; HR = heart rate; QTc = corrected QT interval; RR = respiratory rate; SaO₂ = oxygen saturation; SBP = systolic blood pressure

Table 3
Multivariable Logistic Regression Model for AEs for Total Population (n = 904)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Any AE</th>
<th>Respiratory AE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>31–64</td>
<td>1.2 (0.8 to 1.8)</td>
<td>1.1 (0.7 to 1.8)</td>
</tr>
<tr>
<td>≥65</td>
<td>2.8 (1.1 to 7.1)</td>
<td>1.5 (0.4 to 5.7)</td>
</tr>
<tr>
<td>Male</td>
<td>1.4 (1.0 to 2.1)</td>
<td>2.0 (1.2 to 3.3)</td>
</tr>
<tr>
<td>Regular psychotropic medications</td>
<td>0.9 (0.6 to 1.3)</td>
<td>0.8 (0.5 to 1.3)</td>
</tr>
<tr>
<td>Alcohol intoxicated</td>
<td>1.8 (1.2 to 2.6)</td>
<td>2.2 (1.4 to 3.5)</td>
</tr>
<tr>
<td>Illicit drug intoxicated</td>
<td>1.0 (0.7 to 1.5)</td>
<td>0.8 (0.5 to 1.3)</td>
</tr>
<tr>
<td>Need for mechanical restraint</td>
<td>1.3 (0.9 to 1.9)</td>
<td>1.6 (1.0 to 2.6)</td>
</tr>
<tr>
<td>Sedatives were administered prior parenteral sedation</td>
<td>1.3 (0.8 to 2.1)</td>
<td>1.3 (0.7 to 2.4)</td>
</tr>
<tr>
<td>Multiple types of parenteral sedation were administered within 60 minutes</td>
<td>2.1 (1.5 to 3.1)</td>
<td>2.6 (1.6 to 4.1)</td>
</tr>
</tbody>
</table>

Data are reported as OR (95% CI).
Adjusted ORs generated by the simultaneous entry of covariates in the logistic regression model. The p-value for Hosmer-Lemeshow goodness-of-fit statistics for all AE and respiratory AE are 0.990 and 0.815, respectively.

<sup>a</sup>Reference group with which other groups are compared.
the Food and Drug Administration placed a “black box” warning on its use in 2001.21,22 This warning highlighted the potential risk of QT prolongation, TdP, and sudden death in patients receiving droperidol at the recommended doses. However, our findings indicate that patients receiving droperidol alone reported the lowest incidence of sedation-related AEs. The finding that no patient developed TdP is consistent with previous reports that the absolute risk of TdP is low.10,12–16,19,23 Our findings, therefore, provide additional data to support the safety profile of droperidol for sedation of agitated patients in the ED.

Considering the droperidol shortage in the United States following the black box warning and similar effects and comparable safety profile of droperidol and olanzapine,6,14 olanzapine has been the first choice of initial parenteral sedation for acute agitation in some EDs.24,25 While previous studies examining patients receiving olanzapine in the ED have reported a low rate of cardiovascular AEs,6,23–25 we found that when compared with patients receiving other parenteral sedation regimens, cardiovascular AEs were more commonly experienced by patients receiving only olanzapine. Bradycardia occurred more frequently than hypotension and QTc prolongation. However, all cardiovascular AEs resolved without sequelae. Despite the difference, our findings add to the published literature supporting the safe use of parenteral olanzapine in ED patients.

Alcohol intoxication is a known risk factor for sedation-related AEs.27,28 Consistent with previous studies, reduction in oxygen saturation was the main respiratory complication in this subgroup of patients.25,29 One previous study identified that parenteral sedation was associated with increased odds for use of critical care resources by patients with alcohol intoxication and acute agitation presenting to the ED.30 Given that alcohol has additive effects with other central nervous system depressant medications, regardless of the type of parenteral sedation administered, a high level of vigilance should be maintained following administration of parenteral sedation to patients with alcohol intoxication.

Although being elderly, especially aged 65 years and above, is associated with increased odds of experiencing a sedation-related AE when compared with those aged 30 years or less, the proportion of patients sedated for acute agitation in this older age group was relatively small. In this study, it is difficult to distinguish whether the increased risk of harm is due to underlying medical comorbidities or other unidentified factors not present in younger patients. Future research with a larger sample size is required to provide a more precise evaluation of this relationship.

LIMITATIONS

This study has several limitations. It was an analysis of data from a RCT and an observational study, which may introduce selection bias. However, as both studies involved adult patients with severe acute agitation that required parenteral sedation, the risk of selection bias is likely to be low. Furthermore, because the occurrence of AEs was monitored and documented in a similar method for both studies, the differences in the study design are unlikely to change the findings.

Theoretically, the risk of sedation-related events can be dose-dependent or medication-specific. However, statistical comparisons of AEs associated with different dosage regimens for each sedative medication were not performed, as the statistical power was low when comparing across subgroups. Similarly, we were unable to examine the association between AEs and route of sedative administration (i.e., intravascular vs. intramuscular) as some patients received both intravascular and intramuscular sedation within 60 minutes of the initial parenteral sedation.

This study is also limited by the small numbers of intoxicated patients with a documented blood alcohol level. Final diagnosis of alcohol and illicit drug intoxication was decided by the treating clinician based on historical information, clinical presentation, and/or blood alcohol level. Specific diagnosis tests were only done where required as part of routine clinical care; therefore, the prevalence of alcohol and illicit drug intoxication may be an underestimate. Although alcohol intake appears to be associated with decreasing oxygen saturations, our study was not powered to determine the association between blood alcohol level and the occurrence of AEs. It is also possible that lack of documentation may have led to nonidentification of some intoxicated patients. Hence, we may have underestimated the true risk of alcohol intoxication.

Pretreatment electrocardiograms (ECGs) are not routinely obtained in the ED for patients with severe agitation, so it is not known whether the QTc prolongations were preexisting conditions or medication-induced. The low incidence of QTc prolongation in this analysis, and the finding that no patient developed TdP, is consistent with previous reports that the
absolute risk of TdP related to parenteral sedation in this group of patients is small.\textsuperscript{6,31} However, firm conclusions cannot be made because the study was not powered to compare QTc intervals, and not all patients had an ECG performed.

CONCLUSIONS

In summary, patients presenting with acute agitation, especially those aged 65 years and older, intoxicated with alcohol, or managed with multiple types of parenteral sedation, carry increased risk of sedation-related adverse events. Decades of research have shown that antipsychotics and benzodiazepines, alone or in combination, are effective for use in the management of acute agitation. Although all medications currently used for sedation carry a risk of adverse events, our findings suggest that the majority of the adverse events can be managed with relatively minor interventions. Hence, an emphasis should be placed on close physiologic monitoring to ensure early detection and management of these adverse events, regardless of the type of parenteral sedation administered to manage the acute agitation.

The authors acknowledge the cooperation and support provided by the staff of the participating emergency departments.

References

22. Richards JR, Weiss SJ, Brett SW, Schneir AB, Rinetti D, Derlet RW. The effects of the FDA warning on the use of...

**APPENDIX**

Additional authors and members of the SIESTA Collaborative Study Group:

Andis Graudins, MBBS (Hons), PhD, Emergency Medicine and Clinical Toxicology Research Unit, Monash Health, Dandenong, Victoria, Australia

Gerben Keijzers, MBBS, PhD, Emergency Department, Gold Coast University Hospital, Southport, Queensland, Australia

Sanjeeewa Kulawickrama, MBBS, Emergency Department, Gold Coast University Hospital, Southport, Queensland, Australia

Ogilvie Thom, MBBS, Emergency Department, Nambour General Hospital, Nambour, Queensland, Australia

Luke Lawton, MBBS (Hons), MPH (Aeromedical Retrieval), Emergency Department, The Townsville Hospital, Townsville, Queensland, Australia

Jeremy Furyk, MBBS, Emergency Department, The Townsville Hospital, Townsville, Queensland, Australia

Daniel P. Finucci, MBBS, MMedSci, Emergency Department, Liverpool Hospital, Liverpool, New South Wales, Australia

Anna Holdgate, MBBS, MMed, Emergency Medicine Research Unit, Emergency Department, Liverpool Hospital, Liverpool BC, New South Wales, Australia

Gina Watkins, MBBS, Emergency Department, Sutherland Hospital, Taren Point, New South Wales, Australia

Peter Jordan, MBBS, Emergency Department, Northern Health, Epping, Victoria, Australia

Georgina A. Phillips, MBBS, Emergency Department, St Vincent’s Hospital, Fitzroy, Victoria, Australia

Jonathan Karro, MBBS, Emergency Department, St Vincent’s Hospital, Fitzroy, Victoria, Australia

Esther W. Chan, BPharm (Hons), PhD, Centre for Safe Medication Practice and Research, Department of Pharmacology and Pharmacy, Li Ka Shing Faculty of Medicine, University of Hong Kong, Hong Kong

David J. Castle, MD, St Vincent’s Hospital and The University of Melbourne, Fitzroy, Victoria, Australia
Multicenter Comparison of Nonsupine Versus Supine Positioning During Intubation in the Emergency Department: A National Emergency Airway Registry (NEAR) Study

H. Hill Stoecklein, MD¹, Christopher Kelly, MD¹, Amy H. Kaji, MD, PhD², Andrea Fantegrossi, MPH³, Margaret Carlson¹, Megan L. Fix, MD¹, Troy Madsen, MD¹, Ron M. Walls, MD³, and Calvin A. Brown III, MD³, on behalf of the NEAR Investigators

ABSTRACT

Objective: Head-up positioning for preoxygenation and ramping for morbidly obese patients are well-accepted techniques, but the effect of head-up positioning with full torso elevation for all intubations is controversial. We compared first-pass success, adverse events, and glottic view between supine (SP) and nonsupine (NSP) positioning for emergency department (ED) patients undergoing orotracheal intubation.

Methods: We performed a retrospective analysis of prospectively collected data for ED intubations over a 2-year period from 25 participating centers in the National Emergency Airway Registry (NEAR). We compared characteristics and outcomes for adult patients intubated orotracheally in SP and NSP positions with either a direct or video laryngoscope. We report odds ratios (OR) with 95% confidence interval (CI) for categorical variables and interquartile ranges with 95% CI for continuous variables. Our primary outcome was first-attempt intubation success and secondary outcomes were glottic views and peri-intubation adverse events.

Results: Of 11,480 total intubations, 5.8% were performed in NSP. The NSP group included significantly more obese patients (OR = 2.2 [95% CI = 1.9–2.6]) and patients with a suspected difficult airway (OR = 1.8 [95% CI = 1.6–2.2]). First-pass success (adjusted OR = 1.1 [95% CI = 0.9–1.4]) and overall rate of grade I glottic views (OR = 1.1 [95% CI = 0.9–1.2]) were similar between groups while NSP had a significantly higher rate of grade I views when direct laryngoscopy was employed (OR = 1.27 [95% CI = 1.04–1.54]). NSP was associated with higher odds of any adverse event (OR = 1.4 [95% CI = 1.1–1.7]).

Conclusions: ED providers utilized SP in most ED intubations but were more likely to use NSP for patients who were obese or in whom they predicted a difficult airway. We found no differences in first-pass success between groups but total adverse events were more likely in NSP. A randomized trial comparing patient positioning during intubation in the ED is warranted.

From the ¹Division of Emergency Medicine, University of Utah, Salt Lake City, UT; the ²Department of Emergency Medicine, Harbor-UCLA, Torrance, CA; and the ³Department of Emergency Medicine, Brigham and Women’s Hospital, Boston, MA.

Received January 16, 2019; revision received May 11, 2019; accepted May 18, 2019.

Presented at the at the Society for Academic Emergency Medicine Annual Meeting, Indianapolis, IN, May 17, 2018.

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

Author contributions: HHS and CAB conceived the study; AF and MC supervised the overall and local (in Salt Lake City) conduct of the trial and data collection; AHK provided statistical advice on study design and analyzed the data; HHS and CK drafted the manuscript; and all authors contributed substantially to its revision. RMW is the founder of NEAR and CAB is the current principal investigator of NEAR. HHS takes responsibility for the paper as a whole.

Supervising Editor: Rob Reardon, MD.

Address for correspondence and reprints: H. Hill Stoecklein, MD; e-mail: Hill.stoecklein@hsc.utah.edu.

ACADEMIC EMERGENCY MEDICINE 2019;26:1144–1151.

© 2019 by the Society for Academic Emergency Medicine
doi: 10.1111/acem.13805
There is good evidence that head-up positioning is best for preoxygenation prior to intubation. It is also well accepted that the best head and neck position for intubation in all patients includes aligning the ear canal and sternal notch, which may require head elevation in some patients and ramping of the shoulders and head in morbidly obese patients. Recently, the concept of intubating all patients in a head-up position with full torso elevation has been proposed but there is little evidence to support this practice.1–10

Importance
Both first-pass success11,12 and hypoxia13 have been established as independent predictors of intubation-related complications. However, recent studies from inpatient14,15 and ED8 settings comparing positioning during emergent intubation have shown conflicting results regarding first-pass success, adverse events, and glottic view. Multicenter data from the ED setting are limited.

Goals of This Investigation
Our study sought to compare the rate of first-pass success, peri-intubation adverse events, and Cormack and Lehane laryngeal view for patients undergoing intubation in supine position (SP) and nonsupine position (NSP) across multiple EDs.

METHODS
Study Design and Setting
We performed a secondary analysis of the National Emergency Airway Registry (NEAR), a prospectively collected database of ED intubations from an international network of 25 academic and community hospitals. This database has been in use for over 20 years to conduct surveillance of emergency department (ED) airway management. As such, we adhered to the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) Statement (https://strobe-statement.org). Each of the participating sites obtained institutional review board approval prior to data collection and analysis.

Methods of Measurement and Data Collection and Processing
After intubation of an ED patient, the primary intubator entered data into a secure, Web-based data collection form requiring institution-specific login credentials and passwords (StudyTRAX, Version 3.47.0011, ScienceTRAX). Variables collected included patient demographics, body habitus and estimated weight, preintubation hemodynamics, methods of preoxygenation, impression of airway difficulty, neck mobility (e.g., presence of cervical collar), airway characteristics (e.g., mouth opening, Mallampati score), intubation position and device, medications and doses, operator characteristics, first-pass intubation success or failure, adverse events, and patient disposition. After data upload, study investigators reviewed all data, using quality assurance algorithms to identify and correct data entry errors. Each participating center had a designated site investigator to help track local intubations and maximize compliance with data entry. The study coordinator (AF; Brigham and Women’s Hospital, Boston MA) monitored data compliance and ensured that a registry-wide average of 90% of intubations were captured among all participating sites in order for data to be entered into the registry’s database.

Selection of Participants
We included patients 18 years of age or older whose peri-intubation positioning was recorded in the NEAR database over the 2-year period from January 1, 2016, through December 31, 2017 (Figure 1). Patients who underwent intubation with a flexible fiberoptic or video device and those who underwent an “awake intubation” with topical anesthesia alone or in combination with subinduction doses of sedative agents (i.e., non-RSI cases) were excluded. Periods of participation varied for individual centers because facilities joined NEAR on a rolling basis. We performed four post hoc subgroup analyses. First, we analyzed only those patients for whom there was a medical indication for intubation, as trauma patients are often immobilized with a cervical collar and may be systematically different than medical patients. Second, we analyzed the select group of patients with medical indications for intubation who were obese or morbidly obese and were initially suspected to have a difficult airway. In an attempt to better evaluate the possibility of confounding by indication, we analyzed outcomes among obese, nonobese, difficult airway, and nondifficult airway patients between positioning groups.

Outcome Measures
The primary outcome was first-pass success. Secondary outcomes included glottic view, using the Cormack and Lehane grading system, and composite adverse event rates. Glottic view was further compared between SP and NSP for direct laryngoscopy (DL) and video laryngoscopy (VL) separately. Composite adverse events
included peri-intubation hypoxia (defined as oxygen saturation less than 90% or a decrease of more than 10%), postintubation bradycardia (heart rate less than 60 beats/min), postintubation hypotension (systolic blood pressure less than 100 mm Hg), emesis or aspiration, mainstem intubation, and peri-intubation cardiac arrest.

### Primary Data Analysis

Data were downloaded from ScienceTRAX as a Microsoft Excel file (Microsoft Corp.) and transferred to SAS 9.4 (SAS Institute) for analysis. Patient positioning was primarily stratified based on the placement of the torso (and not manipulation of the cervical spine) in relationship to the waist and therefore were categorized as SP if they were laid flat and not flexed at the hips or NSP if they were noted to be “ramped” or “upright.” Both groups include patients with variable cervical spine positions including neutral position, simple extension, and full sniffing position. The current data form allows for selection from seven positions, which include fully upright, ramped with any of three neck positions, and supine with any of the same three neck positions. “Ramped” patient groups may include patients with both torso elevation from ramping the stretcher itself or creating a shoulder roll ramp that elevates the upper back and head as is commonly done for morbidly obese patients.

We compared categorical variables with the chi-square test and describe odds ratios (ORs) with respective 95% confidence intervals (CI) for binary variables. For continuous variables, such as saturation at the beginning of the intubation, we describe medians with interquartile ranges and compare the two cohorts with the Hodges-Lehmann’s median difference and the associated 95% CI. Adjusted ORs for the outcomes of first-pass success and desaturation during intubation were calculated using logistic regression. Patient and airway characteristics (age, sex, preintubation saturation, initial impression suggesting airway difficulty, reduced neck mobility, body habitus), intubator characteristics (specialty and level of training), and procedural characteristics (DL vs. VL and whether preintubation vasopressors were used) were included in the multivariable regression based on prior knowledge of their contribution to first-pass success. We included body habitus and whether the initial impression suggested a difficult airway in the regression analysis for desaturation during intubation, because patients with these characteristics are more likely to be placed in a NSP. Model fit was determined by assessing the Hosmer-Lemeshow fit statistic.

### RESULTS

#### Characteristics of Study Subjects

From January 1, 2016, through December 31, 2017, a total of 12,722 adult intubations were recorded and 11,480 intubations were included in the overall
analysis after exclusions (Figure 1). Most intubations, 94.2% (n = 10,815), were performed in SP, VL was used in 65.8% of intubations and DL in 34.2%. Patients with obese or very obese body habitus, patients with medical indications for intubation (as opposed to traumatic indications), patients with neck immobility, patients with a suspected difficult airway, and females were significantly more likely to be intubated in NSP (Table 1). Details regarding specific patient positioning relative to body habitus and method of intubation are included in Table 2.

**Main Results**

Overall first-pass success was 87.0% and was similar between NSP and SP cohorts (Table 3). Multivariable analysis showed no significant relationship between

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Nonsupine (n = 665)</th>
<th>Supine (n = 10,815)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>Median = 58, IQR 44–69</td>
<td>Median = 53, IQR 35–67</td>
<td>Median diff = 3.5 (2–5)</td>
</tr>
<tr>
<td>Oxygen saturation at start of intubation</td>
<td>Median = 100, IQR 98–100</td>
<td>Median = 100, IQR 97–100</td>
<td>Median diff = 0 (0–0)</td>
</tr>
<tr>
<td>Male sex</td>
<td>405 (60.9%)</td>
<td>7,279 (67.3%)</td>
<td>0.8 (0.6–0.9)</td>
</tr>
<tr>
<td>Obese or very obese body habitus</td>
<td>336 (50.5%)</td>
<td>3,436 (31.8%)</td>
<td>2.2 (1.9–2.6)</td>
</tr>
<tr>
<td>Trauma indication</td>
<td>28 (4.2%)</td>
<td>2,746 (25.4%)</td>
<td>0.1 (0.1–0.2)</td>
</tr>
<tr>
<td>Intubator training level (missing 260)</td>
<td>n = 647</td>
<td>n = 10,573</td>
<td></td>
</tr>
<tr>
<td>PGY1</td>
<td>108 (16.7%)</td>
<td>1,154 (10.9%)</td>
<td>1.6 (1.3–2.0)</td>
</tr>
<tr>
<td>PGY2</td>
<td>269 (41.6%)</td>
<td>3,475 (32.9%)</td>
<td>1.5 (1.2–1.7)</td>
</tr>
<tr>
<td>PGY3</td>
<td>191 (29.5%)</td>
<td>4,524 (42.0%)</td>
<td>0.6 (0.5–0.7)</td>
</tr>
<tr>
<td>PGY4</td>
<td>59 (9.1%)</td>
<td>913 (8.6%)</td>
<td>1.1 (0.8–1.4)</td>
</tr>
<tr>
<td>Fellow</td>
<td>3 (0.5%)</td>
<td>363 (3.4%)</td>
<td>0.1 (0.04–0.4)</td>
</tr>
<tr>
<td>Attending</td>
<td>17 (2.6%)</td>
<td>414 (3.9%)</td>
<td>0.7 (0.4–1.1)</td>
</tr>
<tr>
<td>Laryngoscopic device</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Video</td>
<td>420 (63.2%)</td>
<td>7,135 (66.0%)</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>Direct</td>
<td>245 (36.8%)</td>
<td>3,680 (34.0%)</td>
<td>1.1 (0.9–1.3)</td>
</tr>
<tr>
<td>Neck immobility (missing 14)</td>
<td>81 (12.2%)</td>
<td>3,099 (28.7%)</td>
<td>0.3 (0.3–0.4)</td>
</tr>
<tr>
<td>Initial impression suggests difficult airway (missing 21)</td>
<td>317 (47.7%)</td>
<td>3,570 (33.1%)</td>
<td>1.8 (1.6–2.2)</td>
</tr>
<tr>
<td>EM-trained intubator</td>
<td>6,326 (95.6%)</td>
<td>10,227 (94.6%)</td>
<td>1.3 (0.9–1.8)</td>
</tr>
<tr>
<td>Preintubation vasopressor used</td>
<td>33 (5.0%)</td>
<td>165 (1.5%)</td>
<td>3.4 (2–4.9)</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>1. C-spine Extension Only (Original Form), n = 2,098</th>
<th>2. Full Sniffing (Original Form), n = 4,396</th>
<th>3. Neutral C-spine (Original Form), n = 4,431</th>
<th>4. Upright (Original Form), n = 182</th>
<th>5. Ramped (Added Sept 2016), n = 411</th>
<th>6. Ramped and C-spine Extension (Added Sept 2017), n = 47</th>
<th>7. Ramped and Neutral C-spine (Added Sept 2017), n = 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>VL (n = 7,555)</td>
<td>413</td>
<td>1,045</td>
<td>916</td>
<td>69</td>
<td>149</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Obese/morbidly obese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal/thin/very thin</td>
<td>744</td>
<td>1,748</td>
<td>2,269</td>
<td>52</td>
<td>102</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>DL (n = 3,925)</td>
<td>257</td>
<td>507</td>
<td>298</td>
<td>15</td>
<td>66</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Obese/morbidly obese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal/thin/very thin</td>
<td>654</td>
<td>1,096</td>
<td>868</td>
<td>46</td>
<td>94</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>2,068</td>
<td>4,396</td>
<td>4,351</td>
<td>182</td>
<td>411</td>
<td>47</td>
<td>25</td>
</tr>
</tbody>
</table>

Positions 1, 2, and 3 comprise the SP group and positions 4,5,6, and 7 comprise the NSP group. C-spine = cervical spine; DL = direct laryngoscopy; NSP = nonsupine; SP = supine; VL = video laryngoscopy.
positioning and first-pass success. Factors independently associated with increased first-pass success in the multivariable analysis were emergency medicine–trained intubator, higher intubator level of training, and preintubation oxygen saturation. Factors independently associated with decreased first-pass success included initial impression suggestive of a difficult airway, reduced neck mobility or cervical collar presence, and use of DL (Table 4). After within-site clustering was adjusted for, reduced neck mobility was no longer independently associated with decreased first-pass success.

More patients experienced at least one adverse event in the NSP group (Table 3). This association persisted in a multivariable analysis that included position, body habitus, and suspicion of difficult airway (OR = 1.4 [95% CI = 1.1–1.7]). In the univariate analysis, hypoxia and hypotension were more common in the NSP group (Table 3) but in a multivariable analysis of the risk of hypoxia controlling for patient position, body habitus, and suspected difficult airway, NSP was not independently associated with increased odds of hypoxia (OR = 1.0 [95% CI = 0.8–1.3]). In the multivariable analysis obese body habitus (OR = 1.9 [95% CI = 1.7–2.3]) and suspected difficult airway (OR = 2.2 [95% CI = 1.7–2.5]) were independently associated with an increased risk of hypoxia. Data were missing for presence of hypoxia in 1,872 of 10,911 patients in the SP group and in 22 of 743 in the NSP group. Quantitative values for the lowest oxygen saturation were recorded in fewer than 10% of patients. Overall, intubators reported similar glottic views in SP and NSP groups; however, NSP was associated with increased odds of a Grade 1 view when DL was used (Table 5).

### Table 3
Summary of First-pass Success and Adverse Event Rates

<table>
<thead>
<tr>
<th></th>
<th>NSP (n = 665)</th>
<th>SP (n = 10,815)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First-pass success</td>
<td>583 (87.8%)</td>
<td>9401 (87.0%)</td>
<td>1.1 (0.7–1.5)</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>70 (10.5%)</td>
<td>775 (7.2%)</td>
<td>1.5 (1.2–2.0)</td>
</tr>
<tr>
<td>Postintubation bradycardia</td>
<td>8 (1.2%)</td>
<td>69 (0.6%)</td>
<td>1.9 (0.9–4.0)</td>
</tr>
<tr>
<td>Hypotension</td>
<td>47 (7.1%)</td>
<td>360 (3.3%)</td>
<td>2.2 (1.6–3.0)</td>
</tr>
<tr>
<td>Emesis/aspiration</td>
<td>3 (0.5%)</td>
<td>76 (0.7%)</td>
<td>0.6 (0.2–2.0)</td>
</tr>
<tr>
<td>Mainstem intubation</td>
<td>3 (0.5%)</td>
<td>32 (0.3%)</td>
<td>1.5 (0.5–5.0)</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>10 (1.5%)</td>
<td>87 (0.8%)</td>
<td>1.9 (1.0–3.6)</td>
</tr>
<tr>
<td>Any adverse event</td>
<td>121 (18.3%)</td>
<td>1287 (11.9%)</td>
<td>1.7 (1.3–2.0)</td>
</tr>
</tbody>
</table>

NSP = nonsupine; SP = supine.

### Table 4
Multivariable Analysis of First-pass Success

<table>
<thead>
<tr>
<th></th>
<th>Adjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonsupine positioning</td>
<td>1.1 (0.9–1.4)</td>
</tr>
<tr>
<td>Male sex</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>Preintubation oxygen saturation</td>
<td>1.004 (1.001–1.007)</td>
</tr>
<tr>
<td>Reduced neck mobility or cervical collar presence</td>
<td>0.8 (0.7–0.9)</td>
</tr>
<tr>
<td>Body habitus (obese or morbidly obese)</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>Initial impression suggests difficult airway</td>
<td>0.4 (0.3–0.5)</td>
</tr>
<tr>
<td>EM-trained intubator</td>
<td>1.9 (1.4–2.5)</td>
</tr>
<tr>
<td>Level of training</td>
<td>1.2 (1.1–1.2)</td>
</tr>
<tr>
<td>DL</td>
<td>0.4 (0.3–0.5)</td>
</tr>
<tr>
<td>Preintubation vasopressor used</td>
<td>1.4 (0.8–2.3)</td>
</tr>
</tbody>
</table>

Adjusted for clustering within center. DL = direct laryngoscopy.

### Table 5
Glottic View Based on Intubation Position

<table>
<thead>
<tr>
<th>Grade</th>
<th>NSP (n = 665)</th>
<th>SP (n = 10,815)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DL</td>
<td>140 (21.1%)</td>
<td>1,881 (17.4%)</td>
<td>1.3 (1.04–1.5)</td>
</tr>
<tr>
<td>VL</td>
<td>299 (45.0%)</td>
<td>5,136 (47.5%)</td>
<td>0.9 (0.8–1.1)</td>
</tr>
<tr>
<td>Grade 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DL</td>
<td>67 (10.1%)</td>
<td>1,169 (10.8%)</td>
<td>0.9 (0.7–1.2)</td>
</tr>
<tr>
<td>VL</td>
<td>82 (12.3%)</td>
<td>1,500 (13.9%)</td>
<td>0.9 (0.7–1.1)</td>
</tr>
<tr>
<td>Grade 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DL</td>
<td>25 (3.8%)</td>
<td>395 (3.7%)</td>
<td>1.0 (0.7–1.6)</td>
</tr>
<tr>
<td>VL</td>
<td>22 (3.3%)</td>
<td>292 (2.7%)</td>
<td>1.2 (0.8–1.9)</td>
</tr>
<tr>
<td>Grade 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DL</td>
<td>12 (1.8%)</td>
<td>230 (2.1%)</td>
<td>0.8 (0.5–1.5)</td>
</tr>
<tr>
<td>VL</td>
<td>17 (2.6%)</td>
<td>173 (1.6%)</td>
<td>1.6 (0.9–2.6)</td>
</tr>
</tbody>
</table>

DL = direct laryngoscopy; NSP = nonsupine; SP = supine; VL = video laryngoscopy.
In subgroup analyses of patients with a medical indication for intubation (see Table 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.13805/full) and obese patients with a suspected difficult airway intubated for a medical condition (see Table Supplement S2) results were similar to those for the full patient population. In the medical indication subgroup there was no longer a benefit with NSP relative to Grade 1 glottic views when DL was used. In patients with obesity and suspected difficult airways first-pass success rates were lower and adverse event rates higher than the overall population but these results were similar in both NSP and SP groups.

Unadjusted subgroup analyses based on body habitus and difficult airway suspicion were notable for better Grade 1 glottic views among nonobese patients in NSP compared to SP (OR = 1.3 [95% CI = 1.02–1.66]) and similar adverse event rates between NSP and SP among patients not suspected to have a difficult airway. All other results were similar to the full analysis (see Table Supplement S3).

**DISCUSSION**

Most ED intubations are performed in traditional SP and patients who were obese or who were suspected of having a difficult airway were more likely to be intubated in NSP. After multivariable analyses, we observed no significant differences between groups for first-pass success or overall glottic view but did observe higher rates of peri-intubation adverse events with NSP.

Our results for first-pass success contrast with other published studies. Turner et al. found significantly increased rates of first-pass success for each 5-degree increase in head of bed elevation, although this study is limited by its small sample size and single-center setting. In contrast, Semler et al. showed a lower first-pass success rate for patients in a “ramped” (head of bed at 25°) position in intensive care unit patients. Of note, rates of first-pass success for both groups in our study were comparable to the highest success rates in their studies. Multiple possible explanations exist for our findings. First, our results are observational and significantly more patients who were obese or who had suspected difficult airways were intubated in NSP. Obesity has been independently associated with decreased likelihood of first-pass success and increased likelihood of adverse events in an ED population. A second possible explanation is that intubator experience with upright or ramped positioning affects likelihood of first-pass success. These data are not available in the database used in our study and other studies offer conflicting data regarding this possibility. Turner et al. showed that experienced residents were more comfortable intubating patients in a back-elevated position but no association between first-pass success and intubator experience with specific patient positioning was seen by Semler et al. Another possibility is that the relatively high rate of use of VL (65.8% of all intubations) in our study (compared to 0%, 14% 20.8%, and 25% in other studies comparing positioning for emergent intubation) “leveled the playing field” to a certain degree given the significantly increased odds of first-pass success observed in our study with use of VL, which was used equally as often in SP and NSP groups.

Glottic views were not significantly different between groups overall but our results show that in nonobese patients or when DL is used NSP may be of benefit. Prior results examining the impact of positioning on glottic view have been mixed. Laryngeal and pharyngeal axis alignment should not change with elevation of the back, as long as bed height is adjusted for intubator height and head and neck positioning is appropriate. We believe that our results make intuitive sense and that elevation of the head of the bed should not result in worse glottic views as reported in other studies. As laryngoscopy device selection shifts toward routine use of VL in the ED, it may be that optimal glottic visualization will represent less of a challenge, regardless of patient position.

Adverse events were more likely in the NSP group in both univariable and multivariable analyses. We did observe similar rates of adverse events for patients without a suspected difficult airway in NSP and SP but this was an unadjusted analysis. Our results stand in contrast to recent inpatient studies showing significantly fewer adverse events with “back-up, head-elevated” position and equivalent rates of hypoxia with supine versus head of bed elevation. While overall rates of adverse events were similar to those reported in other large, multicenter, observational studies of ED patients, this is a surprising result given the theoretical benefits to head-up positioning, particularly with regard to hypoxia.

Like other studies directly comparing positioning and adverse events, hypoxia was the most common adverse event in our study in both groups. Semirecumbent positioning improves preintubation
oxygenation by displacement of vector force of the abdomen off the diaphragm, improved respiratory mechanics, and increased functional residual capacity, especially in obese patients.\textsuperscript{1–5} Given similar mechanics during intubation, we would have expected to see a lower incidence of desaturation in patients in NSP but instead observed similar rates between groups in a multivariable model. In a subgroup of patients with obesity, medical indication for intubation and a suspected difficult airway, starting oxygen saturations were significantly higher in NSP compared to SP as expected, since preoxygenation is optimized in the upright position and the effects of this are most striking in obese patients. Our results relative to rates of hypoxia are in contrast to recent studies specifically comparing positioning\textsuperscript{14,15} but differences in rates and degrees of hypoxia reported in these studies probably reflect, to some degree, the inherent differences in patient populations and preparation time between inpatient and ED settings. Other characteristics of previous studies including use of DL only\textsuperscript{14} and exclusion of patients requiring “intubation too urgently”\textsuperscript{15} further limit the direct comparison of those results to our study. Interestingly, the rates of hypoxia and hypotension in our study were much higher than those reported in other observational studies in the ED population.\textsuperscript{18,21} We observed increased preintubation vasopressor use in patients in the NSP group who also had higher rates of hypotension as an intubation-related adverse event. Lower preintubation oxygen saturations and blood pressures may be further indicators of a more severely ill subset of patients selected for NSP, perhaps contributing to the higher rates of adverse events seen in this group.

Notably, the only individual adverse event that was less likely in the NSP group was emesis/aspiration. Back-elevated positioning may be beneficial when treating patients in whom the risk of emesis and aspiration are increased such as massive hemoptysis, significant upper gastrointestinal bleeds, or severe bowel obstruction.

These findings suggest that nonsupine positioning is acceptable for emergency airway management even when clinical circumstances do not require it and might be the preferred position when aspiration risk is considered high, in obese patients, or when a difficult airway is suspected. However, a randomized, nonpragmatic trial comparing head of bed/torso position (without strict randomization of head/neck position) between fully supine and 30° to 45° of torso elevation would more specifically address the question of superiority of a specific torso position relative to first-pass success, glottic view, and related adverse events in the general ED population.

**LIMITATIONS**

Our study has several limitations. Although patients were enrolled prospectively, data were recorded after completion of the procedure. Retrospective reporting may have resulted in recall bias and degradation. This is observed most notably in recording of nadir oxygen saturation. The inability to determine to what extent patients may have desaturated limits the utility of this finding. Future studies would benefit from use of automated pulse-oximetry recorders or real-time recording of oxygen saturation and other variables by trained personnel not involved in performing the intubation.

The limited number of intubations performed in upright and each “ramped” position necessitated combining patients into a single group, NSP, for the purposes of comparison. Additionally, there was no specific definition of “ramped” relative to degree of torso elevation. Despite specific language in the data collection tool, it is possible the term may have been interpreted as only elevation to the head, neck, and upper back (through placement of shoulder rolls, for example) without elevation of the entire torso. As a result, we are not able to compare the various degrees of elevation in nonsupine positions. Head and neck positioning to achieve sniffing position with alignment of ear to sternal notch is generally accepted as best practice and our study did not intend to address head/neck positioning. The small number of patients intubated in NSP may also limit our ability to detect statistically significant differences in adverse events and first-pass success.

Our results are likely influenced by indication or selection bias given that providers could choose patient positioning based on clinical judgement or patient factors. The multiple significant differences in baseline characteristics between NSP and SP groups reinforce this likelihood. We included these variables in our regression model to control for many of these; however, we cannot account for all possible confounders or factors that may have contributed to patient positioning.

Finally, we chose to use a composite outcome for adverse events because of the relative infrequency of many of the individual adverse events for which data were collected. Composite outcomes are inherently limited by the fact that not all outcomes included in the composite are of equal importance (e.g., mainstem
intubation and cardiac arrest in this study) and that some outcomes may influence others.

**CONCLUSIONS**

The vast majority of orotracheal intubations in the ED using direct or video laryngoscopy were performed with patients in a supine position. Patients with morbid obesity and predicted difficult airways were more likely to be intubated in a nonsupine position. First-attempt intubation success and overall glottic views were similar between groups with more adverse events in the NSP group. A randomized trial in the ED setting is warranted to further determine effects of patient positioning during emergent intubation and whether routine use of supine positioning should be reconsidered.

**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.13805/full

Data Supplement S1. Supplemental material.
Study Monitoring in Emergency Care Trials: Lessons from the Resuscitation Outcomes Consortium Continuous Chest Compressions Trial

Robert H. Schmicker, MS1,2, Graham Nichol, MD, MPH2, Clifton W. Callaway, MD, PhD3, Sheldon Cheskes, MD4, George Sopko, MD5, and Henry E. Wang, MD, MS6

ABSTRACT

Objective: Clinical trial investigators often assemble internal study monitoring committees (SMCs) to measure individual or group adherence with trial performance benchmarks. We examined the processes and results of study monitoring in an international trial of out-of-hospital cardiac arrest.

Methods: We studied SMC operations for the Resuscitation Outcomes Consortium (ROC) Continuous Chest Compressions (CCC) trial, which compared continuous with interrupted chest compressions upon survival after out-of-hospital cardiac arrest. The SMC defined trial performance benchmarks, which included compliance with the intervention, cardiopulmonary resuscitation (CPR) process data availability and timely data completion. Trial investigators received monthly performance reports. We determined rates of trial noncompliance and suspension from the trial.

Results: ROC-CCC enrolled a total of 23,711 subjects in the primary analysis population. Across 113 enrolling agencies, the SMC monitored performance for a total 2,367 agency-months. Emergency medical services agencies were on probation for a total of 178 (7.5%) agency-months. Fifty-five agencies were placed on probation at least once, of which 78% improved their performance and were approved for continued

From the 1Clinical Trial Center, Department of Biostatistics; and the 2Departments of Medicine and Emergency Medicine, University of Washington, Seattle, WA; the 3Department of Emergency Medicine, University of Pittsburgh, Pittsburgh, PA; the 4Division of Family and Community Medicine, Division of Emergency Medicine, University of Toronto, Toronto, Ontario, Canada; the 5National Heart, Lung, and Blood Institute, Bethesda, MD; the 6Department of Emergency Medicine, The University of Texas Health Science Center at Houston, Houston, TX.

Received February 18, 2019; revision received May 2, 2019; accepted May 29, 2019.

The ROC was supported by a series of cooperative agreements with 10 regional clinical centers and one data coordinating center (U01 HL077863—University of Washington Data Coordinating Center, HL077865—University of Iowa, HL077866—Medical College of Wisconsin, HL077867—University of Washington, HL077871—University of Pittsburgh, HL077872—St. Michael’s Hospital, HL077873—Oregon Health and Science University, HL077881—University of Alabama at Birmingham, HL077885—Ottawa Hospital Research Institute, HL077887—University of Texas Southwestern Medical Center/Dallas, HL077908—University of California at San Diego) from the National Heart, Lung, and Blood Institute in partnership with the National Institute of Neurological Disorders and Stroke; U.S. Army Medical Research and Material Command; the Canadian Institutes of Health Research-Institute of Circulatory and Respiratory Health; Defense Research and Development Canada; the Heart and Stroke Foundation of Canada; and the American Heart Association.

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Heart, Lung, and Blood Institute or the National Institutes of Health.

GN receives salary support from the University of Washington, via the Leonard A Cobb Medic One Foundation Endowed Chair in Prehospital Emergency Care. The Medic One Foundation raises funds to promote improvements in prehospital emergency care. He receives support from Abiomed Inc., GE Healthcare Inc., and ZOLL Medical Corp. He is a consultant to GE Healthcare, Kestra Medical Technologies Inc., and ZOLL Circulation Inc. He has assigned provisional patents for nonimaging ultrasound and for a combination product to modify reperfusion injury to the University of Washington, SC has received honorarium for educational lectures on CPR quality from Zoll Medical and Physio Control, SC has received grant funding from the Laerdal Foundation for the DOSE VF pilot RCT. SC sits on the advisory board of Drone Delivery Canada. The authors have no relevant financial information or potential conflicts to disclose.

Author Contributions: PS—analysis and interpretation of data, drafting of manuscript, statistical expertise; HW—critical revision of the manuscript for important intellectual content, study concept and design; GN, CC, SC, GS—critical revision of the manuscript for important intellectual content.

Supervising Editor: D. Mark Courtney, MD.

Address for correspondence: Henry E. Wang, MD, MS; e-mail: henry.e.wang@uth.tmc.edu. Reprints will not be available.

ACADEMIC EMERGENCY MEDICINE 2019;26:1152–1157.

ISSN 1553-2712 © 2019 by the Society for Academic Emergency Medicine
doi: 10.1111/acefm.13810
participation in the trial. A total of 12 agencies were suspended from trial participation. Data monitoring resulted in high-quality CPR (mean chest compression fraction = 0.80), 87% CPR process availability and timely data completion (75th and 95th percentiles prehospital data = 22 and 57 days; hospital data = 58 and 118 days).

Conclusions: Study monitoring procedures may play an important role in ensuring the performance quality in acute care clinical trials.

Ensuring high-quality data is an important goal of a clinical trial. Accurate and complete data regarding patient screening, enrollment, randomization compliance, protocol compliance, and patient outcomes increase confidence in trial findings and conclusions.1 To help improve data quality, investigators sometimes assemble internal study monitoring committees (SMCs) to measure performance and conduct of the trial. Operating separately from the data safety monitoring board (DSMB), the SMC reviews the performance of individuals or groups of providers participating in a trial and ensures adherence with defined performance benchmarks. Both SMC and the DSMB can be empowered to improve or suspend study participation.

The conduct of clinical trials by out-of-hospital emergency medical services (EMS) poses additional challenges. EMS care occurs in a less controlled environment than the clinic or hospital. EMS patients are often critically ill and require split-second clinical decisions or interventions. EMS care is often delivered by paramedics, emergency medical technicians, or firefighters, with only limited real-time access to physician level input or intervention. Furthermore, the resources for patient assessment, monitoring, and care delivery are limited in the out-of-hospital setting. EMS patients who are critically ill are typically incapacitated and unable to provide meaningful informed consent. Thus, such trials are conducted in the United States under federal rules for exception from informed consent (EFIC). The trial enrolled a total of 23,711 subjects in the primary analysis population from June 6, 2011, to May 28, 2015. The trial found no difference in survival to hospital discharge between CCC (9.0%) and ICC (9.7%).

Establishment of the SMC

The full SMC Charter is available in 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.13810/full). The intent of the SMC was to create standards for acceptable adherence to protocols, to establish guidelines for improved performance, to provide feedback to investigators about ongoing performance, and if necessary, to recommend suspension of agencies from the clinical trials. The consortium

METHODS
The ROC-CCC Trial

The ROC-CCC trial compared the effect of two strategies of cardiopulmonary resuscitation (CPR) chest compressions (continuous vs. interrupted chest compressions [ICC]) upon survival after out-of-hospital cardiac arrest. CCC consisted of three segments of chest compressions lasting 2 minutes (or 200 chest compressions) with ventilations delivered by bag-valve-masks after every 10th compression; there were no interruptions for ventilation. ICC followed the same strategy, but with a full pause after every 30 chest compressions to deliver two full ventilations. Concurrent interventions included early intravenous or intraos- eous access with delivery of epinephrine or vaso- pressin. Endotracheal intubation or supraglottic airway insertion was delayed until the completion of the three epochs of chest compressions.4,5

A total of 104 EMS agencies across eight regional coordinating centers (RCCs), referred to as “sites,” participated in the study. The agencies were divided into 151 randomization clusters consisting of individual emergency vehicles, groups, ambulances, or entire EMS agencies. Clusters were randomly assigned to either CCC or ICC with crossover or rerandomization every 6 months. The trial was conducted under federal rules for EFIC. The trial enrolled a total of 23,711 subjects in the primary analysis population from June 6, 2011, to May 28, 2015. The trial found no difference in survival to hospital discharge between CCC (9.0%) and ICC (9.7%).

Establishment of the SMC

The full SMC Charter is available in 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.13810/full). The intent of the SMC was to create standards for acceptable adherence to protocols, to establish guidelines for improved performance, to provide feedback to investigators about ongoing performance, and if necessary, to recommend suspension of agencies from the clinical trials. The consortium
appointed members of the SMC, including: 1) principal investigators (PIs) from four sites, 2) the two lead study chairs, 3) a National Institutes of Health program manager, and 4) the data coordinating center (DCC) PI. Statisticians and clinical coordinators from the DCC participated on the committee to provide performance information but did not have any voting capacity. One of the four site PI’s served as chair of the SMC for the duration of the trial.

Development of Benchmarks for the ROC-CCC Trial

The SMC developed performance benchmarks for the trial (Data Supplement S1, Appendix S2). Factors driving the selection of quality measures and definition of benchmarks included: 1) endpoints that were easily measured, 2) measures that were relevant to the trial interventions or the scientific quality of data, and 3) standards that were tied to supporting scientific evidence. The lead investigators for the trial and the SMC members agreed on benchmarks by consensus prior to examining performance data. Study group compliance pertained to whether CPR was performed consistent with standards of each CPR protocol. For example, did patients on the CCC arm have long segments of chest compressions with few interruptions or were there many small segments with many interruptions? To be considered compliant on either CCC or ICC arm, the percentage of time actively giving compressions (i.e., chest compression fraction [CCF]) had to be higher than predetermined thresholds (>0.80 and >0.60, respectively) in 75% of minutes. In addition, mean CCF had to be greater on the CCC arm than the ICC arm across all cases at the agency. These CPR performance benchmarks are important since noncompliance can affect trial results.

Compliance to data availability was defined by whether data were captured and entered at appropriate rates. To judge compliance, CPR data captured by an electrocardiogram (ECG) device had to be available. If the files were downloaded by the agencies, they (along with non–CPR-related data) had to be entered by site coordinators to the DCC in a timely manner. These criteria were important to ensure objective and timely monitoring of data. In addition, timely capture and entry of the primary outcome—survival to hospital discharge—was important for the quality and interpretation of the study results. Finally, preshock pause compliance pertained to whether the length of pause prior to delivery of a shock was consistent with previous studies that showed an association with pauses < 10 seconds and increased survival. This was important not just because of the previous scientific association but also because it promoted quality CPR.

Performance Assessment. On monthly conference calls, the SMC reviewed monitoring reports prepared by the DCC. Reports focused on specific benchmark data and were stratified by the respective monitoring unit (e.g., agency or cluster). Reports had a 2-week lag to avoid review of severely incomplete data. Missing or late enrollment were flagged as being out of compliance on future reports. To minimize conflicts of interest, SMC members were recused from participating in discussions or decisions related to EMS agencies from their own RCC.

The SMC first evaluated and approved EMS agencies advancement from run-in to active enrollment phase. The trial specified a run-in phase of no more than 6 months. Patients enrolled in the run-in phase were monitored for compliance and safety, but not included in the primary analysis. Once the agencies showed proficiency with the randomized intervention via meeting of objective run-in phase benchmarks (Data Supplement S1, Appendix S3), they were moved to the evaluable phase. The SMC performance guidelines stipulated that the SMC recommended that EMS agencies who had not progressed out of run-in phase within 6 months to be dropped from the trial.

The SMC then monitored the performance of EMS agencies in the active enrollment phase. These assessments were based upon DCC reports summarizing performance by each EMS agency and site for two time frames, 1) cumulative performance and 2) last-60-day performance; both were artifacts from previous ROC trials benchmarks. After each SMC meeting, the SMC chair provided written summaries of any performance that was below benchmarks to the RCC investigator responsible for the EMS agency. In addition, the SMC identified the lowest performing agencies for any metric, even if performance met the benchmarks, and provided feedback to encourage better performance. Finally, the SMC summarized the patterns of study conduct and performance and recommended specific action items to the executive committee on a regular basis.

The SMC placed agencies on probation if they failed to meet the same benchmark in both the cumulative and the 60-day time frames. Agencies placed on probation continued to enroll in the trial with patients still included in the primary analysis. The SMC asked
results of study monitoring for the ROC-CCC trial. These suggest that study compliance benchmarks may have utility in both detecting gaps in trial performance as well in fostering improved trial practices. While many studies have examined the role and importance of external data monitoring committees or safety boards, to the best of our knowledge no reports have examined the role and importance of study compliance monitoring committees.

Our experience from the ROC-CCC trial yielded important lessons to regarding clinical trial oversight. First, the definition of and application of benchmarks is essential in a clinical trial. Our experience resulted in the detection of underperformance in 7.5% of agency-months as well as fostering improvement study performance. The ability to promptly collect and
report data is essential for providing timely and accurate clinical trial performance feedback. In this study, the process of identifying a performance shortfall to facilitating communication to the site PI to implementation of remedial actions at the EMS agency could require 3 to 4 months; issues were often 2 months “old” by the time the EMS agency received communication of the concern. The crossover design also impacted this process. For example, by the time an EMS agency learned of a performance shortfall, they may have already crossed over to the alternate treatment arm, precluding efforts to remediate the issue.

In remediating trial performance, one must recognize that participating entities have very different organization, culture, and systems of care. Remedial action plans likely need to be individualized to account for these differences. In the CCC trial, EMS agencies devised remedial action plans; the SMC did not dictate the elements of such plans. Future trials may find merit in allowing for variability in plans in as local investigators will likely know what will effective in their agencies.

The definition of performance benchmarks requires careful consideration in a clinical trial. Study benchmarks should be developed collaboratively with participating entities to ensure their support and “buy-in.” Monitoring requirements and the potential to be dropped from the trial should be made clear prior to the start of trial enrollment, potentially even during the planning phase. Candidate study benchmarks should be related to the central scientific premise of the study, be easily and objectively measured, be robust enough to detect underperformance as well as performance improvement, and have ties to scientific evidence. For example, some investigators expressed concern that the pre-shock pause benchmark did not meet these standards because it was based on data from an observational study and were difficult to achieve since they were monitored only on the subset of patients who had a shockable rhythm (approximately 20%-25% of all treated patients). Benchmarks must also be interpretable across a range of study enrollment settings. A challenge in this trial was the small monthly number of cases enrolled by select

![Table](image1.png)

**Figure 1.** Example ROC SMC probation history grid. Green = enrolling; yellow = probation; red = suspended. ROC = Resuscitation Outcomes Consortium; SMC = study monitoring committee.
EMS agencies, making it difficult to assess compliance. For example, all benchmarks were difficult to interpret if an EMS agency enrolled only one subject in a given month; a low-volume EMS agency may never be able to meet performance benchmarks.

The impact on trial enrollment resulting from agency exclusion is an important consideration during a trial. While excluding participating agencies may prolong the length of the trial, this impact will vary with the size of the agency. These considerations naturally influenced SMC discussions, as some investigators voiced concern about monitoring inequity. Future trials should assess the impact of study performance upon the planned duration of study enrollment.

An important consideration is deciding who will perform study monitoring. In this study, the study monitoring committee was made up of participating site investigators, creating potential conflicts of interest between study monitoring decisions. Furthermore, no additional funding was provided for these services. An independent entity may be better positioned to fairly assess study performance as well as to recommend corrective actions. However, the presence of site investigators brought perspectives of trial logistics that were not obvious from the aggregate performance data. Investigators of future efforts may find merits in a hybrid system consisting of independent persons complemented by select study personnel.

For the subsequent ROC Pragmatic Airway Resuscitation Trial (PART), study monitoring procedures were informed by experience in the ROC-CCC trial. The primary protocol performance benchmark was compliance with assigned treatment arm; the study organizers opted to not to include other candidate benchmarks because they could not be reliably measured (e.g., time of airway management attempts) or were not well linked to the study’s objectives (e.g., quality of CPR chest compressions). The study organizers developed performance benchmarks that could be interpreted in both high- and low-volume agencies; for example, the benchmarks allowed no more than 85% or no more than four noncompliant cases in a 60-day window. The study also appointed a neutral party to chair the study monitoring proceedings.

**CONCLUSION**

Study monitoring procedures influenced the execution of the Resuscitation Outcomes Consortium-Continuous Chest Compressions trial. Study monitoring procedures may have an important role in ensuring the performance quality of emergency care trials.

**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.13810/full

Data Supplement S1. Supplemental material.
Public Deliberation as a Novel Method for an Exception From Informed Consent Community Consultation

Patricia E. Powers, MPA1, Karen K. Shore, PhD1, Susan Perez, PhD, MPH1, Dominique Ridley, MPH1, Nathan Kuppermann, MD, MPH2, James F. Holmes, MD, MPH2, Leah S. Tzimenatos, MD2, Hiwote Shawarga2, and Daniel K. Nishijima, MD, MAS2

ABSTRACT

Objectives: Community consultation is required for clinical trials considering federal exception from informed consent (EFIC) procedures. Questions remain about the value of the community consult process and whether it adds intended protections to study subjects. Public deliberation methods that provide baseline participant education and elicit values and opinions about consent options is a novel approach for community consultation. This study evaluated the use of structured public deliberation methods to assess a community’s values and opinions about informed consent procedures for a pediatric trauma trial.

Methods: This was a mixed-methods descriptive study of public deliberation sessions assessing participants’ opinions about informed consent procedures for a pediatric trauma randomized controlled trial (RCT). Participants from communities with high rates of pediatric trauma were recruited via community-based organizations and social media. Deliberation focused on three consent options for a proposed RCT: 1) enrollment using EFIC procedures with no attempt to obtain informed consent, 2) enrollment using EFIC procedures after attempting to reach a parent, or 3) enrollment only with informed consent. Participant demographic data and their opinions about the proposed study and deliberative session were also collected.

Results: There were 102 participants across eight sessions (range of nine to 15/session, mean of 13). Most participants were female (n = 78, 76%) and a plurality were black (n = 48, 47%). The majority of participants preferred enrollment using EFIC procedures only after an attempt was made to reach a parent and informed consent was not possible (n = 56, 55%), followed by enrollment using EFIC procedures with no attempt to obtain informed consent (n = 32, 32%), and enrollment only with written informed consent (n = 13, 13%). One participant declined all options. Eighty-four participants (82%) agreed or strongly agreed that the RCT was...
important to do, and 79 participants (77%) said that the sessions provided enough information to make an informed decision about the proposed RCT.

Conclusions: Structured public deliberation is an effective approach when consulting communities for trials considering EFIC procedures. Future studies are needed to evaluate whether public deliberation methods provide participants with enhanced understanding of clinical trials compared to other community consultation methods.

Patients with life-threatening injuries are frequently unable to consent to research that may inform improved care delivery and health outcomes. This presents emergency care researchers with the ethical challenge of balancing patient autonomy with the need for evidence-based investigations to identify the most effective treatments. The uncommon, but essential, use of the federal exception from informed consent (EFIC) in emergency care research helps achieve a balance between these two important perspectives. Research using EFIC judiciously has provided valuable evidence for improving patient care and health outcomes over the past 20 years.1–3

Exception from informed consent regulations, promulgated by the Food and Drug Administration (FDA) in 1996, permit research in populations unable to give prospective, informed consent due to life-threatening and time-sensitive illness and injuries. However, EFIC regulations do not standardize guidelines or methods for obtaining community input, a key component to the EFIC approval process.4–6 The requirement to conduct community consultation as part of an EFIC application provides an added level of protection for potential study subjects by soliciting community input on the research. This patient proxy input demonstrates respect for community concerns through a bidirectional communication path between researcher/institution and community/study subject.6

Questions remain about the value of the EFIC community consult process and whether it adds intended protections to study subjects.7–9 The evidence of effectiveness of community consultation is ambiguous. Some studies note that the community consultation process is resource-intensive and costly with questionable value.4,10,11 Others report participants’ high satisfaction and acceptance of EFIC through the community consultation process.5,12–14

One validated method that appears to be unexplored, but well matched to the goals of the EFIC process, is public deliberation.15 This qualitative methodology elicits informed public opinion and understanding of ethical and social values. Public deliberation can be especially inclusive of underrepresented groups, bringing the public’s views to decision makers regarding complex social issues. Three primary characteristics differentiate public deliberation from other research methods: 1) the topic is an ethical or value-based dilemma requiring an active exchange of reasons and justifications for preferences, opinions, or values; 2) participants are members of the public who are encouraged to take a societal viewpoint rather than a personal viewpoint, not people with a vested interest or expertise in the topic; and 3) participants are presented with unbiased evidence to inform discussion and positions.15 A bioethics researcher explains that it is a unique method that facilitates the opportunity for community members to “develop, examine, and challenge their own views.”16 The methodology may use a variety of techniques (e.g., case studies, surveys, focus groups); however, all use educational materials and content experts, and all encourage participants to cross-examine experts and peers.

Although public deliberation is used in bioethics research, its use lags in health services research, including emergency care research. This case study employing public deliberation methods aims to demonstrate its application to the community consultation process when informed consent is infeasible. Public deliberation may strengthen the community consultation process as well as the enrollment protocol for a clinical trial.

METHODS

Study Design
We conducted a mixed-methods study that included 1) surveys and 2) public deliberative sessions with community members living within the geographic area served by a Level I trauma center where a pediatric randomized clinical trial (RCT) seeking EFIC is being conducted. Participant demographics were collected. Quantitative methods included surveys with questions about emergency department (ED) use, whether the RCT was important to perform, whether the participants would be willing to have their child included in the study without parental/legal guardian consent, whether they had enough information to give an opinion about the study proceeding, and whether they thought researchers would seriously consider
community input. The qualitative component consisted of participants deliberating about different approaches related to parental informed consent for a blood-clotting drug that may help pediatric patients after a physical traumatic injury; the drug must be administered within a 3-hour time frame to be effective. Participants were asked to respond as decision makers representing their communities and ultimately voted on the acceptability of three predetermined resolutions to the problem. The study was approved by the university’s institutional review board (IRB).

**Study Setting, Recruitment, and Population**

We used community-based organizations (CBOs) and social media to recruit 102 participants in communities that historically experienced relatively high pediatric ED use at a local Level I trauma center. Target geographies were identified by reviewing historical data on pediatric trauma use of the tertiary center’s ED by zip code.

Because many of the target geographic areas are lower income, CBOs within these areas that are viewed as trusted sources were enlisted to assist with recruitment. CBOs deployed a variety of methods to recruit eligible participants, including e-mails, phone calls, flyers, and face-to-face invitations. Sessions were held on site at the CBOs.

To ensure patient confidentiality CBOs are not named here; however, they included a nonprofit for sustainable housing; two youth organizations in different communities that counsel and provide services to underserved youth; an advocacy organization based in a low-income community that manages multiple programs, including the Centers for Disease Control and Prevention REACH program—Racial and Ethnic Approaches to Community Health; a family resource center; and a counseling center with programs and resources primarily serving a Hispanic community.

Three groups were recruited through social media using targeted Facebook groups (e.g., Good Neighbors of [name of city]) and the Nextdoor social media application. Although there was a slightly higher “no response rate” when we circled back to confirm participation with social media recruits, we compensated for that by accepting additional people for those sessions to reach our goal of 12 to 15 participants per 2-hour session. Sessions with social media recruited participants were held in community spaces (e.g., a community center, university conference room). All of the recruitment methods were low cost.

Eight deliberative sessions were conducted: six groups of adults at least 25 years old who had a child under 18 years of age and two groups of youth aged 16 to 18 years (because teens are at higher risk for traumatic injury than younger children and are close to study consent age). A mean of 13 people attended each 2-hour session (range nine to 15 participants), and each participant received a $50 gift card.

**Study Protocol**

We started each session with an explanation of EFIC community consultation and the participants’ role as representing the perspectives of their communities. Facilitators (PEP, KKS, SP, and DR), trained in qualitative research, including public deliberation methods, reviewed and discussed an educational handout defining medical research, the purpose of research, RCTs (including placebo and intervention arms), and informed consent. We developed the handout with input from emergency care physicians and health services researchers. Participants discussed the educational materials in small groups as well as collectively with facilitators.

Facilitators read a description of the study requiring the community consultation. The facilitators provided information on pediatric traumatic injury, including the current standard of care, the current evidence on the efficacy of the study drug to facilitate blood clotting in adults experiencing trauma, and the potential yet unknown benefits and risks of using this drug to treat pediatric traumatic injury. Similar to the development of the educational materials, emergency care physicians and health services researchers provided input to ensure clinical accuracy and clarity of the of the study description. Participants were encouraged to ask questions of the emergency care physician (attending five of eight sessions); in the absence of a physician, facilitators read factual information written by an emergency care physician that addressed questions raised in prior deliberative sessions.

Participants were presented with three potential options if a study-eligible child arrives at the ED: 1) the physicians immediately enroll the child in the study without seeking parental consent; 2) the physicians attempt to contact the parents for up to 3 hours, which is the window of effectiveness for the drug to be administered, and if the physicians are unsuccessful in reaching a parent, enroll the child in the study using EFIC; and 3) the physicians must obtain consent before enrolling the child, which means the child will not be
enrolled if the parent cannot be reached. For options 1 and 2, once the patient is stabilized and the parent available, the physicians would initiate the informed consent process. Parents would be able to disenroll their child from the study at that time. Although the child may have already received the study drug, disenrolling the child would mean that the child would not participate in any follow-up specific to the study.

After the facilitators read the options aloud, participants were asked to choose the most acceptable option. On a visible flipchart, the cofacilitator recorded each participant’s selection. Participants then discussed and deliberated the choices; some people changed their minds or proposed alternatives or modifications to the options. During the initial pre-EFIC trial period of the RCT, researchers learned that many parents of eligible children were driving long distances to reach the ED after they learned of the injury; discussion of this issue was incorporated into subsequent deliberative sessions.

Quantitative and Qualitative Analyses
Quantitative survey analysis consisted of descriptive statistics (means and frequency distributions). The number and percentage of participants who favored the various options were central to assessing results. Initial votes at each session were tallied across the three options after the educational portion of the session, followed by a tally of final votes at the close of deliberation. The purpose of the second vote was to see whether any participant(s) changed their mind following the group discussion where elaboration of alternative viewpoints often occurred.

With participant permission, session discussions were audio-recorded and detailed written notes taken at each session. All of these were analyzed using inductive, grounded theory methods. Three project team members experienced in reviewing and coding qualitative data conducted a theme analysis. The theme analysis focuses on the reasons and values given by participants for why certain options were more or less desirable and how others’ comments influenced their perspectives. By the last session, no new themes were emerging.

RESULTS

Demographics and Survey Analysis
Of the 102 individuals who participated in one of eight deliberative sessions, about one-quarter were under age 18 (two discussion groups were composed only of youth ages 16–18 years), with most of the remainder over age 25 (Table 1). Participants were predominantly female and non-Hispanic, black or white race, with an education level at some college or more.

Survey Results
Most participants (72%) knew someone who had a severe life-threatening injury and had to go to the ED—either for themselves, a child, or other family members or friends. Among those participants, 75% reported knowing two or more such people.

Participants agreed that the pediatric trauma RCT is important to perform, with 82% agreeing or strongly agreeing. Parental desire for inclusion of their child into the study without consent is shown in Table 2 with over half agreeing. Consistent with this, 65% indicated that they would not want their child excluded from the study.

<table>
<thead>
<tr>
<th>Table 1: Demographic Characteristics of Participants (n = 102)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
</tr>
<tr>
<td>16–18</td>
</tr>
<tr>
<td>18–25</td>
</tr>
<tr>
<td>26–35</td>
</tr>
<tr>
<td>36–45</td>
</tr>
<tr>
<td>46–55</td>
</tr>
<tr>
<td>&gt;55</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td><strong>Race</strong></td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>More than one race</td>
</tr>
<tr>
<td>Missing</td>
</tr>
<tr>
<td><strong>Ethnicity (Hispanic/Latino)</strong></td>
</tr>
<tr>
<td>Hispanic/Latino</td>
</tr>
<tr>
<td>Not Hispanic/Latino</td>
</tr>
<tr>
<td>Blank/don’t know</td>
</tr>
<tr>
<td><strong>Highest level of school completed</strong></td>
</tr>
<tr>
<td>Still in high school</td>
</tr>
<tr>
<td>Didn’t finish high school</td>
</tr>
<tr>
<td>High school</td>
</tr>
<tr>
<td>Some college or associate’s degree</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
</tr>
<tr>
<td>Master’s degree or doctorate/professional degree</td>
</tr>
</tbody>
</table>

Data are reported as n (%).
More than three-quarters (77%) responded that they had enough information to give an informed opinion about researchers conducting the RCT. Among those who responded that they did not have enough information, several said they would like to see more specifics on prior research in this area (e.g., patients who were involved in studies in other countries, potential side effects and long-term effects of the drug, dosing for children versus adults), more detail about the ingredients in the drug and how it is administered, and samples of the RCT notifications that would be sent to the community. Several respondents also asked what ED physicians thought about the study and whether they would want one of their family members to participate. About 70% of participants responded that researchers would seriously consider community input into the study design.

Each participant in the deliberative groups was asked to select one of three options that best aligned with how they thought children should be enrolled in a future RCT to assess the effectiveness of a blood clotting drug for traumatic injury. Most participants (55%, n = 56) supported option 2 requiring physicians to attempt to obtain consent; this was true both within and across sessions except for groups 2 and 7 (Table 3). Option 1 ranked second with 32% (n = 32) supporting immediate enrollment of eligible children in the study. This result is consistent with the survey response of 31% (n = 32) strongly agreeing that they would be okay with researchers enrolling the participant’s own child without obtaining their consent ahead of time. Option 3 mandating that parental consent be obtained ranked third (13%, n = 13). This is also consistent with the survey responses of 8% of parents strongly disagreeing and 10% disagreeing that it was acceptable for researchers to enroll their child without obtaining their consent. (One participant declined all three options.)

Twelve participants changed their votes after discussion. Ten changed from option 2 to option 1; thus, option 1 increased by nine percentage points after the discussion.

Key reasons and values that arose during the deliberative session for each option are listed in Table 4 and described in detail below. Specific themes shown in Table 4 were discussed by four or more groups; other themes discussed by a smaller number of groups are described in the narrative sections following Table 4.

Table 2: Postdeliberation Survey Questions about the Pediatric Trauma RCT (n = 102)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>Depends</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you are/were a parent and your child had a severe life-threatening injury, you would be okay with him/her being included in the RCT without giving your consent ahead of time.</td>
<td>32 (31)</td>
<td>26 (25)</td>
<td>22 (22)</td>
<td>10 (10)</td>
<td>8 (8)</td>
<td>1 (1)</td>
<td>3 (3)</td>
</tr>
<tr>
<td>Would you like to tell doctors that you do not want your child to participate in the RCT?</td>
<td>Yes 33 (32)</td>
<td>No</td>
<td>Neutral</td>
<td>1 (1)</td>
<td>Missing 2 (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you feel that you have been given enough information to give your informed opinion about whether you think it is OK for researchers to do the RCT?</td>
<td>Yes 79 (77)</td>
<td>No</td>
<td>Missing</td>
<td>1 (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you think that the RCT researchers will seriously consider what community members like you have to say about this study before starting it?</td>
<td>Yes 71 (70)</td>
<td>Don’t know</td>
<td>Yes/don’t know</td>
<td>1 (1)</td>
<td>Hope so 1 (1)</td>
<td>Missing 1 (1)</td>
<td></td>
</tr>
</tbody>
</table>

Data are reported as n (%).

Table 3: Participant Choice of Consent Options at Completion of Public Deliberation Process

<table>
<thead>
<tr>
<th>Group</th>
<th>Option 1: Immediate Enrollment</th>
<th>Option 2: Attempt to Get Consent</th>
<th>Option 3: Must Obtain Consent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>10</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>11</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>7</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>8</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>56</td>
<td>13</td>
<td>101</td>
</tr>
<tr>
<td>Percent</td>
<td>32</td>
<td>55</td>
<td>13</td>
<td>100</td>
</tr>
<tr>
<td>Consent Option</td>
<td>Theme</td>
<td>Quotes</td>
<td>Group Number</td>
<td>Total No. of Groups Mentioned Theme</td>
</tr>
<tr>
<td>----------------</td>
<td>-------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>1: Immediate enrollment</td>
<td>Time is of the essence</td>
<td>“My home boy [friend who was shot] died this year from bleeding out—this medicine could have helped him. Bled out as soon as soon he got into the ambulance—if this drug exists and could help, don’t wait. Just do it. Don’t waste time at the scene asking questions.” (youth participant)</td>
<td>x x x x x x x x</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Save child at all possible costs</td>
<td>“In a perfect situation, you want to weigh the possibilities, but if there is something to save that child’s life, then we would do it. We would go with immediate enrollment because it is in the best interest of that child.” (adult participant)</td>
<td>x x x x x x x x</td>
<td>7</td>
</tr>
<tr>
<td>2: Attempt to get consent</td>
<td>Importance of patient choice balanced with potential to save life</td>
<td>“At first I was going to pick option 1, but I thought that I would at least want to know the hospital tried to contact me before giving an experimental drug.” (adult participant)</td>
<td>x x x x x x x x</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Doctors may not know important medical history information that may affect drug administration</td>
<td>“I would also want to know the information because my son does have a long medical history. When I take him to the emergency room, I have to give a high level history and doctors don’t see that because it’s so far back in his medical history. I worry them not knowing everything about his medical history.” (adult participant)</td>
<td>x x x x x x x x</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Religious beliefs/values need to be respected</td>
<td>“There are a lot of people that have different religions and what if they [doctors] gave the medications and they [parents] didn’t want them. That would be a huge dilemma. I’ve been through it.” (Youth Participant)</td>
<td>x x x x x x x x</td>
<td>7</td>
</tr>
<tr>
<td>2a amended</td>
<td>Time is of the essence, but at least try to make contact</td>
<td>“If you are not going to reach them in one hour, you are not going to reach them in two hours.” (Adult Participant)</td>
<td>x x x x x x x x</td>
<td>7</td>
</tr>
<tr>
<td>3: Must obtain consent</td>
<td>People must be given a choice so that personal values will be respected</td>
<td>“Anytime you are changing a treatment, that consent is important to me. When you go into a hospital and you can decide for yourself you can feel confident in the outcome. If someone makes the choice for you, then you are not as confident about that outcome. What if they don’t get the drug, or what if they have a reaction to a high dose. Ethically, it’s unsettling to me because you don’t have a choice. It sounds like a positive treatment and I might choose it for my daughter.” (Adult Participant)</td>
<td>x x x x x x x x</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Skeptical of the medical establishment/There is a history of unethical research studies particularly with African American participants</td>
<td>“Now I am thinking about the Tuskegee study, and I feel like I am putting my children on something like that, and I am giving consent to something I don’t even know about. You’re asking a medical idiot to decide if doctors should use this drug on my child when they’re not even sure it’s going to help. These are our children we’re talking about!” (Adult Participant)</td>
<td>x x x x x x x x</td>
<td>7</td>
</tr>
</tbody>
</table>
Participants Supporting Option 1: Immediately Enroll the Child in the Study Without Consent

Participants in favor of option 1 frequently cited “time is of the essence” and that the child should be saved at all possible costs. Several participants shared personal relevant direct experiences about loved ones, relaying the importance of quick action in life-or-death situations. In one youth group, a participant stated,

My home boy [friend who was shot] died this year from bleeding out—this medicine could have helped him. Bled out as soon as soon he got into the ambulance—if this drug exists and could help, don’t wait. Just do it. Don’t waste time at the scene asking questions.

Participants in seven of eight groups were recorded as valuing saving the child at all possible costs, with a person in one group noting that

In a perfect situation, you want to weigh the possibilities, but if there is something to save that child’s life, then we would do it. We would go with immediate enrollment because it is in the best interest of that child.

A number of participants supporting this option deferred to the physicians as the experts and, as one person said, they did not want to “...get in the way of you saving my child’s life.”

Another reason raised by two individuals supporting this option was that the drug had already been tested in adults and was safe for use in that population. One participant noted this while adding, “Children are generally healthier.”

Participants Supporting Option 2: Enroll the Child Into the Study if Contact With Parent Cannot Be Made Within Three Hours (the Window of Effectiveness for the Study Drug)

There were several reasons why supporters of this popular option favored it, with the most common being the need to balance patient choice with the potential to save lives. Some participants stated that they simply wanted to be presented with the choice of enrolling their child. One person said, “At first I was going to pick option 1, but I thought that I would at least want to know the hospital tried to contact me before giving an experimental drug.”

In two groups, participants mentioned that they trust the doctors to determine what is best. While they wanted some attempt to be reached, they felt that if for some reason they could not be contacted, “If this is going to help my child, try it.” One participant stated that most community members are familiar with the oath “Do no harm” and, therefore, should trust that physicians will do the right thing.

In half of the sessions, participants mentioned the importance of respecting others’ religious beliefs and values that may conflict with the first option to administer the drug without informed consent. Participants also noted that some parents oppose medical interventions in general, citing the antivaccine movement as an example. Option 2 provided a balance to respecting the beliefs of those groups by giving them a chance to decide, but also protecting (in their view) the injured child’s interest if the parent was unreachable.

Conflicting emotions or opinions were evident among some participants who selected option 2 based on comments like “It’s worth noting that it’s still research, under study, and not proven yet. Telling parents after the fact, it [it] seems like you could have a lot of angry parents.” One participant observed that it was in the hospital’s interest to ask for consent to protect the facility for liability reasons, stating that “People like to sue for stupid things.”

Another key reason expressed by supporters of option 2 from half of the sessions is that study doctors may not know important medical history that could lead to adverse effects to the child upon administration of the experimental drug. For example, one woman mentioned an experience with a grandchild being given an experimental medication in the ED that triggered an allergic reaction.

Option 2 Modification: Participants Proposed Shortening Length of Time to Contact Parents From Three Hours to Thirty Minutes. Participants in early sessions who supported option 2 suggested a modification that was then presented in subsequent sessions. Participants suggested considerably shortening the 3-hour contact window because the drug is most effective the sooner it is administered. This shorter length of time was consistently supported by participants who favored option 2. Participant comments overall were similar to one person who said, “If you are not going to reach them in one hour you are not going to reach them in two hours.” In general, participants supported reducing the contact window to 30 minutes.
In several sessions, participants suggested that the doctors may determine how much time can be spared for parental outreach based on the patient’s stability. Ideas for gauging stability included measuring the patient’s blood pressure or blood loss; for example, “If [their blood pressure] is really bad, then give them the drug; if not, try to wait for the parents.”

One group of participants engaged in a robust discussion about alternative approaches to contacting parents. This ranged from calling them on the way to the hospital, or at the scene where the child was injured, to sending a police officer to the parents’ home to try to obtain consent. Others suggested that study physicians should try to reach the parents for a specified number of times (e.g., one to three), and if parents cannot be reached, then “take matters into your own [doctors’] hands.”

Participants Expressed Mixed Views on Calling Parents Who Are Driving a Long Distance to the ED. As stated, during the initial pre-EFIC trial period of the RCT, researchers learned that many parents of eligible children were driving long distances to reach the ED after they learned of the child’s injury. The researchers thought that it was inappropriate to reach out to distraught parents while they were driving to explain the study. Because this information was revealed after five of the eight deliberative sessions were already completed, only three groups of participants (about 35 people) were asked how they would feel if they were contacted about the study while driving to meet their child at the ED. Opinions on this were strong and mixed, with some participants wanting the option of being informed of the study while they were driving and others stating that most parents would not be able to process clearly or react appropriately over the phone.

Participants Supporting Option 3: Do Not Enroll Without Consent—Provide Standard of Care If Consent Cannot Be Obtained

In all but one session, at least one person selected option 3. In five of the eight sessions, participants who selected this option felt strongly that parental choice and personal values must be respected by the medical system. Some participants questioned why parents would not always be asked for consent: “I am questioning the whole concept and process. Why is this up for discussion? Shouldn’t everybody have a say in giving consent?”

Others cited the unknown risks: “I don’t want to be a guinea pig, including a new drug. I just want the standard of care,” and “If I had to choose between transfusions and this drug, I would go with transfusions because I know the risks.” In two groups, participants mentioned concerns regarding unknown long-term risks of the drug:

The long-term effects of a drug may not be known on a child, such as reproductive organ or brain development. The follow-up is only for 6 months—what if other effects happen as a child ages? Children are still developing until age 25.

Consistent with these comments and expressing this uncertainty, one participant stated on the survey, “I think the medicine can be a good, life-saving thing but can also be a risk that kills children.” A few participants expressed fatalistic views: “If it’s their time to go, it’s their time to go—I don’t know if the drug would kill the kid, or something else [would]. I would not have any closure and it [not knowing whether the child died from the drug or injury] would bother me a lot.”

In addition to wanting parents to retain the choice of study enrollment, skepticism of the medical system overall was raised in half of the sessions. Some participants pointedly mentioned or alluded to the Tuskegee Syphilis Study. This well-known study is held up as an example of unethical behavior by scientists and led to changes in future research protocols. A representative comment referencing this study from African American participants in the deliberative sessions included,

Now I am thinking about the Tuskegee study, and I feel like I am putting my children on something like that, and I am giving consent to something I don’t even know about. You’re asking a medical idiot to decide if doctors should use this drug on my child when they’re not even sure it’s going to help. These are our children we’re talking about!

Several other comments that arose in one or two sessions by participants who supported option 3 noted that it is easy to contact people so there is no excuse not to try: “We live in an era when you have access to so many people and creative ways to reach out to those people [referring to potential study enrollee parents].” One participant who supported mandatory consent stated, “As much as I’d like the study to get as
many patients enrolled as possible, if any adverse reaction happens as a result of the medication, the parents would attack the hospital and whoever was in charge.”

Proposed Alternatives to the Three Options
In the educational portion of the session, prior to deliberation, participants learned the definition of a placebo. Many people were surprised to learn that a placebo group is commonly used in clinical trials and asked many questions (e.g., what was in the placebo, how it was administered, what is meant by blinded). A handful of participants did not want to vote for any of the three proposed options, with one stating that they would only place their child in the study if there was no placebo. Another person proposed that if a parent decides that they want their child to participate in the study but don’t want them to be given the drug, the child may be given the placebo.

When a youth group was asked about other ideas for this study, one participant proposed conducting a retrospective study of children in other countries rather than “go to the trouble of creating a new clinical trial.” (Part of the education process included the fact that the drug is currently administered to children with traumatic injuries in some European countries).

Key Reasons for Changing Votes Postdeliberation
Most people who switched their vote postdeliberation moved from option 2 to option 1. Youth (5/26, 19%, 95% CI = 6.6% to 39%) were more likely to switch votes than adults (7/76, 7.9%, 95% CI = 3.0% to 16%). Overall, reasons for switching included the fact that the drug has been deemed safe for adults with trauma in the United States and is also used to treat children with traumatic injuries in other countries. Others were influenced by a fellow adolescent participant in one session stating that “If I don’t have any ID and I am about to bleed out or die and you don’t know who to contact, I want someone to try to help me.” Following the group discussion, a couple of participants noted that they could not handle the stressful situation and would want the doctors to do whatever is needed.

Study Notifications and Options for Opting In/Out of Study
Exception from informed consent requires community notification of the protocol, and the FDA website suggests several public notification options, including local newspapers. Participants nearly unanimously viewed this option as antiquated. Many people immediately commented, “Who reads the newspaper?!” A variety of alternatives for notification were suggested, such as posting on social media and including on TV news; asking pediatricians, schools, or insurance companies to inform parents; or registering through the DMV because many traumatic injuries occur through car accidents. Signaling an interest in learning about the study, one participant stated on the survey, “If [the study drug] can save lives or improve our health in any way, sure! I’m all for it. Advertise, promote, educate us more to want to support or consider options that can really save lives.”

An IRB option of opting out by placing a medical bracelet on a child was largely discounted as infeasible. Participants noted that their children would not wear a medical bracelet “just in case,” especially over the 5-year duration of the study. Others noted that a parent may initially want to opt out, but when faced with an actual emergency situation, their views may change. A minority of participants did find medical bracelets acceptable, pointing to people with diabetes or members of specific religions who wear bracelets currently.

Some participants supported opting out in advance, particularly at the pediatrician’s office, noting that it could save time during an emergency situation. Others felt that opting in was more respectful of parents’ choices than opting out. Participants suggested having parents sign papers to opt in or out of research at every physician visit or through schools.

DISCUSSION
Benefits to the Use of Public Deliberation Methods for a Community Consultation
To our knowledge, the published literature yields no EFIC-related studies that employed the public deliberation method in the community consultation process. Kasner et al.14 appear to have used very similar tools; however, participants’ input was primarily based on their personal perspective rather than being asked to represent their communities. Often traditional community consultations are conducted by principal investigators (PIs) of the research seeking an EFIC who present their study and respond to questions from several local community groups. This study created a neutral, third-party environment where the research PIs served as clinical experts and neutral facilitators presented options and elicited participants’ values and opinions.
Another key aim of the study was to conduct the consultations in areas that historically experienced high rates of childhood physical trauma. Consistent with the inclusive nature of public deliberation, participants disproportionately represented areas whose residents are of lower socioeconomic status who are racially and ethnically diverse. Seeking out these members of the community through trusted sources ensured that their opinions would be heard and expressed in a safe community space. This approach may be used to solicit views of any historically underrepresented group(s) for a community consultation.

Public deliberation may be used for both pediatric and adult EFIC studies. Recruitment will vary, with parents/guardians serving as proxies for children. We also found it valuable to include two youth groups of participants aged 16 to 18 since teens are more likely to experience physical trauma than younger children and are close to the age of consent. Depending on the nature of the pediatric study for which an EFIC is being conducted, including youth may be valuable. Youth participants will need to obtain written parental permission.

This study included all three primary characteristics of public deliberation. Participants reflected the community in the hospital catchment area including teens and adult parents from different socioeconomic backgrounds. Additionally, participants were educated about how research is conducted and about the particular intervention option and were asked to represent their community while discussing and negotiating about the value-laden options. Many participants naturally spoke to direct experiences with the ED on behalf of loved ones, and some of them had friends or family members who passed away in the ED. However, they generally noted the importance of factoring into their vote considerations of other community members.

Second, the methods used here included unbiased education and discussion materials written in lay language at a high school reading level and explained in multiple ways—through reading together as a group, through reading individually, and through small-group and then a full-group discussion. Participants were afforded the opportunity to ask questions of the facilitators and clinical expert throughout the session, as well as ask each other why they supported a particular perspective. Third, public deliberation fosters exchange among participants and allows for exploration of value-based decisions, with facilitators probing to elicit and clarify values, while assuring participants that there is no right or wrong answer.

Finally, as evidenced by this study, through the deliberative process, participants may come up with modified or alternative options that were not contemplated by study investigators. In this study, for example, rather than use the full 3-hour window of time to attempt to reach a parent under option 2, participants suggested reducing the time frame to 30 minutes. Further, when discussing how community members would be notified about the study and the methods for opting out, participants pointed out that these methods are unrealistic and outdated. New approaches, including advertising through social media and schools, along with opting out through pediatrician visits, were some of the suggested alternate ideas. Biros notes that challenges remain in optimizing the EFIC flexibility permitted by the FDA regulations.

Public Deliberation May Make Community Consultations More Meaningful

The meaningfulness of a community consultation may be enhanced by requiring researchers to factor in at least some of the results where there is clear participant consensus. For example, in this study, many participants desired a researcher to attempt to contact the parent for at least 30 minutes if their child was injured. This was true for parents who were not driving a long distance. Participant views were mixed, however, on whether they wanted to be contacted if they were driving a long distance to get to the ED as it may be challenging to process the information while also driving safely. If researchers knew that parents were driving a short distance, the IRB could require them to attempt parental contact for at least 30 minutes. If researchers knew that parents were driving a long distance, researchers could be permitted to enroll the child directly into the study and notify the parents when they arrived.

LIMITATIONS

Our study should be interpreted in the context of several limitations. First, the study was conducted in a single region in the United States. Participants from other regions in the United States or from other countries may have differing opinions. Second, participant opinions are in response to a specific pediatric clinical trial. Other clinical trials with different patient populations, interventions, and study procedures may have different responses. Third, we did not compare public deliberation methods to other community engagement methods. Finally, this study was conducted with a relatively small sample size and may not be generalizable to other populations.
methods. Fourth, different recruitment methods may have yielded different findings. Also, while the sample size was sufficient to achieve theme saturation and general consensus, it was relatively small and not sufficient to explore subgroup analyses of demographic characteristics (age, sex, race, education). It is possible that opinions may differ greatly between demographic subgroups. Finally, we presented three different consent options that broadly reflected general consent options to participants. However, there are many variations to each of these consent options (e.g., timing, use of family objections) that we did not evaluate due to the complexity of including multiple options.

CONCLUSIONS

Public deliberation is a novel community consultation method that produces robust information for informing researcher and institutional review board exception from informed consent decisions and ensuring rigorous study protocols that are responsive to the community. Researchers have called for improvements to community consultation guidelines, and public deliberation may serve as a valuable tool for insight into community needs, concerns, and interests. Future studies need to evaluate whether public deliberation methods provide participants with enhanced understanding of clinical trials compared to other community consultation methods.

The authors acknowledge and thank Jennifer Bernstein for her contributions to theme analyses.

References


H. Pain Scores Are Not Predictive of Radiographically Evident Intraabdominal Pathology in Patients With Abdominal Pain

Tony Zitek, MD1,2,3,4, Lauren Pellman, MD4, Jessica Uribe3, and Arantxa Guillen3

Since 1989, when the term “oligoanalgesia” was coined, physicians have been encouraged to be more aggressive about treating pain.1 Although pain scores have sometimes been considered the “fifth vital sign,” it is not clear if this initiative has resulted in improved pain management or if it has contributed to the opioid epidemic.2 That being said, it is possible that pain scores, like traditional vital signs, may have clinical predictive utility.

Currently, a verbal, self-reported pain score from 0 to 10 is commonly used in emergency departments (EDs)3 and is routinely collected at our facility during the patient’s initial assessment. If the pain score is predictive of certain clinical outcomes, this readily available information could be formally incorporated into clinical decision making.

No prior study has attempted to determine if pain scores have predictive utility for patients with abdominal pain. We therefore conducted a study to determine if there is a relationship between the pain scores documented at triage and radiographically evident intraabdominal pathology.

Our study was a chart review at a single, academic county hospital in Las Vegas, Nevada. It received approval from our hospital’s institutional review board. Patients could be included if they presented to the adult ED for abdominal pain and had an abdominal CT scan with IV contrast. We did not include patients who had noncontrast CT scans as they may be less sensitive for some intraabdominal processes.4

Patients were excluded if their initial pain score was listed as “0” or if they presented after a traumatic injury. In our department, pain scores are documented by the triage nurse on the standard 0 to 10 scale (prior to any analgesia).

Patients were identified by searching for abdominal CT scans with IV contrast in our radiology image viewing program. Charts were then reviewed to assess for inclusion and exclusion criteria. For enrolled patients, we abstracted the age, sex, initial vital signs, initial pain score, CT scan results, medications received in the ED, disposition, and the surgical procedures the patient had while in the hospital.

Our primary objective was to assess for an association between initial pain scores and the presence of intraabdominal pathology on CT scan. We hypothesized there would be no significant association. Any radiographically apparent pathology that was thought to explain the patient’s pain was counted as “intraabdominal pathology.”

Secondarily, we sought to determine if pain scores were associated with opioid administration, disposition, or surgical procedures. Of note, in addition to traditional surgeries (such as appendectomy or cholecystectomy), other procedures intended to manage the
among the 993 abdominal CT scans reviewed, 562 (56.6%) were found to have intraabdominal pathology; the two most common abnormal findings were appendicitis and colitis. 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.13841/full) lists the top 10 abnormal findings identified. Of the 993 patient visits analyzed, the patient received opioids in 755 (76.0%), was admitted to the hospital in 470 (47.3%), and had a surgical procedure in 116 (11.7%).

Using logistic regression, we found no statistically significant relationship between increasing pain scores and CT-evident intraabdominal pathology with univariate analysis (p = 0.81) or multivariable analysis (p = 0.21). On multivariable analysis, the odds ratio (OR) for a CT scan finding for each point increase on the pain scale was 1.04 (95% confidence interval [CI] = 0.98 to 1.10). On the other hand, there was a significant relationship between pain scores and opioid administration (p < 0.001). In particular, on multivariable analysis, for each point the initial pain score went up, the chances the patient received opioids increased with an OR of 1.21 (95% CI = 1.14 to 1.29). Multivariable logistic regression found no statistically significant association between initial pain score and other secondary outcomes, including admission to the hospital (p = 0.70) and having a surgical procedure (p = 0.41).

On further analysis, we divided patients into groups of mild, moderate, and severe pain. There was no statistically significant difference among these groups with regard to the frequency of intraabdominal pathology: mild 40 of 67 (59.7%), moderate 138 or 237 (58.2%), and severe 384 of 689 (55.7%). We also divided patients into groups using the median pain score (median = 8). We found that 59.7% of patients with a pain score of 9 or 10 had CT-evident intraabdominal pathology compared to 54.6% for those with a score of 8 or below (difference = 5.1% [95% CI = −1.2% to 11.4%]). Table 1 provides a detailed comparison of patients divided using the median pain score. Of note, those patients with pain scores higher than 8 were more likely to be younger and African American and receive opioids compared to those with scores below the median.

This is the first study to assess the predictive utility of the initial pain score in patients who present to the ED with abdominal pain, and we found no evidence that a high initial pain score is predictive of a CT-
evident cause of their pain, the need for admission, or the need for surgery. This lack of an association is probably not surprising to physicians who have observed that some patients who report pain scores of 10 appear completely comfortable. While our study is the first to specifically examine the predictive utility for pain scores for patients with abdominal pain, other studies have also suggested that higher pain scores are not associated with other markers of more severe pathology (such as vital sign abnormalities).

While pain scores were not found to be predictive of clinical outcomes, we did find that patients with higher pain scores were more likely to receive opioids. Of course, a physician is likely to treat a patient’s pain more aggressively if they report more severe pain. However, given the potential harms of opioids, physicians should consider factors other than just the pain score when deciding to administer opioids.

In interpreting the results of our study, there are several limitations to consider. First of all, this was a single-center study, and the results may not be generalizable to other institutions. Second, this study is limited by its nature as a chart review study. Chart reviews rely upon the accuracy of the available medical records, and we cannot guarantee that the pain scores documented by the triage nurses were obtained in a uniform manner. Finally, based on the results of prior studies, we controlled for age, sex, and race in our regression model, but other confounders may not have been accounted for.

In conclusion, self-reported pain scores recorded by nursing staff at triage on patients who presented to the ED for abdominal pain were not found to be associated with intraabdominal pathology on CT scan, disposition, or the need for surgery. However, patients reporting higher pain scores were more likely to receive opioids. It is uncertain if self-reported pain scores should still have a role in emergency medicine.

References


Table 1
A Comparison of Patients With an Initial Pain Score Above the Median to Those at or Below the Median

<table>
<thead>
<tr>
<th>Clinical Attribute or Outcome</th>
<th>Initial Pain Score ≤ 8</th>
<th>Triage Pain Score &gt; 8</th>
<th>Difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Female</td>
<td>55.8</td>
<td>58.7</td>
<td>2.9 (-3.4 to 9.3)</td>
</tr>
<tr>
<td>Age (mean)</td>
<td>48.2</td>
<td>45.1</td>
<td>3.1 (0.9 to 5.1)*</td>
</tr>
<tr>
<td>% Caucasian</td>
<td>75.3</td>
<td>69.6</td>
<td>5.7 (-0.3 to 11.8)</td>
</tr>
<tr>
<td>% African American</td>
<td>18.1</td>
<td>24.9</td>
<td>6.8 (1.2 to 12.4)*</td>
</tr>
<tr>
<td>Initial pain score (mean)</td>
<td>6.1</td>
<td>9.7</td>
<td>3.6 (3.5 to 3.8)*</td>
</tr>
<tr>
<td>Heart rate (mean)</td>
<td>86.5</td>
<td>87.3</td>
<td>0.8 (-1.6 to 3.3)</td>
</tr>
<tr>
<td>Respiratory rate (mean)</td>
<td>17.4</td>
<td>17.7</td>
<td>0.25 (-0.05 to 0.54)</td>
</tr>
<tr>
<td>SBP (mean)</td>
<td>132.8</td>
<td>135.6</td>
<td>2.8 (-0.3 to 6.0)</td>
</tr>
<tr>
<td>% with fever</td>
<td>3.0</td>
<td>1.3</td>
<td>1.7 (-0.1 to 3.4)</td>
</tr>
<tr>
<td>% with a finding on CT</td>
<td>54.6</td>
<td>59.7</td>
<td>5.1 (-1.2 to 11.4)</td>
</tr>
<tr>
<td>% who received opioids</td>
<td>71.1</td>
<td>83.9</td>
<td>12.8 (7.7 to 18.0)*</td>
</tr>
<tr>
<td>% who were admitted</td>
<td>47.0</td>
<td>48.1</td>
<td>1.1 (-5.4 to 7.4)</td>
</tr>
<tr>
<td>% who got surgery</td>
<td>11.2</td>
<td>12.5</td>
<td>1.3 (-2.9 to 5.4)</td>
</tr>
</tbody>
</table>

SBP = systolic blood pressure.
*Statistically significant


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.13841/full

Data Supplement S1. The 10 most common positive findings on the CT scans ordered in this study.
Oriented 3D Ultrasound for Central Venous Cannulation Using an Augmented 2D Ultrasound System

Joshua S. Broder, MD1, Matthew R. Morgan, MS2, Elias J. Jaffa, MD1, and Rebecca G. Theophanous, MD1

Two-dimensional ultrasound (2DUS) guidance for central venous cannulation is a best practice for patient safety identified by the Agency for Healthcare Research and Quality and the American College of Emergency Physicians.1 2DUS has been shown to reduce mechanical complications of insertion (e.g., arterial puncture, pneumothorax) by up to 71% and improves procedure performance (e.g., reduced total procedure time, reduced number of skin punctures, decreased number of needle redirection events), but complications remain in the setting of ultrasound guidance, including pneumothorax and arterial puncture.2

Puncture of the posterior vessel wall (a surrogate for incorrect needle tip placement and a potential contributor to hematoma formation and inadvertent arterial puncture) occurred in 34% of ultrasound-guided central venous catheter insertions in a phantom study, including 31% with short-axis (SA) approach and 37% with long-axis (LA) approach (no statistical difference).3 The internal jugular vein (IJV) overlies the common carotid artery (CCA) in approximately 50% of patients, raising concern that posterior wall puncture (PWP) of the IJV could lead to puncture of the CCA.4

The limitations of 2DUS in preventing mechanical complications arise from the fact that users must select from one of two common approaches, each with advantages and disadvantages. SA (also called “out-of-plane”) approach allows the user to center on the target vessel of interest, but the needle tip is commonly not visualized, and the depth of insertion cannot be judged accurately. If the needle tip beyond the image plane deviates medially, laterally, or deep to the vessel, this cannot be identified without active tracking of the needle by the user. LA (also called “in-plane”) approach allows the user to see the entire length of the inserted needle in a single image. The depth of insertion can be seen at all times, reducing the risk of the needle being inserted too deeply. However, skill is required to align the transducer, ultrasound plane, needle, and target, and the adjacent artery is not seen. Errors have been described with this method, including PWP of the target vein and inadvertent puncture and even cannulation of the adjacent artery.5 A phantom study comparing LA and SA approaches showed shorter time to cannulation, fewer needle redirections, and lower rates of PWP with LA, compared with SA.6 Even with LA approach, PWP rates of 21% were observed for IJV cannulation. Combined SA and LA approach (skin puncture with SA visualization, followed by vessel puncture under LA visualization) in a phantom model allowed higher procedure success rate for novices and reduced rate of PWP in a nonrandomized study in patients.7,8 However, a randomized study of patients undergoing cardiac surgery showed higher...
first-pass success rates and fewer needle redirections with the SA approach, compared with LA, and carotid artery puncture occurred only in the LA approach group.5

Complications might be mitigated by the simultaneous visualization of LA and SA planes or by the depiction of a three-dimensional field of view of interest as a volume-rendered model. Existing three-dimensional ultrasound (3DUS) systems are typically designed for cardiac or fetal visualization and thus do not include high-frequency transducers, which are commonly used to guide catheter insertion because of their high resolution for superficial structures. Most traditional 3D-capable systems are also expensive and large, making them less well suited or less feasible for the bedside environment. A low-cost system for augmentation of any 2DUS system and transducer to generate automatically oriented 3D volumes can be constructed using an inertial measurement unit (IMU).9,10 We hypothesized that an IMU-augmented 2D high-frequency linear ultrasound transducer would enable rapid 3DUS visualization of the IJV and carotid artery as well as needle, wire, dilator, and catheter. We tested this in vivo and in a phantom model.

We paired a 2D linear high-frequency transducer (FujiFilm SonoSite M-Turbo) with an augmentation system incorporating an IMU (STEVAL-MKI121V1I-NEMO-M1 Discovery, STMicroelectronics).9,10 Source 2DUS images were captured from the video-out port on the ultrasound system using a capture device (Epi- phan DV12USB 3.0). A computer (Dell Precision M4800) was used to perform image reconstruction using software designed by the research team (C++, MatLab). Reconstruction was triggered automatically, immediately following image acquisition. Total acquisition time (including transducer fanning and file writing), total reconstruction time (including MatLab and data loading, image filtering, reconstruction, and file writing), and angular field of view were automatically logged by the software and are reported as measures of clinical feasibility of the technique. During acquisitions, the operator fanned the IMU-equipped ultrasound probe once around a central rotational axis on the phantom or body surface to traverse the region of interest, spanning an arc of approximately 70°. Source 2D images were transformed to 3D volumes using a pixel-based reconstruction algorithm, with a slice thickness of 5 pixels. Volumes were visualized using 3DSlicer (https://www.slicer.org/), an open-source medical image application.

Using a central venous cannulation model (BluePhantom, CAE), images were acquired before insertion and at each stage of insertion of a central venous catheter (Arrow Multi-Lumen central venous catheterization kit, Teleflex; needle inserted, guidewire inserted, dilator inserted, catheter inserted). Images of the IJV and carotid artery were also acquired in a single human subject. Institutional review board approval was obtained for the study. Informed consent was obtained from the human subject.

Representative images of the IJV and carotid artery in the human subject are shown in Figure 1. The region of interest is shown as a volume-rendered image (left) and planar stacked images matching the cardinal anatomic planes (right). The human figure icon is an automated orientation feature that rotates with the image volume, as do letters indicating anterior (A), posterior (P), right (R), left (L), inferior (I), and superior (S). Additional images of each of the stages of catheter insertion in the phantom model are available for online review (Data Supplement S1, Figures S1–S5, available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13831/full).

The mean angular field of view was 73.6°. Image acquisition time averaged 18.31 seconds. Mean reconstruction time was 12.0 seconds.

Using an IMU-augmented 2DUS system, we demonstrated 3D visualization of the IJV and carotid artery in a human subject and in a simulated phantom model of central venous catheter insertion. Field of view was sufficiently broad to include relevant anatomy and medical devices. The resulting 3D volumes can be flexibly rendered, including windowing methods similar to CT, facilitating visualization of anatomy and medical equipment.

A variety of other procedures might benefit from this imaging technique, including any procedure requiring precise and accurate insertion of a needle or catheter into a target while avoiding adjacent vulnerable nontargets. Examples include peripherally inserted central catheter placement, peripheral intravenous catheter insertion, arterial cannula insertion, abscess drainage, percutaneous nephrostomy, cholecystostomy, catheter-directed ablation of tumors, percutaneous needle biopsy of masses, regional anesthesia catheter placement, stenting of ducts and vascular
structures, and amniocentesis. Benefits include low cost and wide compatibility with existing ultrasound systems and transducers, allowing use of existing equipment.

This was a preliminary study of feasibility and cannot determine clinical utility. Although acquisitions and reconstructions were rapid, we did not explore image quality resulting from even shorter acquisitions and reconstructions, which would be desirable for real-time guidance of certain procedures. Total acquisition time plus reconstruction time averaged approximately 30 seconds; improvements in speed would be desirable for critical care scenarios. The minimum (fastest) acquisition time providing sufficient image quality for recognition of anatomy and medical devices should be determined in future studies. Because image reconstruction time is linearly related to acquisition time (via the number of acquired 2D pixels requiring reconstruction into corresponding 3D voxels), shortening acquisition time would also improve reconstruction time, even in the absence of other algorithm improvements. Image reconstruction could be performed in parallel with acquisition, rather than sequentially as in the current approach. Under our algorithm, reconstruction time is uniformly shorter than acquisition time; therefore, if performed in parallel, the reconstructed image would be available almost instantly upon completion of acquisition. Faster processors and cropping or down-sampling source images to reduce pixel counts requiring reconstruction are additional means to enhance speed.

Future studies using appropriate blinded comparisons are needed to determine whether 3D visualization reduces clinically relevant procedure complications, preserves important feasibility factors such as procedure speed, and achieves acceptable image quality in comparison to standard 2D techniques.

We successfully imaged a central venous catheter insertion using 2DUS augmented to produce 3D images. Field of view was broad and imaging times totaled approximately 30 seconds. Additional work is needed prior to broad clinical adoption.

References


4. Maecken T, Marcon C, Bomas S, Zenz M, Grau T. Relationship of the internal jugular vein to the common

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.13831/full

Data Supplement S1. Supplemental material.
BACKGROUND

Salary disparity between men and women has existed for as long as it has been measured, and despite efforts such as the Equal Pay Act of 1963, this disparity continues to exist. This gap is seen across numerous professions, including law, marketing, administration, and medicine. In the United States, women working full time are typically paid just 80% of what men are paid.1–4

According to one 2010 analysis, the disparity in medicine is one of the highest for any professional industry, trailing only dentistry.5 Women now represent half of medical school graduates and 38% of faculty members in U.S. medical schools.6 After controlling for multiple factors, including specialty, age, faculty rank, and metrics of productivity, male physicians earned nearly $20,000 more per year than their female counterparts.7,8 Within emergency medicine, studies have shown female faculty are paid 10% to 13% less than males.9,10

ARTICLE SUMMARY

This study asks if there is a difference in compensation for male and female academic emergency physicians practicing in the United States. It is a cross-sectional, observational study done over 4 years from 2013 to 2017 (excluding 2014). The reported compensation was the adjusted median annual base salary for physicians.

QUALITY ASSESSMENT

Overall this was a well-done observational study performed in academic emergency departments across the United States. Within the sampled group they controlled for confounders such as work region, practice setting, and years at academic rank.

However, this study has several limitations. First, the response rate of this survey is not certain because the survey is sent to the listserv of all AACEM (Association of Academic Chairs in Emergency Medicine) and AAAEM (Academy of Administrators in Academic Emergency Medicine) and we do not have denominator data for the survey. We are unsure whether the physicians sampled in each year of the survey were the same, as it was anonymized administrative data, rather than being provided by the individual physicians. Thus year to year the results may represent a different group of physicians. Also, the year 2014 was excluded because of a change in the group administering the survey (more details in podcast). Furthermore, the sample of physicians may not be representative of non–academic emergency physicians or those in other countries than the United States, thus raising questions about external validity. As the data is observational, it demonstrates an association, but not a clear cause and effect. There may be unobserved confounders. Despite these limitations, results of this study do fit with other available evidence regarding the gender pay gap.
KEY RESULTS

The median salary increase over the course of the study was greater for men ($226,746 in 2013 to $252,000 in 2017) than women ($217,000 in 2013 to $240,000 in 2017). Overall salaries increased across all 4 years studied with an overall increase of 10.8% (95% confidence interval [CI] = 9.6% to 12%). Women’s salaries increased 10.6% (95% CI = 9.4% to 11.8%) while men’s salaries increased 11.1% (95% CI = 10.2% to 12%).

The overall difference in salary for males was higher and this was significant at all four time points ($ = 6.33, p < 0.001). This pay difference persisted in the predictive model controlling for covariates.

An optimistic finding of this study was that between 2016 and 2017, women’s salaries increased at a rate of 6.56% compared to 3.82% for men. Only time will tell if this is a true and sustainable change. At all time points, the proportion of respondents at higher academic ranks and higher salaries was always greater for men than women.

AUTHORS’ COMMENTS

With recruitment of new faculty, chairs, or their designees should institute a standard base pay rate based on rank and years of service. This does not include total compensation, which might include benefits, resources available to a faculty member, access to protected time, discretionary accounts, and relocation bonuses. With regard to elimination of these disparities in already established faculty, different targeted strategies would be required for parity of compensation. If you are motivated by, disturbed by, or interested in the findings of this study, pursue further study in this area so that we have more information to better define this problem.

TOP SOCIAL MEDIA COMMENTARY

On the SGEM blog and Twitter, Kim Sordyl commented:

“What Do I Tell the Colleague?” correctly says complain to leadership and give [opportunity] to correct. (Do this via email, cc your private acct so you have a record ... my clients have complained verbally and leadership denied it ever happened and then retaliated) Women have been complaining for years, and [are] often ignored and/or retaliated against. Pay gap studies [are] ignored. Internal HR, Title IX, AAEO, legal staff often engage in cover-ups or hire morally challenged outside “investigators” who routinely bury discrimination for their clients.

My advice? Take it out of their hands. How? I’ll tell you.

File BOLI complaints (in Oregon), EEOC complaints (nationally), and lawsuits. Academic hospital employees can file @NIH complaints, @acgme complaints, Federal Office of Civil Rights complaints www2.ed.gov/about/offices/...

Files have been ineffective and punished. #TimesUp

COMMENTS FROM TWITTER

Twitter Poll

One Twitter discussion between @anish_koka, @AliRaja_MD, and @kemdvm was about clinical productivity and its impact on the study results.

@anish_koka
This is adjusted for clinical productivity? Don’t see that on my initial read.

@AliRaja_MD responds and asks @DrJenniferWiler

Please correct me if I’m wrong, but I don’t think the data could have adjusted for clinical productivity... the survey is filled out in such a way that linking individual faculty members’ salaries to clinical productivity would be impossible.

@kemdvm

From paragraph 8: After controlling for multiple factors, including... metrics of productivity, male physicians earned nearly $20,000 more per year than their female counterparts... studies have shown female faculty are paid 10% to 13% less than males.9,10

@AliRaja_MD

Great find, @kemdvm! However, I’m not sure that “metrics of productivity” necessarily equates to “clinical productivity” instead of publications and other metrics of academic productivity.

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

Meme Contest

接管-to-work Points

We all need to be more aware of this persistent pay gap and how it continues despite our best intentions. Although these data do not indicate the reasons for the gap, nor the means to fix it, we need to try to employ means of being more objective and consistent in the way that we allocate compensation. Every few years a review should be performed to look at salaries and other forms of compensation in physicians. We also need further research aimed at determining the underlying cause of the pay gap. This is to ensure that we correct any unexplained differences to make sure we have a safe and equitable environment.

References

Tranexamic Acid for Upper Gastrointestinal Bleeding

Raymond Beyda, MD1, and Davood Johari, MD2

NARRATIVE

Upper gastrointestinal bleeding is common and accounts for at least half of the nearly 500,000 annual U.S. hospitalizations for gastrointestinal bleeding.1 In the acute setting, severe bleeding is treated with intravenous fluids, blood products, antiulcer therapy, and hemostasis by endoscopy.2 Tranexamic acid (TXA) is an antifibrinolytic agent shown to reduce bleeding.3,4 TXA has been proven to be effective in improving patient-centered outcomes after severe hemorrhage due to trauma.5 The authors of this systematic review sought to evaluate the benefit of TXA administration specifically for upper gastrointestinal bleeding.

The systematic review summarized here6 identified eight randomized trials of TXA in 1,701 subjects presenting with acute upper gastrointestinal bleeding among patients admitted to the hospital, including some in the intensive care unit. Two comparisons were made: TXA versus placebo and TXA versus antiulcer therapy (cimetidine or lansoprazole). Primary outcomes were mortality and adverse events. Compared to placebo, TXA reduced mortality (relative risk [RR] = 0.60, 95% CI = 0.42 to 0.87, ARR = 3.5%, NNT = 30, moderate-quality evidence). However, because of a high attrition in several trials the results must be interpreted with caution. About 20% of the studied patients were withdrawn or excluded for reasons such as lack of confirmation of the presence of bleeding, presence of malignancy, terminal illness, or late administration of treatments. Reanalysis including all participants and considering missing patients as treatment failures did not show mortality benefit.5

In the second comparison, TXA versus antiulcer therapy (cimetidine or lansoprazole), only two trials were included, and no mortality benefit was found. Administration of TXA did not reduce the risk of rebleeding (RR = 0.72, 95% CI = 0.50 to 1.03, low

---

The NNT color recommendation | Yellow
---
Summary heading | Tranexamic acid may improve survival in upper gastrointestinal bleeding.
Benefits in NNT | 1 in 30 were helped (death prevented) when compared to placebo; no one was helped when compared against antiulcer therapy
Benefits in percentages | 3.5% were helped (death prevented) when compared to placebo; no one was helped when compared against antiulcer therapy
Harms in NNT (NNH) | No one was harmed
Harms in percentages | No one was harmed
Efficacy endpoints | Death, rebleeding, and requirement for surgery
Harm endpoints | Thromboembolic events, myocardial infarction, pulmonary embolism, cerebral infarction, or deep vein thrombosis
Who was in the studies | 1,701 patients from eight randomized controlled trials with acute upper gastrointestinal bleeding

---

From the 1Department of Emergency Medicine and the 2Department of Internal Medicine, Division of Pulmonary and Critical Care, State University of New York, Downstate Medical Center & Kings County Hospital, Brooklyn, NY. Received May 9, 2019; revision received July 16, 2019; accepted July 16, 2019. The authors have no relevant financial information or potential conflicts to disclose.

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 (email: Shahriar.Zehtabchi@downstate.edu). Supervising Editor: Kabir Yadav, MDCM, MS, MSHS. Address for correspondence and reprints: Raymond Beyda, MD; e-mail: Raymond.Beyda@Downstate.edu.


ISSN 1553-2712

1181
quality evidence) or blood transfusion (RR = 1.02, 95% CI = 0.94 to 1.11, very-low-quality evidence).

Although meta-analysis could not be performed for harm endpoints due to lack of adverse event reporting for all trials, three studies did include data on thromboembolic events. There was no difference between the TXA and placebo groups in combined serious thromboembolic events (myocardial infarction, pulmonary embolism, and cerebral infarction; RR = 1.37, 95% CI = 0.36 to 5.28), nor did TXA increase the risk of deep vein thrombosis (RR = 2.32, 95% CI = 0.60 to 8.89).

CAVEATS

The authors of this Cochrane review judged the available evidence to be of moderate to low quality, largely due to the risk of bias and clinical heterogeneity among included trials. Notably, the trials were conducted over nearly four decades (from 1973 to 2011), with six of eight published between 1973 and 1987, likely accounting for much of the heterogeneity. A high dropout rate was also concerning. When this was accounted for (in a worst-case scenario), the mortality benefit was not significant. The included trials also used different doses and routes of administration for TXA and were mostly performed 30 to 45 years ago. Management patterns, hemostatic technology, and cointerventions have since changed, in some cases dramatically, making applicability to current practice questionable. Finally, all trials enrolled admitted patients. Previous trials have shown that TXA is most efficacious when administered early (within 1 hour). Therefore, the delay in administration of TXA might have reduced efficacy, further reducing applicability and generalizability for ED patients.

We have assigned a color recommendation of yellow (unclear benefits) to this intervention. Limitations of the reported data, particularly the lost to follow-up and dropout rates, the high risk of bias, and the presence of significant heterogeneity justify this rating. A large pragmatic double-blind controlled trial with a target sample size of 12,000 subjects is currently ongoing. We are hopeful this trial will provide better evidence. Despite TXA’s lack of demonstrated benefit compared to standard treatments with respect to the endpoints of mortality or rebleeding, given the relative safety, lack of significant adverse events, and low cost of the medication, it may be reasonable to consider TXA in severe upper gastrointestinal bleeding as an adjunct to standard therapy or if standard therapy fails.

References

Retinal Pathology in Patients With Acute-onset Flashes and Floaters

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

**Summary heading**

Visual acuity reduction, >10 new floaters, vitreous hemorrhage, and vitreous pigments are suggestive of retinal tear in patients with posterior vitreous detachment.

**Positive LR findings (LR+)**

| Symptoms: | Visual reduction = 5 |
| Signs: | Vitreous hemorrhage = 10 |
| | Vitreous pigment = 44 |

**Negative LR findings (LR-)**

| Symptoms: | NA |
| Signs: | Vitreous pigment = 0.23 |

**Who was in the studies**

2,496 patients referred to ophthalmologists for evaluation of acute-onset floaters and flashes of suspected ophthalmologic origin and/or diagnosed posterior vitreous detachment.

**Narrative**

Posterior vitreous detachment (PVD), or separation of the posterior vitreous from the retina, is usually due to degeneration and age. The condition most commonly results from vitreous degeneration and shrinkage.1 PVD may present with floaters and/or flashes or may be asymptomatic for years.1 The incidence of PVD increases with age, from 25% in those 50-59 years to 87% in those 80-89 years.2 This condition sets the stage for further ophthalmologic pathologies.3,4 As the vitreous shrinks and detaches from the retina, traction can result in a retinal tear.3,4 This tear can allow fluid to enter the subretinal space, which may cause separation of the retinal neurosensory layer from the retinal pigment epithelium, otherwise known as a retinal detachment. Thus, previously diagnosed PVD is an important component of the history in a patient with an ophthalmologic complaint due to its potential to result in retinal detachment. Retinal detachment occurs in 33% to 46% of patients with retinal tear and affects 0.8 to 1.8 per 10,000 persons per year,3,4 with a population prevalence of 0.3%.5,6 Rapid diagnosis and treatment of retinal detachment can reduce visual loss and may even restore vision.7

This review included studies evaluating elements of the history and physical examination in patients with acute floaters and flashes of suspected ophthalmologic origin and suspected or diagnosed PVD.8 The systematic review and meta-analysis assessed the symptoms or clinical findings that could predict retinal tear in patients with acute onset floaters and/or flashes and a diagnosis of PVD established by the ophthalmologist.8

The authors of the meta-analysis identified 12 relevant studies (n = 2,496 patients). All 12 were...
performed in ophthalmology clinics, with patients referred from primary care, optometry, or general ophthalmology. All patients had floaters and/or flashes of suspected ophthalmologic origin and suspected or diagnosed PVD. The prevalence of retinal tear was 14%. Only one study evaluated subjective vision reduction, finding that this increased likelihood of retinal tear (positive likelihood ratio [LR+] = 5.0, 95% confidence interval [CI] = 3.1 to 8.1). Normal visual acuity decreased the likelihood of retinal tear (LR+ = 0.60, 95% CI = 0.5 to 0.7). Twelve studies evaluated slit-lamp examination findings, showing that vitreous hemorrhage and vitreous pigment increased the likelihood of retinal tear (LR+ = 10, 95% CI = 5.1 to 20; and LR+ = 44, 95% CI = 2.3 to 852, respectively).

**CAVEATS**

While certain features on history and examination increase the likelihood of retinal tear in the presence of flashes and/or floaters and suspected or known PVD, several findings depended on a thorough fundoscopic and slit-lamp examination. Thus, ED provider experience and equipment for fundoscopic and slit-lamp examination play an important role in evaluation for retinal tear. Importantly, slit-lamp examination does not evaluate the posterior chamber of the eye. To appropriately visualize the posterior chamber, fundoscopy, typically with full eye dilation, is needed. However, the majority of emergency clinicians do not perform full eye dilation in the ED. While point-of-care ocular ultrasound can be diagnostic of several ophthalmologic conditions, this modality was not evaluated in this meta-analysis. The prevalence of retinal tear in patients presenting to the ED with visual symptoms such as vision loss and flashes/floaters is likely lower than found in this meta-analysis, suggesting spectrum bias, and in fact, most patients enrolled in the trials were diagnosed with PVD first or were suspected to have PVD based on direct ophthalmoscopy, making this a highly select group likely to be different from patients with these complaints in the emergency department (ED). Regardless, this information might help ED physicians suspect retinal tear early and refer the patients to an ophthalmologist as soon as possible, as retinal tear leads to retinal detachment in 33% to 46% of patients.

Finally, many of the likelihood ratios generated by the meta-analysis had wide CIs, with lower limits approaching 1.0, most likely resulting from small sample sizes. Larger studies are needed to generate better precision.

Based on the existing data, new-onset floaters and/or flashes, subjective vision loss, and vitreous pigment or hemorrhage on ophthalmologic examination are associated with increased risk of retinal tear among patients with suspected or known PVD. In most studies included in the meta-analysis, PVD was often established by the ophthalmologist during initial encounter. Thus, further data are needed to determine whether these findings remain consistent among patients in acute care settings such as the ED. Nonetheless, in the absence of other relevant data, this review suggests that the findings outlined here may be useful in the evaluation of acute floaters/floaters. Newer data also suggest that point-of-care ultrasound may be a useful indicator of retinal detachment. Future studies should determine how ultrasound may be used in combination with the above findings to risk stratify patients with new vision changes in nonophthalmology settings.

**References**

8. Hollands H, Johnson D, Brox AC, Almeida D, Simel DL, Sharma S. Acute-onset floaters and flashes: is this...


ABSTRACT

Objectives: The Global Emergency Medicine Literature Review (GEMLR) conducts a systematic annual search of peer-reviewed and gray literature relevant to global emergency medicine (EM) to identify, review, and disseminate the most rigorously conducted and widely relevant research in global EM.

Methods: An electronic search of PubMed, a comprehensive retrieval of articles from specific journals, and search of the gray literature were conducted. Title and abstracts retrieved by these searches were screened by a total of 22 reviewers based on their relevance to the field of global EM, across the domains of disaster and humanitarian response (DHR), emergency care in resource-limited settings (ECRLS), and emergency medicine development (EMD). All articles that were deemed relevant by at least one reviewer, their editor, and the managing editor underwent formal scoring of overall methodologic quality and importance to global EM. Two independent reviewers scored all articles; editors provided a third score in cases of widely discrepant scores.

Results: A total of 19,102 articles were identified by the searches and, after screening and removal of duplicates, a total of 517 articles underwent full review. Twenty-five percent were categorized as DHR, 61% as ECRLS, and 15% as EMD. Inter-rater reliability testing between the reviewers revealed a Cohen’s kappa score of 0.213 when considering the complete score or 0.426 when excluding the more subjective half of the score. A total of 25 articles scored higher than 17.5 of 20; these were selected for a full summary and critique.

Conclusions: In 2018, the total number of articles relevant to global EM that were identified by our search continued to increase. Studies and reviews focusing on pediatric infections, several new and traditionally underrepresented topics, and landscape reviews that may help guide clinical care in new settings represented the majority of top-scoring articles. A shortage of articles related to the development of EM as a specialty was identified.
The Global Emergency Medicine Literature Review (GEMLR) began in 2005 with a goal of improving the practice of emergency medicine (EM) worldwide by facilitating global EM practitioners' awareness of the most current and important research published in global settings. We work to identify and consolidate the relevant global EM literature into a format that is readily available to academicians, practitioners, and public policy personnel. Each year, a panel of reviewers and editors is recruited to screen and critique literature identified from a systematic electronic and manual literature search. While the definition of global EM is open to interpretation, we consider it to be the practice and development of EM in settings without robust or mature EM systems commonly seen in resource-rich western countries.

The GEMLR seeks to identify the most relevant practice-changing articles by systematically scouring both the peer-reviewed and the gray literature via a comprehensive search strategy. Gray literature, representing material produced specifically to share research and clinical guidelines outside of the peer-reviewed literature, represents an important contribution to systematic reviews. Given the amount of global EM research conducted by government agencies, non-governmental organizations, and other entities, manually searching for this information has the potential to identify important practice-changing findings.

Major goals of this review are to illustrate best practices, stimulate research, and promote further professionalization in the field of global EM through the identification of important new publications that focus on emergency care in the global context, especially disaster and humanitarian response, emergency care in resource-limited settings, and the development of EM as a clinical discipline worldwide. The review has a structure and guidelines refined over more than a decade to bring reproducibility to the process, but we acknowledge that there is an inherent subjectivity to any such endeavor. Nevertheless, this is a subjectivity we aim to minimize by using the collective experience of more than two dozen clinicians with vast knowledge and training in global EM who provide feedback on the literature with multiple layers of review and feedback.

Given the ever-increasing onslaught of medical literature and the ever-increasing contribution of emergency conditions to global morbidity and mortality worldwide, we aim to provide a highly curated annual resource—a starting point—for our colleagues worldwide to explore and understand important new developments in the field. This is not a formal systematic review or meta-analysis, as we do not aim to synthesize the literature around a specific topic or research question; GEMLR conducts a separate annual systematic review for that purpose.

**METHODS**

Full details of our procedures are available in 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.13832/full). Significant changes from prior years’ methodology included how articles with widely discrepant reviewer scores are handled and how articles written by members of the editorial board are handled in terms of managing potential conflicts of interest. In the past, articles that were cowritten by members of the editorial board were automatically excluded, but as this may have excluded some high-quality articles, our new conflict of interest policy allows for these articles to be included if three other senior members of the review independently agree that such articles were screened and scored appropriately without favorable bias given to the authors.

All participants in the review are unpaid volunteers selected based on their experience providing frontline emergency care and education around the world. This year’s panel of 27 reviewers, seven editors, and five editorial board members included physicians practicing in Australia, Canada, Egypt, Ethiopia, Ghana, Haiti, Laos, and the United States. The full list of participants is available in Appendix A.

**Peer-reviewed Literature Search**

PubMed was searched in two blocks: the first block covered publications included in Medline from January 1 to August 31, 2018, and the second from September 1 to December 31, 2018. The search for original research and review articles that contained at least one “emergency medicine” search term plus one “global” search term (Data Supplement S2). Additionally, all articles published during 2018 in certain journals that have traditionally published a large number of global EM articles were retrieved to ensure that no relevant articles from these journals were missed by the Medline search. The journals included in this comprehensive retrieval process were Academic Emergency Medicine, African Journal of Emergency Medicine, Annals of Emergency Medicine, Bulletin of the World

Based on the linguistic abilities of our team this year, we restricted our searches to articles published in English, French, Portuguese, and Spanish. All studies were limited to human subjects only; news articles, editorials, case reports, commentaries, and letters to the editor were excluded.

Gray Literature Search
The Web sites of a list of academic, think tank, government, United Nations, and nongovernmental organizations known to conduct significant global health research or implementation work (Data Supplement S3) were methodically searched by two reviewers. This year, the Emergency Nutrition Network and Partners In Health were added to this search. Specifically, needs assessments, program monitoring, evaluation reports, topic reviews, white papers, conference proceedings, and any other work that may be relevant to the field of global EM were sought.

Article Screening
The titles and abstracts of articles identified by these three search strategies were distributed among the reviewers for initial screening based on their relevance to the field of global EM. Those articles that were selected by the reviewers were further reviewed by an editor, and this year additionally by the assistant managing editor and managing editor for appropriateness. The articles that made it through this screening process were then selected for scoring.

Article Scoring
The full text of articles selected for scoring were obtained and classified as either original research (OR) or review (RE) articles. Articles were also categorized as being most relevant to disaster and humanitarian response (DHR), emergency care in resource-limited settings (ECRLS), or emergency medicine development (EMD). DHR articles include research on the care of civilian populations in conflict; disaster migration, assessment, and response; and the health care of refugees and internally displaced people. ECRLS articles focus on research to improve our understanding or management of acute conditions in resource-limited settings. EMD articles include research on the development of EM as a specialty, EM training programs, and emergency medical care systems in countries without advanced health care systems and fully developed EM systems.

Each full-text article was independently scored by two reviewers using a predefined grading scale that assessed each article’s clarity, design, ethics, importance, and impact. Each of these topic areas was scored, totaling a final score range from 0 to 20 (Data Supplement S4). These criteria are designed to help identify methodologically sound and scientifically impactful research in the field of global EM.

The differences between the two scores for each article were then calculated, and the median and standard deviation (SD) of these differences computed. Those articles whose scores differed by more than two SDs from the median were then rescored by an editor using the same 0 to 20 scale. The arithmetic mean of these three scores was then calculated and assigned as the final article score.

Full Article Review
Articles with scores in the top 5% of all scores were then selected for full formal review. These articles were then distributed to reviewers who wrote one-page

Table 1
Summary Statistics for Article Scoring

<table>
<thead>
<tr>
<th></th>
<th>Number (%)</th>
<th>Minimum</th>
<th>25th Percentile</th>
<th>Median</th>
<th>75th Percentile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>517 (100)</td>
<td>5</td>
<td>12</td>
<td>15.5</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Article category</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disaster and humanitarian response (DHR)</td>
<td>129 (25.0)</td>
<td>5</td>
<td>11.5</td>
<td>13.5</td>
<td>15</td>
<td>18.5</td>
</tr>
<tr>
<td>Emergency care in resource-limited settings (ECRLS)</td>
<td>313 (60.5)</td>
<td>5.67</td>
<td>12.5</td>
<td>14</td>
<td>15.75</td>
<td>20</td>
</tr>
<tr>
<td>Emergency medicine development (EMD)</td>
<td>75 (14.5)</td>
<td>5</td>
<td>11.5</td>
<td>13</td>
<td>14.5</td>
<td>17</td>
</tr>
<tr>
<td>Type of research article</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original research (OR) article</td>
<td>400 (77.4)</td>
<td>5</td>
<td>12</td>
<td>14</td>
<td>15.25</td>
<td>19.5</td>
</tr>
<tr>
<td>Review (RE) article</td>
<td>117 (22.6)</td>
<td>6</td>
<td>12</td>
<td>14.5</td>
<td>16.5</td>
<td>20</td>
</tr>
</tbody>
</table>
### Table 2
Global Emergency Medicine Literature Review 2018 Articles

<table>
<thead>
<tr>
<th>Category</th>
<th>First Author</th>
<th>Title</th>
<th>Journal</th>
<th>OR or RE</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disaster and humanitarian response (DHR)</td>
<td>Boulton22</td>
<td>Prehospital haemostatic dressings for trauma: a systematic review</td>
<td>Emerg Med J</td>
<td>RE</td>
<td>Hemostatic dressings in the prehospital environment are effective, but this systematic review was unable to identify a superior type.</td>
</tr>
<tr>
<td></td>
<td>Eckert23</td>
<td>Health-related disaster communication and social media: mixed-method systematic review</td>
<td>Health Commun</td>
<td>RE</td>
<td>This review applies rigorous methodology to analyze the existing quantitative and qualitative literature regarding the use of social media in health disasters.</td>
</tr>
<tr>
<td></td>
<td>Moham-madinia24</td>
<td>Domains and indicators of resilient children in natural disasters: a systematic literature review</td>
<td>Int J Prev Health Commun</td>
<td>RE</td>
<td>This meta-analysis and qualitative evaluation of literature regarding children in natural disasters investigates the various methods used to assess “resiliency” and summarizes the categories in a framework.</td>
</tr>
<tr>
<td></td>
<td>Singh25</td>
<td>Evaluating the effectiveness of sexual and reproductive health services during humanitarian crises: a systematic review</td>
<td>PLoS ONE</td>
<td>RE</td>
<td>This broad review of 40 years of literature on sexual and reproductive health in humanitarian crises highlights evidence-based interventions useful for designing future programs.</td>
</tr>
<tr>
<td>Emergency care in resource-limited settings (ECRLS)</td>
<td>Balk30</td>
<td>Lung ultrasound compared to chest X-ray for diagnosis of pediatric pneumonia: a meta-analysis</td>
<td>Pediatr Pulmonol</td>
<td>RE</td>
<td>Although chest X-ray is the standard imaging modality for diagnosing pediatric community-acquired pneumonia, it has many limitations and is often inaccessible in resource-limited settings. The review demonstrates that lung ultrasound may be a feasible alternative that is more sensitive than chest x-ray in the diagnosis of pediatric pneumonia.</td>
</tr>
<tr>
<td></td>
<td>Broccoli44,45</td>
<td>Essential medicines for emergency care in Africa</td>
<td>Emerg Med J; Afr J Emerg Med</td>
<td>RE</td>
<td>This review proposes an essential medicines list (EML) specifically for emergency care in resource-constrained settings. Through structured literature review and expert consensus, the authors present an EML for emergency care in Africa composed of 213 medicines, 25 of which are new to the emergency-focused EML.</td>
</tr>
<tr>
<td></td>
<td>Chowdhury43</td>
<td>Salbutamol in acute organophosphorus insecticide poisoning - a pilot dose-response phase II study</td>
<td>Clin Toxicol (Phil)</td>
<td>OR</td>
<td>This pilot, proof-of-concept, dose-response randomized controlled trial reports no significant difference in resuscitation parameters and outcomes when adding nebulized salbutamol to the standard treatment of acute self-inflicted organophosphate poisoning in a tertiary care center in Bangladesh.</td>
</tr>
<tr>
<td></td>
<td>Dahn46</td>
<td>Acute care for the three leading causes of mortality in lower-middle-income countries: a systematic review</td>
<td>Int J Crit Illn Inj Sci</td>
<td>RE</td>
<td>Diagnostic and therapeutic interventions for acute presentations related to the three leading causes of mortality in lower-middle-income countries (ischemic heart disease, stroke, and lower respiratory infections) are available and effective, but data are lacking outside of Asia.</td>
</tr>
<tr>
<td></td>
<td>E Silva43</td>
<td>Safety and efficacy of intravenous lidocaine for pain management in the emergency department: a systematic review</td>
<td>Ann Emerg Med</td>
<td>RE</td>
<td>IV lidocaine has been used effectively as an analgesic in well-controlled outpatient and inpatient settings; however, its efficacy and safety in the ED has not been established. This review shows that more study is needed before it can be recommended for an ED population.</td>
</tr>
<tr>
<td></td>
<td>Fleischmann-Struzek30</td>
<td>The global burden of paediatric and neonatal sepsis: a systematic review</td>
<td>Lancet Respir Med</td>
<td>RE</td>
<td>This systematic review and meta-analysis estimated the population-based incidence of sepsis among neonates and children globally, but was only able to use data from high-income settings, thereby limiting generalizability.</td>
</tr>
<tr>
<td></td>
<td>Freedman33</td>
<td>Oral ondansetron administration to nondehydrated children with diarrhea and associated vomiting in emergency departments in Pakistan: a randomized controlled trial</td>
<td>Ann Emerg Med</td>
<td>OR</td>
<td>Nondehydrated children in Pakistan with vomiting as a result of acute gastroenteritis do not benefit from a single oral dose of ondansetron. Ondansetron in these children did not decrease the use of IV fluids.</td>
</tr>
<tr>
<td></td>
<td>Fuchs36</td>
<td>Reviewing the WHO guidelines for antibiotic use for sepsis in neonates and children</td>
<td>Paediatr Int Child Health</td>
<td>RE</td>
<td>A systematic review of recent literature and guidelines regarding antibiotic treatment regimens for bacterial sepsis in neonates and young children in low- and middle-income communities recommends no change in practice.</td>
</tr>
</tbody>
</table>

(Continued)
<table>
<thead>
<tr>
<th>Category</th>
<th>First Author</th>
<th>Title</th>
<th>Journal</th>
<th>OR or RE</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Howie28</td>
<td>Zinc as an adjunct therapy in the management of severe pneumonia among Gambian children: randomized controlled trial</td>
<td>J Glob Health</td>
<td>OR</td>
<td>Providing zinc supplementation to children in Gambia who were being treated for severe pneumonia did not have an impact on treatment failure rates.</td>
</tr>
<tr>
<td></td>
<td>Iro35</td>
<td>Rapid intravenous rehydration of children with acute gastroenteritis and dehydration: a systematic review and meta-analysis</td>
<td>BMC Pediatr</td>
<td>RE</td>
<td>There is very limited evidence, including a paucity of high-quality studies in low-income settings, in support of the WHO guideline for rapid IV rehydration in children with severe dehydration due to acute gastroenteritis.</td>
</tr>
<tr>
<td></td>
<td>Kailemia26</td>
<td>Caregiver oral rehydration solution fluid monitoring charts versus standard care for the management of some dehydration among Kenyan children: a randomized controlled trial</td>
<td>Int Health</td>
<td>OR</td>
<td>When children’s caregivers use a chart to monitor the administration of oral rehydration solution, there is a reduction in the amount of dehydration in children with diarrhea.</td>
</tr>
<tr>
<td></td>
<td>Morton39</td>
<td>The early recognition and management of sepsis in sub-Saharan African adults: a systematic review and meta-analysis</td>
<td>Int J Environ Res Public Health</td>
<td>RE</td>
<td>The first review of early sepsis interventions in adults in sub-Saharan Africa found that protocolized care may be associated with higher mortality, although this conclusion is based on only two of three high-quality studies from the region.</td>
</tr>
<tr>
<td></td>
<td>Nainggolan41</td>
<td>The tolerability and efficacy of oral isotonic solution versus plain water in dengue patients: a randomized clinical trial</td>
<td>Indian J Community Med</td>
<td>OR</td>
<td>This small single-blind randomized controlled trial comparing oral isotonic solution to oral plain water for the treatment of dengue found no statistically significant differences in efficacy or tolerability of the two solutions.</td>
</tr>
<tr>
<td></td>
<td>Nayani29</td>
<td>The clinical respiratory score predicts paediatric critical care disposition in children with respiratory distress presenting to the emergency department</td>
<td>BMC Pediatr</td>
<td>OR</td>
<td>The Clinical Respiratory Score (CRS) is a triage tool previously studied only in high-income settings related to specific respiratory diseases. In this study, the authors validated its expanded use through a prospective observational study of pediatric patients who presented to the ED with a variety of diagnoses in a single-center tertiary care ED in Pakistan.</td>
</tr>
<tr>
<td></td>
<td>Nepal40</td>
<td>Tenecteplase versus alteplase for the management of acute ischemic stroke in a low-income country-Nepal: cost, efficacy, and safety</td>
<td>Cureus</td>
<td>RE</td>
<td>The current evidence for efficacy and safety of IV tenecteplase in comparison to IV alteplase as thrombolytic therapy for acute ischemic stroke is reviewed. Tenecteplase is a reasonable alternative to alteplase, especially in low-income settings.</td>
</tr>
<tr>
<td></td>
<td>Pérez-Gaxiola33</td>
<td>Smectite for acute infectious diarrhoea in children</td>
<td>Cochrane Database Syst Rev</td>
<td>RE</td>
<td>Smectite may reduce duration of diarrhea by 24 hours and increase clinical resolution by day 3 after treatment but conclusions are based on low-quality evidence and trials at high risk of bias.</td>
</tr>
<tr>
<td></td>
<td>Sadruddin27</td>
<td>Comparison of 3 days amoxicillin versus 5 days cotrimoxazole for treatment of fast-breathing pneumonia by community health workers in children aged 2-59 months in Pakistan: a cluster-randomized trial</td>
<td>Clin Infect Dis</td>
<td>OR</td>
<td>A 3-day course of amoxicillin reduced treatment failure and improved compliance when compared to a 5-day course of cotrimoxazole in children younger than 5 years of age with fast-breathing pneumonia.</td>
</tr>
<tr>
<td></td>
<td>Vecino-Ortiz47</td>
<td>Effective interventions for unintentional injuries: a systematic review and mortality impact assessment among the poorest billion</td>
<td>Lancet Glob Health</td>
<td>RE</td>
<td>This systematic review summarizes injury reduction interventions that have effectively reduced mortality, as well as the number of lives that could be saved annually by these interventions if they were implemented for the world’s poorest billion people.</td>
</tr>
<tr>
<td></td>
<td>Williams34</td>
<td>Guidelines for the management of paediatric cholera infection: a systematic review of the evidence</td>
<td>Paediatr Int Child Health</td>
<td>RE</td>
<td>After a thorough systematic review, the authors recommend a change in practice by proposing that a single dose of azithromycin be recommended as first-line treatment of cholera in children.</td>
</tr>
</tbody>
</table>

OR = original research article; RE = review article.
summaries of these articles, including a summary of the key findings and a critique of the results. These full reviews were then edited for style, content, consistency, and objectivity by an editor and the managing editor, as needed, prior to publication as part of this review.

RESULTS

A total of 15,893 articles were identified by the Medline search; an additional 3,098 articles were identified by the comprehensive retrieval process of select journals and 19 articles were identified by the gray literature search. Among these, 25 were written in French, 16 in Portuguese, and 51 in Spanish. After duplicates were screened and removed, a total of 517 articles underwent full scoring (Table 1; Data Supplement S5).

Inter-rater reliability for reviewer scoring, measured using weighted Cohen’s kappa, was 0.213 (95% confidence interval [CI] = 0.160 to 0.267), generally considered “fair” reliability for such studies. Much of the variability in reviewer scores stemmed from the more subjective “importance” and “impact” scores (Data Supplement S4). When these two components of the overall scores were excluded, the weighted Cohen’s kappa improved considerably to 0.426 (95% CI = 0.372 to 0.479).

The threshold score that identified at most 5% of the top-scoring articles was identified as the cutoff for full reviews. For this year’s review, the threshold was 17.5, which identified a total of 25 articles (4.8% of the 517 scored) for full review (Table 2; Data Supplement S6). Of these 25 articles, four (16%) were categorized as DHR and 21 (84%) as ECRLS; no articles from the gray literature search or in the EMD category achieved the threshold score for full review this year. Nine articles (36%) were original research articles and 16 (64%) were review articles. Full summaries and critical analyses of these top-scoring 25 global EM articles of 2018 identified by our search are available as Data Supplement S7.

DISCUSSION

The number of articles identified by our search as relevant to global EM increased by 7.3% compared to last year’s search; however, the addition of a third screening step to verify the relevance of articles to global EM decreased the number of articles for formal scoring by 39%.

As has been the case with previous years’ reviews, the articles that scored highest continued to be dominated by those classified as ECRLS. No EMD articles scored in the top 5% of all articles, which we believe reflects a shortage in the field and thus an opportunity for further research or descriptive studies about the advancement and implementation of emergency care around the world. Most of the highly scored articles this year were review articles, which may represent a maturation of the relevant literature to the degree that high-quality comprehensive syntheses and analyses of existing literature are being published.

A significant limitation of the study is the relatively low interobserver agreement between each set of two reviewers that scored the 517 articles selected for full review. A significant portion of this discrepancy arises from the more subjective “importance” and “impact” components of the scoring rubric (Data Supplement S4). This can be viewed as a disadvantage of the study methods and will warrant increased training for consistency and uniform comprehension and interpretation of the scoring rubric for future reviews. One might also consider these discrepancies to be an advantage, as this reflects the diversity of backgrounds and experiences of the GEMLR reviewers who trained and practice in such a wide variety of different settings around the world. The top-scoring articles thus truly reflect a consensus among diverse reviewers and editors of what are indeed the most impactful global EM articles from the prior year.

Disaster and Humanitarian Response

All four DHR articles identified as top-scoring were review articles. While not entirely unique to global EM, Boulton et al. reviewed various types of prehospital hemostatic dressings for trauma and found little specific evidence to support one type of dressing over another but that there was the most experience and success with QuickClot combat gauze. Given the potentially long delay in transport for definitive trauma care in global settings, this finding has potentially important impact in global trauma settings where a selection of hemostatic dressings must be made; cost and availability would of course still have to be addressed.

The other three DHR articles that scored highly focused on what might be considered relatively new topics in global EM. Eckert et al. reviewed the role of social media in health emergencies—this has growing influence across all of our lives, but especially so...
in developing countries where access to other media may be limited, delayed, or censored. Although the data in this study was mostly from richer countries, no doubt social media will become continue to gain influence globally and will be increasingly used in emergencies. Awareness of the benefits in informing the public and the potential harms of spreading misinformation is important to all practitioners of global EM.

An increasing trend in literature on mental health was exemplified by Mohammadinia et al.24 who attempted to understand what factors into resilience among children in natural disasters. They found a multitude of domains to consider but no perfect definition. Finally, Singh et al.25 reviewed 40 years of literature on sexual and reproductive health to highlight specific interventions that may be useful for future programming in this domain in humanitarian crises.

Emergency Care in Resource-limited Settings

This year’s ECRLS articles were dominated by those most relevant to pediatric EM. Recognizing that accurate weight measurement is fundamental to pediatric care, Shrestha et al.26 showed that the novel PAWPER XL tape facilitated accurate rapid visual weight estimation in a population of Nepali children presenting for emergency care. This method has great potential for improved accuracy of dosing and selection of appropriately sized equipment not only in populations where children are malnourished, but also in populations where a growing number of children are overweight/obese as well.

Four articles focused on pediatric pneumonia, which remains the leading cause of death among children worldwide. Sadruddin et al.27 demonstrated in a cluster-randomized pragmatic trial that a 3-day course of amoxicillin was superior to a 5-day course of cotrimoxazole for children with fast-breathing pneumonia treated in the community. This has significant potential for changing worldwide treatment patterns and additionally help decrease cost and increase compliance. Howie et al.28 conducted a multicenter, placebo-controlled, double-blind, randomized controlled trial (RCT) of zinc added to routine care for community-acquired pneumonia in The Gambia. Although there was no decrease in failure rates, this may have been due to a relatively low rate of baseline zinc deficiency, which should motivate a similar study in a population where zinc deficiency is a more pervasive problem. Nayani et al.29 validated the Clinical Respiratory Score in children presenting to a single ED in Pakistan for determining its predictive value for admission to a critical care unit of the hospital. A simple and affordable scoring system such as this one has great potential for helping with triage and appropriate resource utilization. A review by Balk et al.30 found higher sensitivity using ultrasound compared to X-ray for diagnosing pediatric community-acquired pneumonia, which may help increase rates of pneumonia diagnosis and appropriate treatment worldwide. This is an excellent example of an affordable technology that can be used to democratize and improve care in resource-limited settings.

Another effective use of novel technology was demonstrated by Bilal et al.31 who tested the use of a novel mobile phone application for diagnosing dehydration in children and adults in Bangladesh. The technology was a significant improvement in assessing the degree of dehydration, particularly in adults and older children. Several other important articles studying pediatric gastroenteritis, the second largest cause of pediatric mortality, were also identified.

In terms of treatment, Freedman et al.32 conducted a rigorous, placebo-controlled RCT in Pakistan demonstrating that ondansetron was of little benefit to nondehydrated children with gastroenteritis in the emergency setting. Given the cost of this medication and the assumption that it would be widely useful across many populations, this is important, widely generalizable, evidence that can help limit the use of a potentially expensive medication that may not provide significant clinical benefit in this setting. Pérez-Gaxiola et al.33 conducted a rigorous Cochrane Review of the added benefit of smectite, a clay mineral that may adsorb toxin, to the treatment regimen for children with diarrhea. The review was limited by low-quality evidence and trials at high risk of bias but there was the implication of enough equipoise to justify a rigorously conducted trial with clearer enrollment, methods, and outcome measures. With regard to a specific infection, Williams et al.34 reviewed recent microbiologic and clinical literature to identify the optimal antimicrobial treatment regimen for pediatric cholera infection. After a thorough review that leaned heavily on data from adult patients and with significant consideration to rising rates of antimicrobial resistance, the authors conclude that single-dose azithromycin is the best antibiotic regimen for children with cholera that balances effectiveness with practical delivery.
Iro et al.\textsuperscript{35} attempted to identify RCTs that would provide evidence for or against the World Health Organization (WHO) recommendation for rapid intravenous (IV) fluid resuscitation for children with severe dehydration due to acute gastroenteritis. There were no trials identified in resource-poor settings and only three trials identified overall, none of which produced evidence to support the current WHO recommendation, once again demonstrating that clinical evidence from resource-rich settings may not necessarily apply directly to resource-limited settings in all cases.

Kailemia et al.\textsuperscript{36} conducted a creative RCT wherein children’s caregivers documented oral rehydration solution intake and symptoms during the course of treatment for diarrhea and dehydration. This task-shifting activity proved effective in reducing the rates of dehydration and hospitalization. This may be generalizable to other settings and leveraged to help improve patient care and efficiency for other illnesses also.

Two reviews related to pediatric sepsis were also selected for full review. Fleischmann-Struzek et al.\textsuperscript{37} conducted a systematic review and meta-analysis to attempt to define the burden of pediatric and neonatal sepsis worldwide. However, significant limitations in the availability of literature and data from low-income settings greatly limited the review’s generalizability and provides what is really a lower estimate for pediatric sepsis. Fuchs et al.\textsuperscript{38} conducted a thorough systematic review of appropriate antibiotics for pediatric sepsis in lower-middle-income countries (LMICs) and found no specific evidence to warrant a change in WHO guidelines or common clinical practice.

With regard to adult patients, Morton et al.\textsuperscript{39} conducted the first review of bundled interventions against sepsis among adults in sub-Saharan Africa and found that this protocolized care actually results in higher mortality, emphasizing the importance of local data used to generate local protocols rather than universally applied bundles. Nepal et al.\textsuperscript{40} reviewed tenecteplase as a thrombolytic agent for acute ischemic stroke. When compared to the more widely used alteplase, they found it to be a justifiable alternative in resource-limited settings, given its safety and efficacy profiles as well as lower cost. Nainggolan et al.\textsuperscript{41} conducted a pilot study comparing oral isotonic solution to water for hydration in adults with dengue. Although this very small trial did not demonstrate any statistically significant benefits from the oral isotonic solution, there were small trends toward secondary benefits that are worth exploring in a larger trial.

Another RCT for an important global EM topic was conducted by Chowdhury et al.\textsuperscript{42} who studied the effect of salbutamol (albuterol) on organophosphate poisoning. This pilot study proved to be too small and limited to demonstrate any difference in efficacy between placebo, 2.5 mg of salbutamol, and 5 mg of salbutamol. This does not exclude the possibility that salbutamol would be effective in this setting, but this was not proven in this case. E Silva\textsuperscript{43} conducted a comprehensive review of the use of IV lidocaine for pain management of several common acute conditions with the intention of providing an alternative to opiates. This is a potentially powerful alternative intervention in a time of the global opiate crisis, but also important in places around the world where opiates may not be available. Unfortunately, no clear evidence was found to show its safety and usefulness in the ED setting yet.

Finally, three “big picture” landscape reviews scored highly and were evaluated in full. Broccoli et al.\textsuperscript{44,45} summarized the process by which an essential medicines list (EML) for emergency care providers in Africa was created through a series of consensus meetings. This list has tremendous importance for planners who may want to start EDs and plan for emergency care in places where this development has been relatively decentralized and variable from setting to setting. Dahn et al.\textsuperscript{46} undertook a comprehensive landscape review of acute clinical care for emergency conditions that contribute most to morbidity and mortality in LMICs. This review provides a good starting point for practitioners entering the field and also highlights the need for more contextual local data, as the review was mostly only able to identify data from Asian settings. Vecino-Ortiz et al.\textsuperscript{47} conducted a comprehensive review of interventions to prevent unintentional injuries in LMICs and estimate how many lives might be saved if all of these interventions were able to be implemented throughout countries where the world’s poorest billion live.

CONCLUSIONS

The 2018 Global Emergency Medicine Literature Review again identified several hundred articles related to global EM. The highest scoring articles were all in DHR and ECRLS. New technologies and traditionally less studied topics were well represented, including social media, mental health, sexual and reproductive health, and pain management. This year’s top-scoring
articles were dominated by pediatric infectious emergencies, including pneumonia, gastroenteritis, and sepsis. Several high-quality reviews that help define fundamental issues in the field were also identified that may provide concrete guidance as global EM develops standardized care models. Overall, the clinical research literature in global EM is robust and growing despite many barriers, although large room for growth remains for data emanating from resource-limited settings.

REFERENCES


Appendix A

Global Emergency Medicine Literature Review (GEMLR) Group (in alphabetical order) members:

Holly Bannon-Murphy, MBBS, Emergency and Trauma Centre, Alfred Health, Melbourne, Australia
Susan A. Bartels, MD, MPH, FRCPC, Department of Emergency Medicine and Department of Public Health Sciences, Queen’s University, Kingston, Ontario, Canada
Temesgen Beyene, MD, Department of Emergency Medicine, Addis Ababa University, Addis Ababa, Ethiopia
Joseph Bonney, MBChB, MPH, Emergency Medicine, Komfo Anokye Teaching Hospital, Kumasi, Ghana
Amanda T. Collier, MD, DTM&H, Department of Emergency Medicine, Queen’s University, Kingston, Ontario, Canada
Jolene Cook, MD, Department of Emergency Medicine, Dalhousie University, Halifax, Canada, Hôpital Universitaire de Mirebalais, Mirebalais, Haiti, and Emergency Health Services, Government of Nova Scotia, Halifax, Nova Scotia, Canada
Jonathan W. Dyal, MD, MPH, Department of Emergency Medicine, Brigham and Women’s Hospital, Boston, MA
Kayla T. Enriquez, MD, MPH, Department of Emergency Medicine, University of California, San Francisco, San Francisco, CA
Danica J. Gomes, MD, MSc, Centers for Disease Control and Prevention, Atlanta, GA
Alison S. Hayward, MD, MPH, Department of Emergency Medicine, Brown University, Providence, RI
Wesam M. A. Ibrahim, MBChB, MSc, Department of Emergency Medicine and Traumatology, Tanta University, Tanta, Egypt
Devin M. Keefe, MD, Department of Emergency Medicine, Portsmouth Regional Hospital, Portsmouth, NH
J. Austin Lee, MD, MPH, Department of Emergency Medicine, University of Virginia, Charlottesville, VA
Sangil Lee, MD, MS, Department of Emergency Medicine, University of Iowa, Iowa City, IA
Richard Lowsby, MBChB, FRCEM, DTMH, Emergency Department, Mid Cheshire Hospitals NHS Foundation Trust, Cheshire, UK
Rishi P. Mediratta, MD, MSc, MA, Department of Pediatrics, Stanford University, Stanford, CA
Carl T. Mickman, MD, Department of Emergency Medicine, Mount Sinai Hospital, New York, NY
Benjamin D. Nicholson, MD, Department of Emergency Medicine, Boston Medical Center, Boston, MA
Gerard M. O’Reilly, MBBS, FACEM, MPH, MBiostat, PhD, Emergency and Trauma Centre, The Alfred, and School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia
Pryanka Relan, MD, MPH, Emergency Medicine, Emory Healthcare Network, Atlanta, GA
Kyle T. Ragins, MD, MBA, Department of Emergency Medicine, University of California at Los Angeles, Los Angeles, CA
Eleanor A. Reid, MD, MSc, DTM&H, Department of Emergency Medicine, Yale University, New Haven, CT
Charlott M. Roy, MD, Section of Emergency Medicine, University of Chicago, Chicago, IL
Megan M. Rybarczyk, MD, MPH, Department of Emergency Medicine, Brigham and Women’s Hospital, Boston, MA
Megan L. Schultz, MD, MA, Department of Pediatrics, Medical College of Wisconsin, Milwaukee, WI
Kimberly A. Stanford, MD, Section of Emergency Medicine, University of Chicago, Chicago, IL
Lara D. Vogel, MD, MBA, Harvard Affiliated Emergency Medicine Residency Program, Boston, MA
Alex H. Wang, MD, Department of Emergency Medicine, University of Connecticut, Hartford, CT
Ayalew Zewdie, MD, Department of Emergency Medicine and Critical Care, St. Paul’s Hospital Millennium Medical College, Addis Ababa, Ethiopia

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.13832/full
Data Supplement S1. GEMLR 2018 Procedure Manual.
Data Supplement S2. Medline search terms.
Data Supplement S3. Gray literature sources.
Data Supplement S4. GEMLR scoring criteria.
Data Supplement S5. Complete database of all 517 identified global EM articles for 2018.
Data Supplement S6. Flow diagram of articles selected for review.
Data Supplement S7. Full summaries and critical analyses of the top-scoring GEMLR articles of 2018.
In this issue of *Academic Emergency Medicine*, Iyengar et al. publish a study where patients in the University of Michigan emergency department (ED) were asked about decisions to forgo head CT in minor traumatic brain injury. Participants were given a clinical scenario: their theoretical CT had a one in 100 or one in 1,000 chance of showing an intracranial bleed, but also carried similar risks of developing cancer from CT radiation. Patients also were asked about how a cash incentive paid to them (either $0 or $100) would impact their decision to forgo testing.

The goal of these scenarios was to assess to what degree patients are sensitive to risks and benefits in testing for a common ED situation. In 913 patients, they found that increasing the chance of a hemorrhage from one in 1,000 to one in 100 raised the likelihood patients would want the theoretical CT by 60%, while increasing the risk of cancer increased their likelihood of forgoing the CT by 30% and the financial incentive of $100 by 40%.

This study is timely and important for many reasons. This is because health care in America is in an epic struggle to control health care costs today. ED visits are a focal point of cost reduction discussions and are perceived by many as potentially avoidable and, when they occur, are seen as too intensive and costly. Targeting head CT use in minor head injury prototypical way to lower costs: it is common, an evidence base exists to reduce testing, it involves a high-cost test, and is high stakes where missed diagnoses can worsen outcomes. Yet, the trouble with ED cost reduction efforts is that the myriad stakeholders involved in the decision to CT or not have different perspectives.

Specifically, stakeholder groups of physicians, hospitals, insurance companies, and the patients all have different risks and payoffs in this important decision. Asymmetries in payoffs are common in the field of study in health care economics. One particularly insightful perspective on asymmetry comes from Nicholas Nassim Taleb, a former Wall Street trader turned academic who writes popular books on the topic. Many of his examples and ideas are directly pertinent to the concepts of medicine and to low-value testing. In *The Black Swan: The Impact of the Highly Improbable* (2007), Taleb describes the mathematics behind unpredictable events—termed black swans—that can cause extreme consequences. The black swan analogy refers to the late 1600s discovery by Dutch explorers that black swans exist in Australia. Previously, it was thought that black swans were impossible, because before their discovery, there only were white swans. Examples that Taleb uses for black swan events include the September 11, 2001, attacks and the financial crisis of 2008. At the time, both were unexpected and monumental. By analogy, a positive head CT in a very-low-risk patient is also black swan of sorts: it is also unpredictable and, if undetected, carries extreme consequences for the physician, hospital, and patient.

In a later book *Skin in the Game: Hidden Asymmetries in Daily Life* (2018), Taleb describes that learning and discovery best occurs when people have skin in the game. Skin abrasions are a mechanism of organic signaling, what the Greeks called *pathemata mathemata* (“guide your learning through pain”). Applying these two ideas—black swan and skin in the game—to low-value testing may help elucidate the asymmetries...
between stakeholders, as well as how to address them. Each stakeholder group has different skin in the game when it comes to reducing testing for potential black swans (unpredicted, positive testing) when it comes to their own risk, benefit, and cost.

Let’s take physicians first, and lump us together with hospitals, for now. The decision to order a head CT in a low-probability scenario is not about personal economics: the physician does not benefit directly from a single CT. The choice to order the test is driven by uncertainty of the potential result. There is a deep desire to not “miss” the black swan finding. Less importantly, there is an added benefit of improving the patient’s experience in the ED with a definitive diagnosis, even if it’s negative. There is tremendous skin in the game for emergency physicians in this decision, particularly the hapless doc who discharges a patient with what turns out later to be an intracranial bleed, regardless of whether the patient suffered any poor outcome. Such misses cause personal anguish, as well as the threat of censure in form of local peer review and rare but real threat of malpractice litigation or loss of licensure.6 The hospital is one step removed and has a bit less skin in the game for these decisions but can be similarly harmed by misses through corporate negligence. However, the hospital has a competing desire to utilize their fixed expense resource—i.e., the CT scanner.

In the days before health care costs were on anyone’s radar in America, there was very little push to avoid these tests. Decisions were left entirely to the pen or click of the physician, and more often than not, we’d just order the CT. Why take the risk, we’d think? But the value-based movement has brought a realization by physicians that resources are finite, as well as new ways to think about risk. One solution is the new emerging science of shared decision-making that brings patients into this decision process, i.e., sharing skin in the game—at least theoretically—for black swan events. Shared decision making involves trying to explain the complex tradeoffs to patients, allowing them to help make the decision.7 Yet, an expectation of shared decision making is a tall order: that patients will understand the difference between one in 100 and one in 1,000 and what a head bleed really means as they lie ill and injured in a foreign ED environment, with a white-coated person sharing images of white and black stick figures and speaking in long sentences. Nevertheless, sharing in the decision together and avoiding a costly, likely negative test may help vaccinate the physician (and hospital) from black swan risk and redistribute at least some theoretical the skin in the game to the patient for the “shared” decision. I use the term “may help vaccinate” because there is actually little data to suggest that shared decision making lower actual malpractice risk.8

The novelty of the Michigan study is that it demonstrates that patients are actually sensitive to theoretical differences in risk and do change their desire for testing meaningfully moving from 1% to 0.1% and back. This is the precise probability zone where many high-stakes but low-risk ED decisions occur, including head CTs for minor head injury, but also for acute coronary syndrome, pulmonary embolism, and subarachnoid hemorrhage.

Next, let’s move to another stakeholder: insurance companies. From their perspective, their skin in the game for black swans—or any health care utilization for that matter—is nearly 100% economic. In particular, whether emergency physicians in their network or region decide to practice defensively has implications to what insurers pay, the premiums they charge, and their bottom line. ED decisions—in particular admission and less so, advanced imaging—result in large vectors of expense. In recent years, the stakes have increased as the price of each of these decisions has increased dramatically. Therefore, there is greater focus on reducing low-probability testing, such as head CT and other decisions.

In Taleb’s terms, insurance companies are rent seekers with their use of protective regulations to collect money and do not direct add value to health care delivery. In this role, they cannot directly influence bedside decisions, but they can raise the rent. Their strategy is to redistribute skin in the game to the patient through high-deductible health plans. In a high-deductible plan, insurance only kicks in after the patient has paid, for example, $5,000 in out-of-pocket expenses. In the Michigan study, patients’ desire for testing decreased 40% when their out-of-pocket costs increased from $0 to $100. A February ED visit before the deductible is met results in a patient paying for most of the ED visit cost, including the costly CT scan. Therefore, avoiding a low-value scan likely means a much larger out of pocket cost than $100.

If generalized, this demonstrates that patients in today’s health care system may be even more sensitive to costs than personal risk of black swans when it comes to what they actually may need to pay to avoid one. Insurance companies have also sought to redistribute skin to the provider, through retrospectively
denying claims for visits that were deemed unnecessary after the visit occurred (e.g., S00.93 Contusion of unspecified part of the head). Such efforts to deny payment seem to be redoubled if a thorough hunt for black swans was conducted.

So how can we resolve these asymmetries and improve care for patients, as more powerful and knowledgeable parties seek to redistribute skin in the game for health care risk as well as costs? The answer comes in designing a system where stakeholder perspectives are aligned or at least more aligned than they are today. It is first important to state that there is no perfectly aligned model, because patients and physicians will always have asymmetric information, larger, organized groups like insurance companies will work to maintain the status quo, and there will never be truly equal skin in the game. However, there are some good models out there that get us closer.

One is the Kaiser Permanente model, where the economic and health care outcomes fate of all parties (physician–hospital–insurance) are linked together under the same roof where patients pay a monthly capitated rate.9 In this model, there are strong incentives for the physician and hospital to practice efficiently and safely, as well as economies of scale to develop and implement patient-facing tools that may include shared decision making and clinical decision rules and ensure safety longitudinally through follow-up programs. Kaiser has successfully and safely installed several ED-based clinical decision rules to reduce intensity of care. One of those programs resulted in lower CT use for minor head injury in children and was demonstrated to be safe in recent study.10 In addition, using within network services in Kaiser also helps reduce patient exposure to large out-of-network bills. However, Kaiser does offer some high-deductible health plans, so it does not entirely shield patients. Yet, the challenge, is trying to replicate Kaiser-like structures in open systems.

Another approach is to better align the interests of the ultimate payer (i.e., the employer) with health care providers and create new patient-centered models of care. US Acute Care Solutions (my employer, so full disclosure) has operated the Culinary Care Center (CCC) since 2011, a location in Las Vegas for culinary workers in their families. In this model, there is zero copay for emergency services at the CCC and it funded entirely by the self-insured culinary union. This model reduces the role of health insurance in arbitrating appropriateness and dramatically reduces out-of-pocket and overall costs of care. In the CCC, because patients are able to be seen and return for no additional cost, providers are able to take more of a wait-and-see approach rather than necessarily ordering a CT or searching for other black swans on the first visit.

Ultimately, what is needed is a system where patients can get the right care with access to the best information on their options at a reasonable price and one where skin in the game is appropriately distributed across stakeholders for black swan risks. It is the challenge of our generation to move the broader system in that direction where care is more equitable, high quality, and safe and everyone’s interests are most closely aligned.

Jesse M. Pines, MD, MBA, MSCE
(pinesj@usacs.com)
US Acute Care Solutions, Canton, OH

References

To the Editor:

In a recent issue of *Academic Emergency Medicine*, we read with interest the article “Hospital Observation Upon Reversal (HOUR) with Naloxone: A Prospective Clinical Prediction Rule Validation Study” by Clemency et al.\(^1\) To avoid overreliance on this decision rule and possible untoward effects of early discharge, we feel that there are some key points worth considering in this regard.

It is important to note that the average dose of prehospital naloxone was 3.1 mg, which was administered intranasally (IN) in 85% of the patients. This fact was briefly discussed in the paper in terms of area under the curve (AUC). However, since AUC terminology may not readily translate to clinical meaning for many readers, we feel that expanded discussion on this potential confounder is necessary. A 2-mg IN naloxone dose will produce blood concentrations more than twice that of a 0.4-mg dose administered either IM or IV for at least 2 hours after administration.\(^2\) Therefore, a 3-mg IN dose would be expected to result in blood concentrations significantly more than twice that of IM and IV administration for at least 2 hours afterward. It is known that the effective dose for reversing opioid-induced respiratory depression may be as little as 0.04 mg IV.\(^3\) A 3-mg IN naloxone dose would be expected to produce a blood concentration of naloxone enough to maintain opioid reversal for several hours after the initial dose, providing therapeutic benefit long enough for the opioid to be metabolized.

Given the current opioid epidemic and increasing prevalence of opioid dependence, there is an emphasis placed on the administration of a lower initial, prehospital naloxone dose to avoid precipitated withdrawal. In our locale, prehospital providers are commonly administering 0.4-mg naloxone doses IM or IV. A 0.4-mg dose via these routes of administration would satisfy the HOUR rule and provide reassurance to the provider that discharge is appropriate. The average half-life of naloxone is 64 ± 12 minutes. However, it may be as little as 30 minutes. Additionally, the pharmacologic activity of naloxone may be more short-lived than its half-life would suggest due to rapid redistribution out of the brain.\(^4\) Therefore, although initially satisfying the HOUR rule, recrudescence of opioid toxicity may occur in those who receive smaller IM or IV naloxone doses. Since this scenario was not well represented in this study, we urge caution in applying the HOUR rule in patients who receive smaller IV or IM doses of naloxone. We agree with the authors that more study is needed.

Finally, proper SUD assessment, initiation of medication assisted treatment, and active linkage to proper addiction treatment are becoming common practices in the emergency department. Although feasible in larger academic centers with more resources, many community hospitals cannot accomplish that in 1 hour. In those settings, it is important to emphasize quality of care over speed of disposition.

Andrew Koons, DO
(Andrew.Koons@lvhn.org)
Robert Cannon, DO
Gillian Beauchamp, MD
Kenneth Katz, MD
Matthew Cook, DO
Ryan Surmaitis, DO
Emergency Medicine and Medical Toxicology
Lehigh Valley Health Network
Bethlehem, PA

References


To the Editor:

We appreciate the insights of Dr. Koons and colleagues in response to our study “Hospital Observation Upon Reversal (HOUR) with Naloxone: A Prospective Clinical Prediction Rule Validation Study.” As they noted, a majority (85.4%) of our patients received intranasal (IN) naloxone rather than parenteral (IV) naloxone. This finding mirrors the national trend of increasing IN naloxone utilization. IN naloxone has many potential advantages over IV naloxone, especially when administered by individuals without formal medical training. We agree that it is ideal to administer a low initial dose of naloxone followed by a slow-dose titration to achieve reversal of respiratory depression, and we encourage trained medical professionals to follow this approach. However, this is not practical for EMTs, law enforcement officers, firefighters, or laypersons who generally have less training than paramedics, but who are more ubiquitous and more likely to be the first to encounter a patient who has overdosed. This is especially true for responders who do not have training in supportive airway management. In these scenarios, it is imperative to rapidly administer a dose of naloxone that will reverse the patient’s respiratory depression while awaiting emergency medical services. Although larger doses may precipitate opioid withdrawal, the minor risks associated with this are far outweighed by the benefits of a restored respiratory drive.

It is important to consider the pharmacokinetic differences of IN naloxone. However, the clinical implications of these differences are not well established. The absorption and onset of action of IN naloxone are similar to intramuscular (IM) naloxone, but are slower than IV naloxone. The delayed onset can create a false impression that the dose was inadequate and may result in unnecessary redosing and opioid withdrawal symptoms. The prolonged absorption of IN naloxone also contributes to a higher area under the curve when compared to IV naloxone. This means that although administering 4 mg of IN naloxone and 0.4 mg of IV naloxone results in nearly identical peak serum levels, IN naloxone maintains a higher concentration in the blood than IV naloxone over a 120-minute period. Although these data support that IN naloxone remains in circulation for a longer time than IV naloxone, it does not provide any evidence that there is a difference in the pharmacodynamics (the duration of naloxone’s clinical effect) after IN or IV administration. Although pharmacokinetics can be helpful in guiding patient care, it is important to recognize that they do not always correlate to the duration of a drug’s clinical effects (pharmacodynamics).

This clinical prediction rule is designed to inform the discussion about the risks of recurrent toxicity during the shared decision-making process, but it is just one piece of the puzzle. We strongly agree with Dr. Koons and colleagues that initiating medication assisted treatment, establishing linkage to care, reviewing high-risk opioid behaviors (using opioids alone or in combination with other central nervous system depressants), and providing take-home naloxone are important components of appropriate patient care. Emergency physicians should not rush to discharge patients until all of these pieces are addressed.

Brian M. Clemency, DO
William Eggleston, PharmD
Heather A. Lindstrom, PhD
(hlindstrom@ecmc.edu)

1 Department of Emergency Medicine University at Buffalo Jacobs School of Medicine and Biomedical Sciences Buffalo, NY
2 Upstate New York Poison Center Syracuse, NY

Supervising Editor: John H. Burton, MD
References

Pediatric major trauma.” The cold announcement echoes.

As my resident and I joke in the empty trauma bay, someone writes on the whiteboard: “Drowning, CPR, age unknown.” Our smiles dissipate. We all think the same thing.

“Damn.”

A lifeless girl rolls in on the gurney. She’s intubated, and one hand is rhythmically compacting her small chest. Broselow tape at bedside, we go with orange. It’s a quick EMS report: she drowned. Father went into the house while she played in the pool unattended.

Epinephrine, sodium bicarbonate, calcium. Compressions. Breaths. Two minutes exactly. Asystole. Repeat. Our team is in sync. All eyes are on the motionless, delicate body.

The father stumbles into the trauma bay, sobbing, hands quivering as he tries to hold his face. He knows. He’s accepted. “It’s OK baby.”

I look at my resident. Tears pool at the bottom of his eyes. I stare at our patient. I glance at the father. I can’t hold it back anymore, but I try. God knows I try.

The intensivist gathers the attendings to discuss ending the resuscitation. He says that even if we obtain ROSC, prognosis is poor. I know he is right, but I am angry. So angry. How can he say that? I refuse to give up.

Grandmother then arrives to the quiet room. Cruelly, another drowning rings overhead. “Can you talk to family while I go to the other trauma?” the surgeon asks. He must see my red, weepy eyes and hear my uncontrollable congestion.

“Yes, I’ll tell family.”

Deep breath after deep breath, I try to pull myself together. There she is. Grandmother is standing outside the door. She is so serene.

I lose it.

Completely.

“I’m so sorry,” I muster. She meets me in the middle of the fluorescent-lit hallway. “It’s OK.” Her embrace is comforting. I wrap my arms around her, squeezing tight. I uncontrollably sob into her right shoulder.

“It’s OK, baby. Look at you. There’s nothing you could do.” My soul needs this. She shouldn’t be worried about me, but for some reason, she holds me. I hold her. The social worker finally intervenes, sensing I would never let go, “Dr. Lew, they need you in the ER.”

I sit at my computer. I feel paralyzed. There are patients to be seen, residents to be supervised—the department must go on. EKGs continue to be thrust in my face. Phones continue to ring. Stuff continues to ask questions. The chaos must be controlled. I know this. But, I still can’t move.

The other ED attending finally breaks my unresponsiveness. Fortunately, his drowning patient lived. I immediately think, “Why couldn’t I save her? What did I do wrong?”

He hugs me, giving me the reprieve I need. “Take your time. I’ll manage your side.”

I rush out the double-doors and sit on a nearby cold, concrete curb. The sun warms my back as I cradle my head in between my knees.

I cry.

And I cry—drowning in my own tears.
Somehow I stop. My heart has no more to give. It’s empty. I stand up and inspect my surroundings. Green leaves are still carelessly floating in the wind. People are still laughing and spiritedly conversing. Ambulances never seem to stop—sirens blazing, gurneys roll in and out.

I take the deepest breath possible. The fresh air expands my lungs and feels rejuvenating. I close my eyes. I exhale wholly. I purposefully walk through the sliding doors. A girl has drowned and so has my soul. But, I am the one who has survived. I live with this.

Edward K. Lew, MD
(lewe@ohsu.edu)
Department of Emergency Medicine
Oregon Health & Science University
Portland, OR

Supervising Editor: Brian Zink, MD