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WEBSITE
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ART

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Art Director
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PRODUCTION AND MANUFACTURING

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CIRCULATION

Subscription Service:
(833) 836-2705
custsvc.jhm@fulcoinc.com

PUBLISHING STAFF

Publisher
Mark Branca
(973) 290-8246
mbranca@mdedge.com

Advertising Sales
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Cell (973) 202-5402
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Association between Inpatient Delirium and Hospital Readmission in Patients ≥ 65 Years of Age: A Retrospective Cohort Study

Sara C LaHue, MD[1,2]; Vanja C. Douglas, MD[1,2]; Teresa Kuo, MD[3]; Carol A Conell, PhD[4]; Vincent X Liu, MD, MS[4]; S Andrew Josephson, MD[1,2]; Clay Angel, MD[5]; Kristen B Brooks, MD[6]

[1]Department of Neurology, School of Medicine, University of California, San Francisco, California; [2]Weill Institute for Neurosciences, Department of Neurology, University of California, San Francisco, California; [3]Department of Medicine, Kaiser Permanente San Francisco Medical Center, San Francisco, California; [4]Division of Research, Kaiser Permanente Northern California, Oakland, California; [5]Department of Hospital Medicine, Kaiser Permanente San Rafael Medical Center, San Rafael, California; [6]Department of Psychiatry, Kaiser Permanente San Rafael Medical Center, San Rafael, California.

BACKGROUND: Delirium affects more than seven million hospitalized adults in the United States annually. However, its impact on postdischarge healthcare utilization remains unclear.

OBJECTIVE: To determine the association between delirium and 30-day hospital readmission.

DESIGN: A retrospective cohort study.

SETTING: A general community medical and surgical hospital.

PATIENTS: All adults who were at least 65 years old, without a history of delirium or alcohol-related delirium, and were hospitalized from September 2010 to March 2015.

MEASUREMENTS: The patients deemed at risk for or displaying symptoms of delirium were screened by nurses using the Confusion Assessment Method with a follow-up by a staff psychiatrist for a subset of screen-positive patients. Patients with delirium confirmed by a staff psychiatrist were compared with those without delirium. The primary outcome was the 30-day readmission rate. The secondary outcomes included emergency department (ED) visits 30 days postdischarge, mortality during hospitalization and 30 days postdischarge, and discharge location.

RESULTS: The cohort included 718 delirious patients and 7,927 nondelirious patients. Using an unweighted multivariable logistic regression, delirium was determined to be significantly associated with the increased odds of readmission within 30 days of discharge (odds ratio (OR): 2.60; 95% CI, 1.96-3.44; $P < .0001$). Delirium was also significantly ($P < .0001$) associated with ED visits within 30 days postdischarge (OR: 2.18; 95% CI: 1.77-2.69) and discharge to a facility (OR: 2.52; 95% CI: 2.09-3.01).

CONCLUSIONS: Delirium is a significant predictor of hospital readmission, ED visits, and discharge to a location other than home. Delirious patients should be targeted to reduce postdischarge healthcare utilization. *Journal of Hospital Medicine* 2019;14:201-206. © 2019 Society of Hospital Medicine

Delirium is an acute change in mental status, affecting more than seven million hospitalized patients in the United States annually.[1] Several factors increase the risk of developing delirium, including advanced age,[2] cognitive dysfunction,[3] hearing and vision impairment,[4-6] and severe illness or major surgery.[7] Delirium may be precipitated during hospitalization by common inpatient interventions, such as the use of physical restraints, polypharmacy, or bladder catheters.[4,8] In-hospital delirium impacts an estimated 10%-15% of the general medical admissions and as many as 81% of patients in the intensive care unit (ICU).[9-11] Despite the relative frequency with which delirium is encountered in the hospital, subsequent emergency department (ED) presentations or hospital readmissions for these patients are poorly characterized.

The development of delirium is associated with several negative outcomes during the hospital stay. Delirium is an independent predictor of prolonged hospital stay,[7,9,12,13] prolonged mechanical ventilation,[14] and mortality during admission.[14,15] Inpatient delirium is associated with functional decline at discharge, leading to a new nursing home placement.[16-19] Preexisting dementia is exacerbated by inpatient delirium, and a new diagnosis of cognitive impairment[20] or dementia becomes more common after an episode of delirium.[21]

These data suggest that people diagnosed with delirium may be particularly vulnerable in the posthospitalization period. Hospitals with high rates of unplanned readmissions face penalties from the Centers for Medicare and Medicaid Services.[22,23] However, few investigations have focused on postdischarge healthcare utilization, such as readmission rates and ED visits. Studies that address this topic are limited to postoperative patient populations.[24]

***Corresponding Author:** Sara Catherine LaHue, MD; E-mail: Sara.LaHue@ucsf.edu; Telephone: 415-476-1489.

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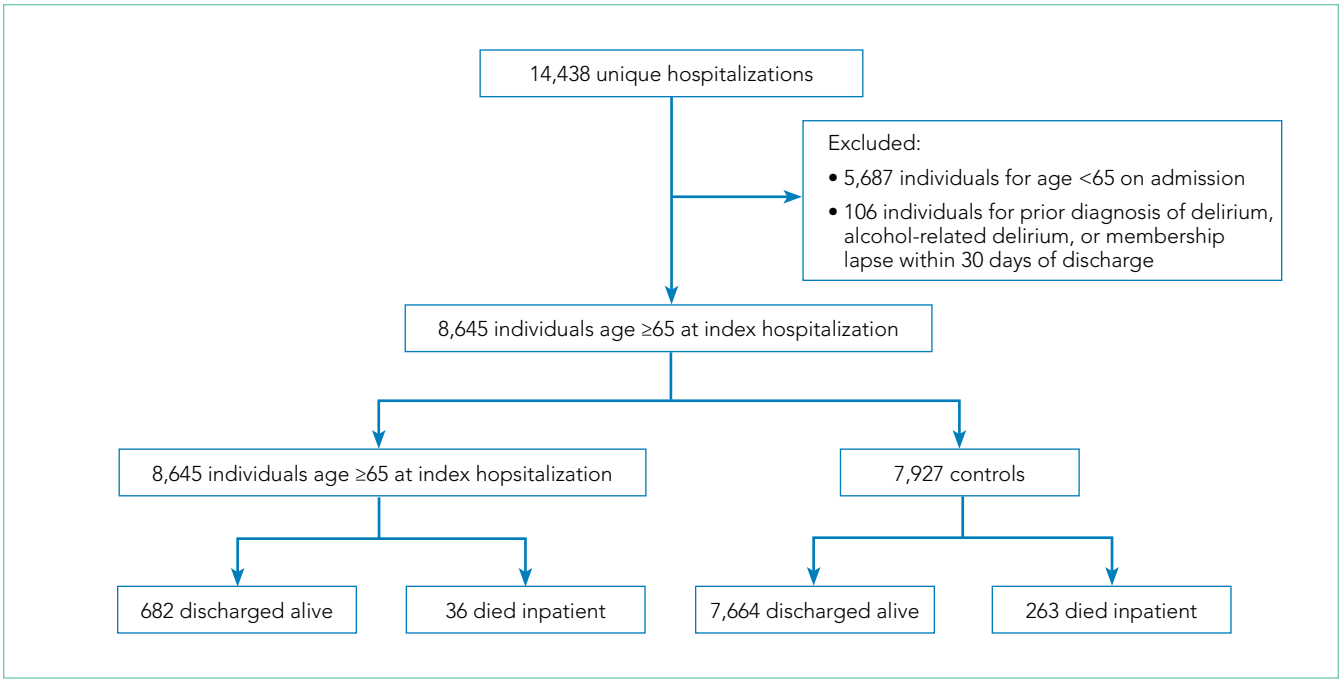

FIG. Subject acquisition flow diagram.

Using a cohort of hospitalized patients, we examined whether those diagnosed with delirium experienced worse outcomes compared with patients with no such condition. We hypothesized that the patients diagnosed with delirium during hospitalization would experience more readmissions and ED visits within 30 days of discharge compared with those without delirium.

METHODS

Study Design

This single-center retrospective cohort study took place at the Kaiser Permanente San Rafael Medical Center (KP-SRF), a 116-bed general community medical and surgical hospital located in Northern California, from September 6, 2010 to March 31, 2015. The Kaiser Permanente Northern California institutional review board, in accordance with the provisions of the Declaration of the Helsinki and International Conference on Harmonization Guidelines for Good Clinical Practice (CN-15-2491-H), approved this study.

Participants and Eligibility Criteria

This study included Kaiser Permanente members at least 65 years old who were hospitalized at KP-SRF from September 2010 to March 2015. Patient data were obtained from the electronic medical records. Patients with delirium were identified from a delirium registry; all other patients served as controls.

Starting on September 6, 2010, a hospital-wide program was initiated to screen hospitalized medical and surgical patients using the Confusion Assessment Method (CAM).[25] As part of this program, nurses completed a four-hour training on delirium; the program included delirium identification and CAM administration. Patients deemed at risk for delirium by their nurse or displaying symptoms of delirium (fluctuation in attention or awareness, disorientation, restlessness, agitation, and psychomotor slowing) were screened by nurses one to two times within a 24-hour period. Physicians were notified by the nurse if their patient screened positive. Nurses were prohibited from performing CAMs in languages that they were not fluent in, thus resulting in screening of primarily English-speaking patients. Psychiatry was consulted at the discretion of the primary team physician to assist with diagnosis and management of delirium. As psychiatry consultation was left up to the discretion of the primary team physician, not all CAM-positive patients were evaluated. The psychiatrists conducted no routine evaluation on the CAM-negative patients unless requested by the primary team physician. The psychiatrist confirmed the delirium diagnosis with a clinical interview and assessment. The patients confirmed with delirium at any point during their hospitalization were prospectively added to a delirium registry. The patients assessed by the psychiatrist as not delirious were excluded from the registry. Only those patients added to the delirium registry during the study period were classified as delirious for this study. All other patients were included as controls. The presence of the nursing screening program using the CAM enriched the cohort, but a positive CAM was unnecessary nor was it sufficient for inclusion in the delirium group (Table 1).

To eliminate the influence of previous delirium episodes on readmission, the subjects were excluded if they reported a prior diagnosis of delirium in 2006 or later, which was the year the electronic medical record was initiated. This diagnosis was determined retrospectively using the following ICD-9 codes: 290.11, 290.3, 290.41, 292.0, 292.81, 292.89, 293.0, 293.0E, 293.0F, 293.1, 293.89, 294.10, 294.21, 304.00, 304.90, 305.50, 331.0, 437.0, 780.09, V11.8, and V15.89.[26] Subjects were also excluded if they were ever diagnosed with alcohol-related delirium, as defined

by ICD-9 codes 291, 303.9, and 305. Subjects were excluded from the primary analysis if Kaiser Permanente membership lapsed to any degree within 30 days of discharge. Patients who died in the hospital were not excluded; however, the analyses of postdischarge outcomes were conducted on the subpopulation of study subjects who were discharged alive.

For subjects with multiple entries in the delirium registry, the earliest hospitalization during the study period in which a delirium diagnosis was recorded was selected. For eligible patients without a diagnosis of delirium, a single hospitalization was selected randomly from the individual patients during the time period. The analysis database included only one hospitalization for each subject. The flowchart of patient selection is outlined in the Figure.

Patient Characteristics

Patient demographics and clinical data were obtained from the electronic medical records. We used several scores to characterize illness severity, including the Charlson comorbidity index,[27] Laboratory-Based Acute Physiology, version 2 (LAPS2) score[28]—an externally validated score for acute severity of illness—and disease categories as defined by the Healthcare Cost and Utilization Project (HCUP).[29]

Outcomes

The primary outcome was the rate of readmission to the hospital within 30 days of discharge from the hospitalization in which delirium was first diagnosed. Readmissions and ED visits to any Kaiser Permanente hospital and to hospitals outside of the Kaiser Permanente network with Kaiser Permanente insurance were captured. To avoid incorrectly coding patients transferred from the index hospital to another hospital as readmissions, we excluded readmissions that occurred on the day of discharge or the following calendar day. This action was expected to lower the absolute number of readmissions but restrict the analysis to true readmissions. The models of postdischarge outcomes are based on the subset of patients discharged alive. The secondary outcome measures included discharge from the index hospitalization to a skilled nursing facility or hospice rather than to home and emergency room visits within 30 days of discharge. We also quantified rates of mortality during hospitalization and at 30 days postdischarge.

Statistical Analysis

Comparisons between patients with delirium and those without were performed using Pearson's X^2 test for categorical variables and student t-test for continuous variables. The estimated odds of our outcome measures for delirious and nondelirious subjects were calculated from multivariable logistic regression models, which controlled for predictors of delirium and additional information obtained during the hospitalization. For inpatient outcomes (in-hospital mortality and discharge to skilled nursing facility or hospice), we adjusted only for admission characteristics: age, race/ethnicity, admission to ICU, Charlson comorbidity index, HCUP category, and admission category. To limit the number of variables in our model, we consolidated the initial 30 HCUP categories (Appendix Table 1) by illness type into 13 categories (Appendix Table 2). For postdischarge outcomes, we adjusted for all the variables, including disposition (Table 2). The average estimated odds were calculated based on the observed marginal distribution of the control variables. The *P* value indicates how likely the odds on each outcome for delirious subjects differed significantly from those for other subjects. All statistical analyses were performed using SAS 9.3 (SAS Institute Inc., Cary, North Carolina).

TABLE 1. **Delirium Assessments Included in Exposed and Unexposed Groups**

Assessment	Delirium + (Exposed)	Delirium – (Unexposed)
Nurse CAM Screen	CAM+ or CAM–	CAM+ or CAM–
Psychiatrist Delirium Assessment	+DSM IV Delirium	–DSM IV Delirium or no psychiatry assessment

Abbreviations: CAM, confusion assessment method; DSM IV, Diagnostic and Statistical Manual of Mental Disorders 4th edition.

RESULTS

Demographics and Clinical Characteristics

A total of 718 patients with delirium and 7,927 patients without delirium were included in this study. The related demographic information is outlined in Table 2. On average, the patients with delirium were older (83 ± 8 years versus 77 ± 8 years, $P < .0001$) but no difference in gender distribution was observed between groups. A similar racial breakdown was noted between groups, with white patients accounting for 87% of both patients with delirium and those without. The majority of admissions were unplanned medical admissions. The delirium cohort included more emergent surgical admissions compared with patients who did not develop delirium. Patients who developed delirium exhibited higher levels of illness severity on admission, as measured by the Charlson and LAPS2 scores, and were more often admitted to the ICU. Significant differences were also observed between admission illness categories between patients with delirium and those without.

Primary Outcome

Delirium during admission was significantly associated with hospital readmission within 30 days of discharge (adjusted odds ratio [aOR] = 2.60, 95% CI: 1.96–3.44; $P < .0001$; Table 3).

Secondary Outcomes

Delirium during admission was significantly ($P < .0001$; Table 3) associated with an ED visit within 30 days of discharge (OR: 2.18; 95% CI: 1.77–2.69) and discharge to a skilled nursing facility or hospice rather than home (OR: 2.52; 95% CI: 2.09–3.01). Delirium was not associated ($P > .1$) with death during hospitalization nor death 30 days following discharge.

As the delirious patients were much more likely to be discharged to a skilled nursing facility than nondelirious patients, we tested whether discharge disposition influenced readmis-

TABLE 2: **Patient Demographics Featuring Raw Observational Cohort Data**

Variable	Delirium (n = 718)	No Delirium (n = 7,927)	*P* Value
Age on Admission (years)	83 ± 8	77 ± 8	<.0001
Female	409 (57%)	4,493 (57%)	.9
Race			.6
White (NonHispanic)	626 (87%)	6,900 (87%)	
Black	7 (1%)	107 (1%)	
Hispanic	24 (3%)	306 (4%)	
Asian	18 (3%)	221 (3%)	
Not Elsewhere Classified	43 (6%)	393 (5%)	
Admission Category			<.0001
Medical – Emergent	483 (67%)	4,395 (55%)	
Medical – Planned	59 (8%)	939 (12%)	
Surgical – Emergent	115 (16%)	713 (9%)	
Surgical – Planned	61 (8%)	1,880 (24%)	
Admission Location			<.0001
Intensive Care Unit	64 (9%)	432 (5%)	
NonIntensive Care Unit	654 (91%)	7,495 (95%)	
Charlson Score	1.4 ± 1.3	1.0 ± 1.5	<.0001
LAPS2 Score	75.5 ± 41.1	47.8 ± 36.6	<.0001
HCUP Category			<.0001
Acute Infection	118 (16%)	588 (7%)	
Renal and Electrolyte Disorders	11 (2%)	121 (2%)	
Neurologic and Psychiatric Disorders	135 (19%)	806 (10%)	
Acute Cardiac Disease	26 (4%)	357 (5%)	
Hip Fracture	60 (8%)	184 (2%)	
Endocrine and Related Conditions	17 (2%)	177 (2%)	
Gastrointestinal Disorders	17 (2%)	403 (3%)	
Cancer	10 (1%)	372 (5%)	
Other Infections	23 (3%)	257 (3%)	
Low Acuity Conditions	128 (18%)	2,316 (29%)	
Surgical Conditions	73 (10%)	1,482 (19%)	
Trauma	54 (8%)	402 (5%)	
Acute Pulmonary disease	46 (6%)	462 (6%)	
Length of Hospital Stay (Days)	7.4 ± 9.3	3.4 ± 4.1	<.0001
Duration of time in ICU (Hours)	25.8 ± 114.1	5.6 ± 31.7	<.0001
Serum hemoglobin on discharge	11.1 ± 1.6	11.5 ± 1.7	<.0001
Serum sodium on discharge	138.2 ± 4.5	137.2 ± 3.9	<.0001
Disposition Location			<.0001
Home	334 (47%)	6,373 (80%)	
Hospice	58 (8%)	280 (4%)	
Skilled Nursing Facility	284 (40%)	1,009 (13%)	
Death	42 (6%)	265 (3%)	

Mean ± standard deviation or total with percent from total subject group.
Abbreviations: HCUP, Healthcare Cost and Utilization Project ICU, intensive care unit; LAPDS2, Laboratory Acute Physiology Score, version 2.

sion rates and ED visits between delirious and nondelirious patients in an unadjusted univariate analysis. The association between delirium and readmission and ED utilization was present regardless of disposition. Among patients discharged to skilled nursing, readmission rates were 4.76% and 13.38% ($P < .001$), and ED visit rates were 12.29% and 23.24% ($P < .001$) for nondelirious and delirious patients, respectively. Among patients discharged home, readmission rates were 4.96% and 14.37% ($P < .001$), and ED visit rates were 11.93% and 29.04% ($P < .001$) for nondelirious and delirious patients, respectively.

DISCUSSION

In this study of patients in a community hospital in Northern California, we observed a significant association between inpatient delirium and risk of hospital readmission within 30 days of discharge. We also demonstrated increased skilled nursing facility placement and ED utilization after discharge among hospitalized patients with delirium compared with those without. Patients with delirium in this study were diagnosed by a psychiatrist—a gold standard[30]—and the study was conducted in a health system database with near comprehensive ascertainment of readmissions. These results suggest that patients with delirium are particularly vulnerable in the posthospitalization period and are a key group to focusing on reducing readmission rates and postdischarge healthcare utilization.

Identifying the risk factors for hospital readmission is important for the benefit of both the patient and the hospital. In an analysis of Medicare claims data from 2003 to 2004, 19.6% of beneficiaries were readmitted within 30 days of discharge.[31] There is a national effort to reduce unplanned hospital readmissions for both patient safety as hospitals with high readmission rates face penalties from the Centers for Medicare and Medicaid Services.[22,23] Why delirium is associated with readmission remains unclear. Delirium may precipitate aspiration events, reduce oral intake which complicates medication administration and nutrition, or reduced mobility, leading to pulmonary emboli and skin breakdown, any of which could lead to readmission.[32] Delirium may also accelerate the progression of cognitive decline and overall loss of functional independence.[20] Delirious patients can be difficult to care for at home, and persistent delirium may lead to returns to the ED and readmission. Strategies to reduce readmissions associated with delirium may need to focus on both prevention of hospital-acquired delirium and targeted caregiver and patient support after discharge.

Hospital readmission and ED visits are not mutually exclusive experiences. In the United States, the majority of patients admitted to the hospital are admitted through the ED.[33] Thus, most of the readmissions in this cohort were also likely counted as 30-day ED visits. However, as ED utilization occurs regardless of whether a patient is discharged or admitted from the ED, we reported all ED visits in this analysis, similar to other studies.[34] More delirium patients returned to the ED 30 days postdischarge than were ultimately readmitted to the hospital, and delirious patients were more likely to visit the ED or be readmitted than nondelirious patients. These observations point toward the first 30 days after discharge as a crucial period for these patients.

TABLE 3: **Risk of Clinical outcomes in Patients with and without Delirium**

Clinical Outcome	Delirium (95% CI)	Controls (95% CI)	Odds Ratio (95% CI)	*P* Value
Hospital Readmission 30 Days Postdischarge	5.7 (3.5-9.1)	2.2 (1.4-3.3)	2.60 (1.96-3.44)	<.0001
In-hospital Mortality	1.5 (0.8-2.7)	2.1 (1.3-3.3)	0.74 (0.51-1.06)	.1025
Discharge to SNF or hospice	58.8 (45.5-76.1)	23.3 (19.2-28.3)	2.52 (2.09-3.01)	<.0001
Emergency Department Visits 30 Days Postdischarge	20.6 (15.1-28.2)	9.5 (7.3-12.3)	2.18 (1.77-2.69)	<.0001
Mortality 30 Days Postdischarge	4.5 (2.6-7.8)	5.4 (3.5-8.5)	0.83 (0.60-1.16)	.2765

Abbreviations: CI, confidence interval; SNF, skilled nursing facility.

Our study features several strengths. To our knowledge, this study is one of the largest investigations of inpatients with delirium. One distinguishing feature was that all cases of delirium in this study were diagnosed by a psychiatrist, which is considered a gold standard. Many studies rely solely on brief nursing-administered surveys for delirium diagnosis. Using Kaiser Permanente data allowed for more complete follow-up of patients, including vital status. Kaiser Permanente is both a medical system and an insurer, resulting in acquisition of detailed health information from all hospitalizations where Kaiser Permanente insurance was used for each patient. Therefore, patients were only lost to follow-up following discharge in the event of a membership lapse; these patients were excluded from analysis. The obtained data are also more generalizable than those of other studies examining readmission rates in delirious patients as the hospital where these data were collected is a 116-bed general community medical and surgical hospital. Thus, the patients enrolled in this study covered multiple hospital services with a variety of admission diagnoses. This condition contrasts with much of the existing literature on inpatient delirium; these studies mostly center on specific medical conditions or surgeries and are often conducted at academic medical centers. At the same time, Kaiser Permanente is a unique health maintenance organization focused on preventive care, and readmission rates are possibly lower than elsewhere given the universal access to primary care for Kaiser Permanente members. Our results may not generalize to patients hospitalized in other health systems.

The diagnosis of delirium is a clinical diagnosis without biomarkers or radiographic markers and is also underdiagnosed and poorly coded.[32] For these reasons, delirium can be challenging to study in large administrative databases or data derived from electronic medical records. We addressed this limitation by classifying the delirium patients only when they had been diagnosed by a staff psychiatrist. However, not all patients who screened positive with the CAM were evaluated by the staff psychiatrist during the study period. Thus, several CAM-positive patients who were not evaluated by psychiatry were included in the control population. This situation may cause bias toward identification of more severe cases of delirium. Although the physicians were encouraged to consult the psychiatry department for any patients who screened positive for delirium with the CAM, the psychiatrist may not have been involved if patients were managed without consultation. These patients may have exhibited less severe delirium or hypoactive delirium. In addition, the CAM fails to detect all delirious patients; interrater variability may occur with CAM administration, and non-English speaking patients are more likely to be excluded.[35] These situations are another possible way for our control population to include some delirious patients and those patients with less severe or hypoactive subtypes. While this might bias toward the null hypothesis, it is also possible our results only indicate an association between more clinically apparent delirium and readmission. A major limitation of this study is that we were unable to quantify the number of cohort patients screened with the CAM or the results of screening, thus limiting our ability to quantify the impact of potential biases introduced by the screening program.

This study may have underestimated readmission rates. We defined readmissions as all hospitalizations at any Kaiser Permanente facility, or to an alternate facility where Kaiser Permanente insurance was used, within 30 days of discharge. We excluded the day of discharge or the following calendar day to avoid mischaracterizing transfers from the index hospital to another Kaiser Permanente facility as readmissions. This step was conducted to avoid biasing our comparison, as delirious patients are less frequently discharged home than nondelirious patients. Therefore, while the relative odds of readmission between delirious and nondelirious patients reported in this study should be generalizable to other community hospitals, the absolute readmission rates reported here may not be comparable to those reported in other studies.

Delirium may represent a marker of more severe illness or medical complications accrued during the hospitalization, which could lead to the associations observed in this study due to confounding.[32] Patients with delirium are more likely to be admitted emergently, admitted to the ICU, and feature higher acuity conditions than patients without delirium. We attempted to mitigate this possibility by using a multivariable model

to control for variables related to illness severity, including the Charlson comorbidity index, HCUP diagnostic categories, and ICU admission. Despite including HCUP diagnostic categories in our model, we were unable to capture the contribution of certain diseases with finer granularity, such as preexistent dementia, which may also affect clinical outcomes.[36] Similarly, although we incorporated markers of illness severity into our model, we were unable to adjust for baseline functional status or frailty, which were not reliably recorded in the electronic medical record but are potential confounders when investigating clinical outcomes including hospital readmission.

We also lacked information regarding the duration of delirium in our cohort. Therefore, we were unable to test whether longer episodes of delirium were more predictive of readmission than shorter episodes.

CONCLUSION

In-hospital delirium is associated with several negative patient outcomes. Our study demonstrates that delirium predicts 30-day readmission and emergency department utilization after hospital discharge. Bearing in mind that a third of hospital-acquired delirium cases may be preventable,[32] hospitals should prioritize interventions to reduce postdischarge healthcare utilization and complications in this particularly vulnerable group.

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State of Research in Adult Hospital Medicine: Results of a National Survey

Vineet Chopra, MD, MSc[1]*; Marisha Burden, MD[2]; Christine D Jones, MD, MS[2]; Stephanie Mueller, MD, MPH[3]; Vineet Gupta, MD[4]; Neera Ahuja, MD[5]; Alana Sigmund, MD[6]; Shaker M Eid, MD, MBA[7]; on behalf of the Society of Hospital Medicine Research Committee[8].

[1]The Division of Hospital Medicine, Department of Medicine, University of Michigan, Ann Arbor, Michigan; [2]Division of Hospital Medicine, University of Colorado, Aurora, Colorado; [3]Hospital Medicine Unit, Division of General Internal Medicine, Brigham and Women's Hospital, Boston, Massachusetts; [4]Division of Hospital Medicine, University of California San Diego, San Diego, California; [5]Section of Hospital Medicine, Stanford University School of Medicine, Palo Alto, California; [6]Hospital for Special Surgery, New York, New York; [7]Division of Hospital Medicine, Johns Hopkins Bayview Medical Center, Baltimore, Maryland; [8]Society of Hospital Medicine, Philadelphia, Pennsylvania.

BACKGROUND: Little is known about the state of research in academic hospital medicine (HM) despite the substantial growth of this specialty.

METHODS: We used the Society of Hospital Medicine (SHM) membership database to identify research programs and their leadership. In addition, the members of the SHM Research Committee identified individuals who lead research programs in HM. A convenience sample of programs and individuals was thus created. A survey instrument containing questions regarding institutional information, research activities, training opportunities, and funding sources was pilot tested and refined for electronic dissemination. Data were summarized using descriptive statistics.

RESULTS: A total of 100 eligible programs and corresponding individuals were identified. Among these programs, 28 completed the survey in its entirety (response rate 28%). Among the 1,586 faculty members represented in the 28 programs, 192 (12%) were identified as engaging in or having obtained extramural funding for research, and 656 (41%) were identified as engaging in quality improvement efforts. Most programs (61%) indicated that they received $500,000 or less in research funding, whereas 29% indicated that they received >$1 million in funding. Major sources of grant support included the Agency for Healthcare Research and Quality, National Institutes of Health, and the Veterans Health Administration. Only five programs indicated that they currently have a research fellowship program in HM. These programs cited lack of funding as a major barrier to establishing fellowships. Almost half of respondents (48%) indicated that their faculty published between 11-50 peer-reviewed manuscripts each year.

CONCLUSION: This survey provides the first national summary of research activities in HM. Future waves of the survey can help determine whether the research footprint of the field is growing. *Journal of Hospital Medicine* 2018;14:207-211. © 2019 Society of Hospital Medicine

Almost all specialties in internal medicine have a sound scientific research base through which clinical practice is informed.[1] For the field of Hospital Medicine (HM), this evidence has largely comprised research generated from fields outside of the specialty. The need to develop, invest, and grow investigators in hospital-based medicine remains unmet as HM and its footprint in hospital systems continue to grow.[2,3]

Despite this fact, little is known about the current state of research in HM. A 2014 survey of the members of the Society of Hospital Medicine (SHM) found that research output across the field of HM, as measured on the basis of peer-reviewed publications, was growing.[4] Since then, however, the numbers of individuals engaged in research activities, their background and training, publication output, or funding sources have not been quantified. Similarly, little is known about which institutions support the development of junior investigators (ie, HM research fellowships), how these programs are funded, and whether or not matriculants enter the field as investigators. These gaps must be measured, evaluated, and ideally addressed through strategic policy and funding initiatives to advance the state of science within HM.

Members of the SHM Research Committee developed, designed, and deployed a survey to improve the understanding of the state of research in HM. In this study, we aimed to establish the baseline of research in HM to enable the measurement of progress through periodic waves of data collection. Specifically, we sought to quantify and describe the characteristics of existing research programs, the sources and types of funding, the number and background of faculty, and the availability of resources for training researchers in HM.

METHODS

Study Setting and Participants

Given that no defined list, database, or external resource that

***Corresponding Author:** Vineet Chopra MD, MSc; E-mail: vineetc@umich.edu; Telephone: 734-936-4000; Twitter: @vineet_chopra

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identifies research programs and contacts in HM exists, we began by creating a strategy to identify and sample adult HM programs and their leaders engaged in research activity. We iteratively developed a two-step approach to maximize inclusivity. First, we partnered with SHM to identify programs and leaders actively engaging in research activities. SHM is the largest professional organization within HM and maintains an extensive membership database that includes the titles, e-mail addresses, and affiliations of hospitalists in the United States, including academic and nonacademic sites. This list was manually scanned, and the leaders of academic and research programs in adult HM were identified by examining their titles (eg, Division Chief, Research Lead, etc.) and academic affiliations. During this step, members of the committee noticed that certain key individuals were either missing, no longer occupying their role/title, or had been replaced by others. Therefore, we performed a second step and asked the members of the SHM Research Committee to identify academic and research leaders by using current personal contacts, publication history, and social networks. We asked members to identify individuals and programs that had received grant funding, were actively presenting research at SHM (or other major national venues), and/or were producing peer-reviewed publications related to HM. These programs were purposefully chosen (ie, over HM programs known for clinical activities) to create an enriched sample of those engaged in research in HM. The research committee performed the "second pass" to ensure that established investigators who may not be accurately captured within the SHM database were included to maximize yield for the survey. Finally, these two sources were merged to ensure the absence of duplicate contacts and the identification of a primary respondent for each affiliate. As a result, a convenience sample of 100 programs and corresponding individuals was compiled for the purposes of this survey.

Survey Development

A workgroup within the SHM Research Committee was tasked to create a survey that would achieve four distinct goals: (1) identify institutions currently engaging in hospital-based research; (2) define the characteristics, including sources of research funding, training opportunities, criteria for promotion, and grant support, of research programs within institutions; (3) understand the prevalence of research fellowship programs, including size, training curricula, and funding sources; and (4) evaluate the productivity and funding sources of HM investigators at each site.

Survey questions that target each of these domains were drafted by the workgroup. Questions were pretested with colleagues outside the workgroup focused on this project (ie, from the main research committee). The instrument was refined and edited to improve the readability and clarity of questions on the basis of the feedback obtained through the iterative process. The revised instrument was then programmed into an online survey administration tool (SurveyMonkey®) to facilitate electronic dissemination. Finally, the members of the workgroup tested the online survey to ensure functionality. No identifiable information was collected from respondents, and no monetary incentive was offered for the completion of the survey. An invitation to participate in the survey was sent via e-mail to each of the program contacts identified.

Statistical Analysis

Descriptive statistics, including proportions, means, and percentages, were used to tabulate results. All analyses were conducted using Stata 13 MP/SE (StataCorp, College Station, Texas).

Ethical and Regulatory Considerations

The study was reviewed and deemed exempt from regulation by the University of Michigan Institutional Review Board (HUM000138628).

RESULTS

General Characteristics of Research Programs and Faculty

Out of 100 program contacts, 28 (representing 1,586 faculty members) responded and were included in the survey (program response rate = 28%). When comparing programs that did respond with those that did not, a greater proportion of programs in university settings were noted among respondents (79% vs 21%). Respondents represented programs from all regions of the United States, with most representing university-based (79%), university-affiliated (14%) or Veterans Health Administration (VHA; 11%) programs. Most respondents were in leadership roles, including division chiefs (32%), research directors/leads (21%), section chiefs (18%), and related titles, such as program director. Respondents indicated that the total number of faculty members in their programs (including nonclinicians and advance practice providers) varied from eight to 152 (mean [SD] = 57 [36]) members, with physicians representing the majority of faculty members (Table 1).

Among the 1,586 faculty members within the 28 programs, respondents identified 192 faculty members (12%) as currently receiving extra- or intramural support for research activities. Of these faculty, over half (58%) received <25% of effort from intra or extramural sources, and 28 (15%) and 52 (27%) faculty members received 25%-50% or ≥50% of support for their effort, respectively. The number of investigators who received funding across programs ranged from 0 to 28 faculty members. Compared with the 192 funded investigators, respondents indicated that a larger number of faculty in their programs (n = 656 or 41%) were involved in local quality improvement (QI) efforts. Of the 656 faculty members involved in QI efforts, 241 individuals (37%) were internally funded and received protected time/effort for their work.

Key Attributes of Research Programs

In the evaluation of the amount of total grant funding, respondents from 17 programs indicated that they received ≤$500,000 in annual extra and intramural funding, and those from three programs stated that they received $500,000 to $999,999 in funding. Five respondents indicated that their programs currently received $1 million to $5 million in grant funding, and three reported >$5 million in research support. The sources of research funding included several divisions within the National Institute of Health (NIH, 12 programs), Agency for

TABLE 1. **Characteristics of Survey Respondents and their Facilities**[a]

Hospital Characteristics, n (%)	Total (n = 28)
Type of institution	
University teaching hospital	22 (79%)
University affiliated	4 (14%)
VA Hospital	3 (11%)
Other (eg, community or private)	4 (14%)
Type of Hospital Medicine Group	
Division	15 (54%)
Program	4 (14%)
Section	9 (32%)
Survey Respondent Title/Role	
Division chief	9 (32%)
Research director/lead	6 (21%)
Section chief	5 (18%)
Other (eg, director or chair)	8 (29%)
Number of Faculty in Hospital Medicine Group	
Total per hospital, mean (range)	57 (8-152)
Total (all provider types, n)	1,586
Total number of physicians (n)	1,293

[a]Columns may not add up to 100% because respondents could select multiple categories.

TABLE 2. **Characteristics and Funding of Research and Fellowship Programs**

Funding of Research Programs	Total (n = 28)
Sources of research funding	
National Institute of Health	12 (43%)
Agency for Healthcare Research and Quality	4 (14%)
Foundations	4 (14%)
Internal grants	6 (21%)
Other (eg, VHA, PCORI, CMS, CDC, and industry)	6 (21%)
Amount of extra and intramural funding	
< $500,000	17 (61%)
$500,000 to $999,999	3 (11%)
$1 million - $5 million	5 (18%)
> $5 million	3 (11%)
Types of awards received	
Career development	11 (39%)
Small grants (eg, R21, R03)	8 (29%)
R01 grants	5 (18%)
Program series grants (eg, P and U)	5 (18%)
Foundation grants	8 (29%)
Other (eg, PCORI and philanthropy)	3 (11%)
Research Fellowship Programs/Training	
Current research training or fellowship program at institution	N = 5
Number of fellows per year	
0-1	2 (40%)
2	3 (60%)
Funding sources	
Internal/intramural	4 (80%)
Extramural	2 (40%)
Other (eg, interdepartment funds, etc.)	2 (40%)

Abbreviations: CDC, Centers for Disease Control; CMS, Centers Medicare and Medicaid Services; PCORI, Patient-Centered Outcomes Research Institute, VHA, Veteran's Health Administration.

Healthcare Research and Quality (AHRQ, four programs), foundations (four programs), and internal grants (six programs). Additionally, six programs indicated "other" sources of funding that included the VHA, Patient-Centered Outcomes Research Institute (PCORI), Centers for Medicare and Medicaid Services, Centers for Disease Control (CDC), and industry sources.

A range of grants, including career development awards (11 programs); small grants, such as R21 and R03s (eight programs); R-level grants, including VA merit awards (five programs); program series grants, such as P and U grants (five programs), and foundation grants (eight programs), were reported as types of awards. Respondents from 16 programs indicated that they provided internal pilot grants. Amounts for such grants ranged from <$50,000 (14 programs) to $50,000-$100,000 (two programs).

Research Fellowship Programs/Training Programs

Only five of the 28 surveyed programs indicated that they currently had a research training or fellowship program for developing hospitalist investigators. The age of these programs varied from <1 year to 10 years. Three of the five programs stated that they had two fellows per year, and two stated they had spots for one trainee annually. All respondents indicated that fellows received training on study design, research methods, quantitative (eg, large database and secondary analyses) and qualitative data analysis. In addition, two programs included training in systematic review and meta-analyses, and three included focused courses on healthcare policy. Four of the five programs included training in QI tools, such as LEAN and Six Sigma. Funding for four of the five fellowship programs came from internal sources (eg, department and CTSA). However, two programs added they received some support from extramural funding and philanthropy. Following training, respondents from programs indicated that the majority of their graduates (60%) went on to hybrid research/QI roles (50/50 research/clinical effort), whereas 40% obtained dedicated research investigator (80/20) positions (Table 2).

The 23 institutions without research training programs cited that the most important barrier for establishing such programs was lack of funding (12 programs) and the lack of a pipeline of hospitalists seeking such training (six programs). However, 15 programs indicated that opportunities for hospitalists to gain research training in the form of courses were available internally (eg, courses in the department or medical school) or externally (eg, School of Public Health). Seven programs indicated that they were planning to start a HM research fellowship within the next five years.

Research Faculty

Among the 28 respondents, 15 stated that they have faculty members who conduct research as their main professional ac-

TABLE 3. **Characteristics of Research Faculty**[a]

Category	n
Research Faculty by Institution	
Institutions with faculty conducting research as their major activity (>50% effort)	15
Number of faculty with research as major activity by hospital (range)	1-10
At least one full time professor conducting research	4 (27%)
At least one associate professor conducting research	8 (53%)
At least one assistant professor conducting research	12 (80%)
At least one clinical instructor conducting research	4 (27%)
Main focus of faculty research (>50% effort)	
Health services	11 (73%)
Basic sciences	1 (7%)
Clinical trials	4 (27%)
Other (ie, informatics)	1 (7%)
Domains studied by research faculty	
Quality and process improvement	19 (68%)
Patient safety	17 (61%)
Disease-specific	15 (54%)
Other (ie, bioethics and disparities in care)	6 (21%)
Approximate number of peer-reviewed publications per year	
0-10	10 (40%)
11-50	12 (48%)
50-99	3 (12%)
Research abstracts	
0-10	13 (52%)
11-50	12 (48%)
Faculty Support for Research Effort	
Number of faculty involved in research	192
% extra or intramural support for research activities	
<25% effort support	112 (58%)
25%-50% effort support	28 (15%)
> 50% effort	52 (27%)
Number of faculty involved in quality improvement	656
With protected effort	241 (37%)
Without protected effort	415 (63%)
Number of research faculty involved in teaching	1,168
With protected effort	256 (22%)
Without protected effort	912 (78%)

[a]A total of 28 programs representing 1,586 faculty members were included. Of these, 192 faculty members were identified as receiving extra or intramural funding.

tivity (ie, >50% effort). The number of faculty members in each program in such roles varied from one to 10. Respondents indicated that faculty members in this category were most often midcareer assistant or associate professors with few full professors. All programs indicated that scholarship in the form of peer-reviewed publications was required for the promotion of faculty. Faculty members who performed research as their main activity had all received formal fellowship training and consequently had dual degrees (MD with MPH or MD, with MSc being the two most common combinations). With respect to clinical activities, most respondents indicated that research faculty spent 10% to 49% of their effort on clinical work. However, five respondents indicated that research faculty had <10% effort on clinical duties (Table 3).

Eleven respondents (39%) identified the main focus of faculty as health service research, where four (14%) identified their main focus as clinical trials. Regardless of funding status, all respondents stated that their faculty were interested in studying quality and process improvement efforts (eg, transitions or readmissions, n = 19), patient safety initiatives (eg, hospital-acquired complications, n = 17), and disease-specific areas (eg, thrombosis, n = 15).

In terms of research output, 12 respondents stated that their research/QI faculty collectively published 11-50 peer-reviewed papers during the academic year, and 10 programs indicated that their faculty published 0-10 papers per year. Only three programs reported that their faculty collectively published 50-99 peer-reviewed papers per year. With respect to abstract presentations at national conferences, 13 programs indicated that they presented 0-10 abstracts, and 12 indicated that they presented 11-50.

DISCUSSION

In this first survey quantifying research activities in HM, respondents from 28 programs shared important insights into research activities at their institutions. Although our sample size was small, substantial variation in the size, composition, and structure of research programs in HM among respondents was observed. For example, few respondents indicated the availability of training programs for research in HM at their institutions. Similarly, among faculty who focused mainly on research, variation in funding streams and effort protection was observed. A preponderance of midcareer faculty with a range of funding sources, including NIH, AHRQ, VHA, CMS, and CDC was reported. Collectively, these data not only provide a unique glimpse into the state of research in HM but also help establish a baseline of the status of the field at large.

Some findings of our study are intuitive given our sampling strategy and the types of programs that responded. For example, the fact that most respondents for research programs represented university-based or affiliated institutions is expected given the tripartite academic mission. However, even within our sample of highly motivated programs, some findings are surprising and merit further exploration. For example, the observation that some respondents identified HM investigators within their program with <25% in intra- or extramural funding was unexpected. On the other extreme, we were surprised to find that three programs reported >$5 million in research funding. Understanding whether specific factors, such as the availability of experienced mentors within and outside departments or assistance from support staff (eg, statisticians and project managers), are associated with success and funding within these programs are important questions to answer. By focusing on these issues, we will be well poised as a field to understand what works, what does not work, and why.

Likewise, the finding that few programs within our sample

offer formal training in the form of fellowships to research investigators represents an improvement opportunity. A pipeline for growing investigators is critical for the specialty that is HM. Notably, this call is not new; rather, previous investigators have highlighted the importance of developing academically oriented hospitalists for the future of the field.[5] The implementation of faculty scholarship development programs has improved the scholarly output, mentoring activities, and succession planning of academics within HM.[6,7] Conversely, lack of adequate mentorship and support for academic activities remains a challenge and as a factor associated with the failure to produce academic work.[8] Without a cadre of investigators asking critical questions related to care delivery, the legitimacy of our field may be threatened.

While extrapolating to the field is difficult given the small number of our respondents, highlighting the progress that has been made is important. For example, while misalignment between funding and clinical and research mission persists, our survey found that several programs have been successful in securing extramural funding for their investigators. Additionally, internal funding for QI work appears to be increasing, with hospitalists receiving dedicated effort for much of this work. Innovation in how best to support and develop these types of efforts have also emerged. For example, the University of Michigan Specialist Hospitalist Allied Research Program offers dedicated effort and funding for hospitalists tackling projects germane to HM (eg, ordering of blood cultures for febrile inpatients) that overlap with subspecialists (eg, infectious diseases).[9] Thus, hospitalists are linked with other specialties in the development of research agendas and academic products. Similarly, the launch of the HOMERUN network, a coalition of investigators who bridge health systems to study problems central to HM, has helped usher in a new era of research opportunities in the specialty.[10] Fundamentally, the culture of HM has begun to place an emphasis on academic and scholarly productivity in addition to clinical prowess.[11-13] Increased support and funding for training programs geared toward innovation and research in HM is needed to continue this mission. The Society for General Internal Medicine, American College of Physicians, and SHM have important roles to play as the largest professional organizations for generalists in this respect. Support for research, QI, and investigators in HM remains an urgent and largely unmet need.

Our study has limitations. First, our response rate was low at 28% but is consistent with the response rates of other surveys of physician groups.[14] Caution in making inferences to the field at large is necessary given the potential for selection and nonresponse bias. However, we expect that respondents are likely biased toward programs actively conducting research and engaged in QI, thus better reflecting the state of these activities in HM. Second, given that we did not ask for any identifying information, we have no way of establishing the accuracy of the data provided by respondents. However, we have no reason to believe that responses would be altered in a systematic fashion. Future studies that link our findings to publicly available data (eg, databases of active grants and funding) might be useful. Third, while our survey instrument was created and internally validated by hospitalist researchers, its lack of external validation could limit findings. Finally, our results vary on the basis of how respondents answered questions related to effort and time allocation given that these measures differ across programs.

In summary, the findings from this study highlight substantial variations in the number, training, and funding of research faculty across HM programs. Understanding the factors behind the success of some programs and the failures of others appears important in informing and growing the research in the field. Future studies that aim to expand survey participation, raise the awareness of the state of research in HM, and identify barriers and facilitators to academic success in HM are needed.

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Home Smoke Exposure and Health-Related Quality of Life in Children with Acute Respiratory Illness

Jakobi Johnson, BS[1]; Karen M Wilson, MD, MPH[2]; Chuan Zhou, PhD[3]; David P Johnson, MD[1]; Chén C Kenyon, MD, MSHP[4]; Joel S Tieder, MD, MPH[5]; Andrea Dean, MD[6]; Rita Mangione-Smith, MD, MPH[3]; Derek J Williams, MD, MPH[1]*

[1]Division of Hospital Medicine, Monroe Carell Jr. Children's Hospital at Vanderbilt, Department of Pediatrics, Vanderbilt University School of Medicine, Nashville, Tennessee; [2]Division of General Pediatrics, Kravis Children's Hospital, Icahn School of Medicine at Mount Sinai, New York, New York; [3]Department of Pediatrics, University of Washington and the Center for Child Health, Behavior, and Development, Seattle Children's Research Institute, Seattle, Washington; [4]Center for Pediatric Clinical Effectiveness, The Children's Hospital of Philadelphia and the Department of Pediatrics, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania; [5]Division of General Pediatrics and Hospital Medicine, Department of Pediatrics, University of Washington and Seattle Children's Hospital, Seattle, Washington; [6]Section of Pediatric Hospital Medicine, Texas Children's Hospital, Department of Pediatrics, Baylor College of Medicine, Houston, Texas.

OBJECTIVE: This study aims to assess whether secondhand smoke (SHS) exposure has an impact on health-related quality of life (HRQOL) in children with acute respiratory illness (ARI).

METHODS: This study was nested within a multicenter, prospective cohort study of children (two weeks to 16 years) with ARI (emergency department visits for croup and hospitalizations for croup, asthma, bronchiolitis, and pneumonia) between July 1, 2014 and June 30, 2016. Subjects were surveyed upon enrollment for sociodemographics, healthcare utilization, home SHS exposure (0 or ≥1 smoker in the home), and child HRQOL (Pediatric Quality of Life Physical Functioning Scale) for both baseline health (preceding illness) and acute illness (on admission). Data on insurance status and medical complexity were collected from the Pediatric Hospital Information System database. Multivariable linear mixed regression models examined associations between SHS exposure and HRQOL.

RESULTS: Home SHS exposure was reported in 728 (32%) of the 2,309 included children. Compared with nonexposed children, SHS-exposed children had significantly lower HRQOL scores for baseline health (mean difference –3.04 [95% CI –4.34, –1.74]) and acute illness (–2.16 [–4.22, –0.10]). Associations were strongest among children living with two or more smokers. HRQOL scores were lower among SHS-exposed children for all four conditions but only significant at baseline for bronchiolitis (–2.94 [–5.0, –0.89]) and pneumonia (–4.13 [–6.82, –1.44]) and on admission for croup (–5.71 [–10.67, –0.75]).

CONCLUSIONS: Our study demonstrates an association between regular SHS exposure and decreased HRQOL with a dose-dependent response for children with ARI, providing further evidence of the negative impact of SHS. *Journal of Hospital Medicine* 2019;14:212-217. © 2019 Society of Hospital Medicine

Acute respiratory illnesses (ARIs), including acute exacerbations of asthma, croup, pneumonia, and bronchiolitis, are among the most common illnesses in childhood.[1] Although most ARIs can be managed in the outpatient setting, hospitalization is common with respiratory illnesses accounting for >425,000 hospitalizations annually.[1] Pneumonia, asthma, and bronchiolitis each rank among the top five reasons for pediatric hospitalization in the United States.[1] Successful efforts to prevent or mitigate the severity of ARIs could have a major impact on child health.

Exposure to secondhand smoke (SHS) is a preventable risk factor for ARI in children, particularly when there is regular exposure in the home.[2] Chronic exposure to SHS impacts systemic inflammation by suppressing serum interferon-gamma,[3] which can lead to increased susceptibility to viral and bacterial infections,[4] and increasing Th2 (atopic) cytokine expression, which is associated with asthma.[5] SHS exposure in children has also been linked to diminished lung function.[6] As a result, SHS exposure is associated with increased ARI susceptibility and severity in children.[7-10]

Much research has focused on the clinical impact of SHS exposure on respiratory health in children, but little is known about the impact on patient-reported outcomes, such as health-related quality of life (HRQOL). Patient-reported outcomes help provide a comprehensive evaluation of the effectiveness of healthcare delivery systems. These outcomes are increasingly used by health service researchers to better understand patient and caregiver perspectives.[11] Given the known associations between SHS exposure and ARI morbidity, we postulated that regular SHS exposure would also impact HRQOL in children. In this study, we assessed the relationship

***Corresponding Author:** Derek J Williams, MD, MPH; E-mail: derek.williams@vanderbilt.edu; Telephone: 615-322-2744; Twitter: @dwillmd

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between SHS exposure and HRQOL within a large, multicenter, prospective cohort of children presenting to the emergency department (ED) and/or hospital with ARI.

METHODS

Study Population

This study was nested within the Pediatric Respiratory Illness Measurement System (PRIMES) study, a prospective cohort study of children with ARI in the ED and inpatient settings at five tertiary care children's hospitals within the Pediatric Research in Inpatient Settings Network in Colorado, Pennsylvania, Tennessee, Texas, and Washington. Eligible children were two weeks to 16 years of age hospitalized after presenting to the ED with a primary diagnosis of asthma, croup, bronchiolitis, or pneumonia between July 1, 2014 and June 30, 2016. Because of an anticipated low frequency of croup hospitalizations, we also included children presenting to the ED and then discharged to home with this diagnosis. Children were assigned to a PRIMES diagnosis group based on their final discharge diagnosis. If there was a discrepancy between admission and discharge diagnoses, the discharge diagnosis was used. If a child had more than one discharge diagnosis for a PRIMES condition (eg, acute asthma and pneumonia), we chose the PRIMES condition with the lowest total enrollments overall. If the final discharge diagnosis was not a PRIMES condition, the case was excluded from further analysis. Patients with immunodeficiency, cystic fibrosis, a history of prematurity <32 weeks, chronic neuromuscular disease, cardiovascular disease, pulmonary diseases (other than asthma), and moderate to severe developmental delay were also excluded. Children admitted to intensive care were eligible only if they were transferred to an acute care ward <72 hours following admission. A survey was administered at the time of enrollment that collected information on SHS exposure, HRQOL, healthcare utilization, and demographics. All study procedures were reviewed and approved by the institutional review boards at each of the participating hospitals.

SECONDHAND SMOKE EXPOSURE

To ascertain SHS exposure, we asked caregivers, "How many persons living in the child's home smoke?" Responses were dichotomized into non-SHS exposed (0 smokers) and SHS exposed (≥1 smokers). Children with missing data on home SHS exposure were excluded.

Health-Related Quality of Life Outcomes

We estimated HRQOL using the Pediatric Quality of Life (PedsQL™) 4.0 Generic Core and Infant Scales. The PedsQL instruments are validated, population HRQOL measures that evaluate the physical, mental, emotional, and social functioning of children two to 18 years old based on self- or caregiver-proxy report.[12-15] These instruments have also shown responsiveness as well as construct and predictive validity in hospitalized children.[11] For this study, we focused on the PedsQL physical functioning subscale, which assesses for problems with physical activities (eg, sports activity or exercise, low energy, and hurts or aches) on a five-point Likert scale (never to almost always a problem). Scores range from 0 to 100 with higher scores indicating a better HRQOL. The reported minimal clinically important difference (MCID), defined as the smallest difference in which individuals would perceive a benefit or would necessitate a change in management, for this scale is 4.5 points.[16,17]

Children ≥8 years old were invited to complete the self-report version of the PedsQL. For children <8 years old, and for older children who were unable to complete them, surveys were completed by a parent or legal guardian. Respondents were asked to assess perceptions of their (or their child's) HRQOL during periods of baseline health (the child's usual state of health in the month preceding the current illness) and during the acute illness (the child's state of health at the time of admission) as SHS exposure may influence perceptions of general health and/or contribute to worse outcomes during periods of acute illness.

Covariates collected at the time of enrollment included sociodemographics (child age, gender, race/ethnicity, and caregiver education), and healthcare utilization (caregiver-reported patient visits to a healthcare provider in the preceding six months). Insurance status and level of medical complexity (using the Pediatric Medical Complexity Algorithm)[18] were obtained using the Pediatric Hospital Information System database, an administrative database containing clinical and resource utilization data from >45 children's hospitals in the United States including all of the PRIMES study hospitals.[13]

Analysis

Descriptive statistics included frequency (%) and mean (standard deviation). Bivariate comparisons according to SHS exposure status were analyzed using chi-squared tests for categorical variables and analysis of variance for continuous variables. Multivariable linear mixed regression models were used to examine associations between home SHS exposure and HRQOL for baseline health and during admission, overall and stratified by diagnosis. Covariates in each model included age, sex, race/ethnicity, caregiver education, and healthcare visits in the preceding six months. We also included a hospital random effect to account for clustering of patients within hospitals and used robust standard errors for inference.

In a secondary analysis to explore potential dose-response effects of SHS exposure, we examined associations between an ordinal exposure variable (0 smokers, 1 smoker, ≥2 smokers) and HRQOL for baseline health and during admission for the acute illness. Because of sample size limitations, diagnosis-specific analyses examining dose-response effects were not conducted.

RESULTS

Study Population

Of the 2,334 children enrolled in the PRIMES study, 25 (1%) respondents did not report on home SHS exposure and were excluded, yielding a final study population of 2,309 children, of whom 728 (32%) had reported home SHS exposure. The

TABLE 1. **Characteristics of the Study Population**

Characteristic	Combined N = 2,309	Nonexposed n = 1,581	SHS-Exposed n = 728	*P* Value
Age, mean (SD)	3.6 (3.7)	3.4 (3.7)	3.9 (3.9)	.01
Male	1,326 (59)	917 (60)	409 (58)	.6
Race/Ethnicity				
Non-Hispanic white	912 (40)	663 (42)	249 (34)	
Non-Hispanic black	511 (22)	304 (19)	207 (29)	
Hispanic	559 (24)	402 (26)	157 (22)	
Other	316 (14)	206 (13)	110 (15)	<.001
Comorbidities[a]				
Nonchronic	1,278 (55)	928 (59)	350 (48)	
Noncomplex Chronic	924 (40)	583 (37)	341 (47)	
Complex Chronic	101 (4)	66 (4)	35 (5)	<.001
Caregiver Education				
<High School	233 (10)	146 (9)	87 (12)	
High School	553 (24)	312 (20)	241 (33)	
>High School	1,508 (66)	1,112 (71)	396 (55)	<.001
Public Insurance	1,303 (57)	770 (49)	533 (73)	<.001
Diagnosis				
Asthma	664 (29)	415 (26)	249 (34)	
Bronchiolitis	740 (32)	502 (32)	238 (33)	
Croup	342 (15)	255 (16)	87 (12)	
Pneumonia	563 (24)	409 (26)	154 (21)	<.001
Healthcare Visits in the Last 6 Months				
0	240 (10)	156 (10)	84 (12)	
1-2	932 (40)	645 (41)	287 (39)	
3-4	714 (31)	482 (30)	232 (32)	
5+	423 (18)	298 (19)	125 (17)	.6

[a]Comorbidities were assessed using the Pediatric Medical Complexity Algorithm (see reference 10); Pediatric Respiratory Illness Measurement System eligibility criteria excluded children with immunodeficiency, cystic fibrosis, a history of prematurity <32 weeks, chronic neuromuscular disease, cardiovascular disease, pulmonary diseases (other than asthma), and moderate to severe developmental delay. Data are presented as no. (%) unless otherwise noted. *P* values compared nonexposed to SHS-exposed columns.

Abbreviations: SHS, secondhand smoke; SD, standard deviation.

study population included 664 children with asthma (mean age seven years [3.5]; 38% with home SHS exposure), 740 with bronchiolitis (mean age 0.7 years [0.5]; 32% with home SHS exposure), 342 with croup (mean age 1.7 [1.1]; 25% with home SHS exposure), and 563 with pneumonia (mean age 4.4 [3.8]; 27% with home SHS exposure; Table 1). Compared with non-SHS-exposed children, those with home SHS exposure tend to be slightly older (3.9 vs 3.4 years, $P = .01$), more likely to be non-Hispanic Black (29% vs 19%, $P < .001$), to have a chronic condition (52% vs 41%, $P < .001$), to come from a household where caregiver(s) did not graduate from college (45% vs 29%, $P < .001$), and to have public insurance (73% vs 49%, $P < .001$).

Home SHS Exposure and Health-related Quality of Life

The overall mean HRQOL score for baseline health was 83 (15), with a range across diagnoses of 82 to 87. Compared with non-SHS-exposed children, children with home SHS exposure had a lower mean HRQOL score for baseline health (adjusted mean difference –3.04 [95% CI -4.34, –1.74]). In analyses stratified by diagnosis, baseline health scores were lower for SHS-exposed children for all four conditions, but differences were statistically significant only for bronchiolitis (adjusted mean difference –2.94 [–5.0, –0.89]) and pneumonia (adjusted mean value –4.13 [–6.82, –1.44]; Table 2); none of these differences met the MCID threshold.

The overall mean HRQOL score at the time of admission was 56 (23), with a range across diagnoses of 49 to 61, with lower scores noted among SHS-exposed children compared with non-SHS-exposed children (adjusted mean difference –2.16 [–4.22, –0.10]). Similar to scores representing baseline health, admission scores were lower across all four conditions for SHS-exposed children. Only children with croup, however, had

TABLE 2. **Adjusted Mean Difference in Health-Related Quality of Life (PedsQL Physical Functioning Scale) for SHS-Exposed Children Compared with Nonexposed Children**

	Adjusted Mean Difference (95% CI)	
	Baseline	**Admission**
Combined	–3.04 (–4.34, –1.74)	–2.16 (–4.22, –0.10)
Diagnosis		
Asthma	–2.44 (–5.09, 0.22)	–1.53 (–5.86, 2.81)
Bronchiolitis	–2.94 (–5.00, –0.89)	–2.63 (–5.49, 0.23)
Croup	–0.10 (–2.98, 2.79)	–5.71 (–10.67, –0.75)
Pneumonia	–4.13 (–6.82, –1.44)	–2.04 (–6.57, 2.48)

Covariates included age, gender, race/ethnicity, caregiver education, insurance status, comorbidities, and healthcare visits during the past 6 months.

Abbreviation: PedsQL, Pediatric Quality of Life.

TABLE 3. **Adjusted Mean Difference in Health-Related Quality of Life (PedsQL Physical Functioning Scale) for Children Living with One Smoker or ≥2 Smokers**

	Adjusted Mean Difference (95% CI)	
No. Smokers in the Home	**Baseline**	**Admission**
0	Ref	Ref
1	–2.22 (–3.66, –0.78)	–1.48 (–3.75, 0.79)
≥ 2	–3.92 (–6.03, –1.81)	–3.67 (–6.98, –0.36)

Covariates included age, gender, race/ethnicity, caregiver education, insurance status, comorbidities, and healthcare visits during the past 6 months.

Abbreviation: PedsQL, Pediatric Quality of Life.

significantly lower admission scores that also met the MCID threshold (adjusted mean difference –5.71 [–10.67, –0.75]; Table 2).

To assess for potential dose-response effects of SHS exposure on HRQOL, we stratified SHS-exposed children into those with one smoker in the home (n = 513) and those with ≥2 smokers in the home (n = 215). Compared with non-SHS-exposed children, both HRQOL scores (baseline health and admission) were lower for SHS-exposed children. Consistent with a dose-response association, scores were lowest for children with ≥2 smokers in the home, both at baseline health (adjusted mean difference –3.92 [–6.03, –1.81]) and on admission (adjusted mean difference –3.67 [–6.98, –0.36]; Table 3).

DISCUSSION

Within a multicenter cohort of 2,309 children hospitalized with ARI, we noted significantly lower HRQOL scores among children exposed to SHS in the home as compared with nonexposed children. Differences were greatest for children living with ≥2 smokers in the home. In analyses stratified by diagnosis, differences in baseline health HRQOL scores were greatest for children with bronchiolitis and pneumonia. Differences in acute illness scores were greatest for children with croup.[16]

Our study provides evidence for acute and chronic impacts of SHS on HRQOL in children hospitalized with ARI. Although several studies have linked SHS exposure to reduced HRQOL in adults,[19,20] few similar studies have been conducted in children. Nonetheless, a wealth of studies have documented the negative impact of SHS exposure on clinical outcomes among children with ARI.[8,10,21-23] Our findings that home SHS exposure was associated with reduced HRQOL among our cohort of children with ARI are therefore consistent with related findings in adults and children. The observation that the effects of SHS exposure on HRQOL were greatest among children living with ≥2 smokers provides further evidence of a potential causal link between regular SHS exposure and HRQOL.

Although the magnitude and significance of associations between SHS exposure and HRQOL varied for each of the four diagnoses for baseline health and the acute illness, it is important to note that the point estimates for the adjusted mean differences were uniformly lower for the SHS-exposed children in each subgroup. Even so, only acute illness scores for croup exceeded the MCID threshold.[16] Croup is the only included condition of the upper airway and is characterized by laryngotracheal inflammation leading to the typical cough and, in moderate to severe cases, stridor. Given that chronic SHS exposure induces a proinflammatory state,[3] it is possible that SHS-exposed children with croup had more severe illness compared with nonexposed children with croup resulting in lower HRQOL scores on admission. Further, perceived differences in illness severity and HRQOL may be more readily apparent in children with croup (eg, stridor at rest vs intermittent or no stridor) as compared with children with lower respiratory tract diseases.

Of the four included diagnoses, the link between SHS exposure and asthma outcomes has been most studied. Prior work has demonstrated more frequent and severe acute exacerbations, as well as worse long-term lung function among SHS-exposed children as compared with nonexposed children.[22-24] It was, therefore, surprising that our study failed to demonstrate associations between SHS exposure and HRQOL among children with asthma. Reasons for this finding are unclear. One hypothesis is that caregivers of SHS-exposed children with asthma may be more aware of the impacts of SHS exposure on respiratory health (through prior education) and, thus, more likely to modify their smoking behaviors, or for their children to be on daily asthma controller therapy. Alternatively, caregivers of children with asthma may be more likely to underreport home SHS exposure. Thirty-eight percent of children with asthma, however, were classified as SHS-exposed. This percentage was greater than the other three conditions studied (25%-32%), suggesting that differential bias in underreporting was minimal. Given that children with asthma were older, on average, than children with the other three conditions, it may also be that these children spent more time in smoke-free environments (eg, school).

Nearly one-third of children in our study were exposed to SHS in the home. This is similar to the prevalence of exposure in other studies conducted among hospitalized children[8,10,21,25] but higher than the national prevalence of home SHS exposure among children in the United States.[26] Thus, hospitalized children represent a particularly vulnerable population and an important target for interventions aiming to reduce exposure to SHS. Although longitudinal interventions are likely necessary to affect long-term success, hospitalization for ARI may serve as a powerful teachable moment to begin cessation efforts. Hospitalization also offers time beyond a typical primary care outpatient encounter to focus on cessation counseling and may be the only opportunity to engage in counseling activities for some families with limited time or access. Further, prior studies have demonstrated both the feasibility and the effectiveness of smoking cessation interventions in hospitalized children.[27-30] Unfortunately, however, SHS exposure is often not documented at the time of hospitalization, and many opportunities to intervene are missed.[25,31] Thus, there is a need for improved strategies to reliably identify and intervene on SHS-exposed children in the hospital setting.

These findings should be considered in the context of several limitations. The observational nature of our study raises the potential for confounding, specifically with regard to socioeconomic status, as this is associated with both SHS exposure and lower HRQOL. Our modeling approach attempted to control for several factors associated with socioeconomic status, including caregiver education and insurance coverage, but there is potential for residual confounding. No single question is sufficient to fully assess SHS exposure as the intensity of home SHS exposure likely varies widely, and some children may be exposed to SHS outside of the home environment.[32] The home, however, is often the most likely source of regular SHS exposure,[33,34] especially among young children (our cohort's mean age was 3.6 years). Misclassification of SHS exposure is also possible due to underreporting of smoking.[35,36] As a result, some children regularly exposed to SHS may have been misclassified as nonexposed, and the observed associations between SHS exposure and HRQOL may be underestimated. Confirming our study's findings using objective assessments of SHS exposure, such as cotinine, are warranted. Given the young age of our cohort, the PedsQL surveys were completed by the parent or legal guardian only in >90% of the enrolled subjects, and caregiver perceptions may not accurately reflect the child's perceptions. Prior work, however, has demonstrated the validity of parent-proxy reporting of the PedsQL, including correlation with child self-report.[37] In our study, correlation between child and caregiver reporting (when available) was also very good (r = 0.72, 95% CI 0.64, 0.77). It is also possible that the timing of the HRQOL assessments (on admission) may have biased perceptions of baseline HRQOL, although we anticipate any bias would likely be nondifferential between SHS-exposed and nonexposed children and across diagnoses.

Nearly one-third of children in our study were exposed to SHS exposure in the home, and SHS exposure was associated with lower HRQOL for baseline health and during acute illness, providing further evidence of the dangers of SHS. Much work is needed in order to eliminate the impact of SHS on child health and families of children hospitalized for respiratory illness should be considered a priority population for smoking cessation efforts.

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Internal Medicine Residents' Exposure to and Confidence in Managing Hospital Acute Clinical Events

Alyssa Sclafani, MD[1]*; Paul Currier, MD, MPH[2]; Yuchiao Chang, PhD[3]; Ersne Eromo, MD[4]; Daniel Raemer, PhD[5]; Eli M Miloslavsky, MD[6]

[1]*Department of Medicine, Division of Pulmonary and Critical Care Medicine, Massachusetts General Hospital, Boston, Massachusetts;* [2]*Department of Medicine, Division of Pulmonary and Critical Care Medicine, Massachusetts General Hospital, Boston, Massachusetts;* [3]*Department of Medicine, Massachusetts General Hospital, Boston, Massachusetts;* [4]*Department of Anesthesia, Critical Care and Pain Medicine, Massachusetts General Hospital, Boston, Massachusetts;* [5]*Department of Anesthesia, Critical Care and Pain Medicine, and Center for Medical Simulation, Massachusetts General Hospital, Boston, Massachusetts;* [6]*Department of Medicine, Division of Rheumatology, Massachusetts General Hospital, Boston, Massachusetts.*

BACKGROUND: Internal Medicine (IM) residency graduates should be able to manage hospital emergencies, but the rare and critical nature of such events poses an educational challenge. IM residents' exposure to inpatient acute clinical events is currently unknown.

OBJECTIVE: We developed an instrument to assess IM residents' exposure to and confidence in managing hospital acute clinical events.

METHODS: We administered a survey to all IM residents at our institution assessing their exposure to and confidence in managing 50 inpatient acute clinical events. Exposures assessed included mannequin-based simulation or management of hospital-based events as a part of a team or independently in a leadership role. Confidence was rated on a five-point scale and dichotomized to "confident" versus "not confident." Results were analyzed by multivariable logistic regression to assess the relationship between exposure and confidence accounting for year in training.

RESULTS: A total of 140 of 170 IM residents (82%) responded. Postgraduate year 1 (PGY-1) residents had managed 31.3% of acute events independently vs 71.7% of events for PGY-3/4 residents ($P < .0001$). In multivariable analysis, residents' confidence increased with level of training (PGY-1 residents were confident to manage 24.9% of events vs 72.5% of events for PGY-3/4 residents, $P < .0001$) and level of exposure, independent of training year ($P = .001$). Events with the lowest levels of exposure and confidence for graduating residents were identified.

CONCLUSIONS: IM residents' confidence in managing inpatient acute events correlated with level of training and clinical exposure. We identified events with low levels of resident exposure and confidence that can serve as targets for future curriculum development. *Journal of Hospital Medicine* 2019;14:218-223. © 2019 Society of Hospital Medicine

Internal Medicine (IM) residency graduates are expected to manage a wide range of acute clinical events.[1] Urgent and emergent inpatient situations require a broad knowledge base for rapid bedside diagnosis, yet the essential clinical skills required to manage acute clinical events pose a unique training challenge given the rarity and high-stakes nature of several such emergencies. For example, in three years of residency, a trainee may never have the opportunity to manage anaphylaxis, yet IM graduates must be able to recognize and quickly initiate proper lifesaving treatment for this relatively rare event[2] when it does occur.

In an era of work-hour limitations and heightened trainee supervision, residents perceive diminished familiarity with several clinical situations[3-5] and may feel unprepared to handle crisis events such as cardiac arrest.[6] Given the sporadic nature of clinical medicine, many residents may not be exposed to certain acute inpatient clinical scenarios by the end of their training, a potentially critical education gap. To our knowledge, IM residents' level of exposure to acute clinical events has not previously been studied. The aims of this study were to develop an instrument aimed at assessing IM residents' exposure to hospital acute clinical events at a large academic medical center and to investigate the relationship between exposure and confidence in managing these events.

METHODS

Survey Development

We reviewed the Massachusetts General Hospital (MGH) IM residency program curriculum (including simulation, conferences, and other didactics), the American Board of Internal Medicine certification requirements (primarily related to Advanced Cardiac Life Support [ACLS]), and the MGH inpatient

***Corresponding Author**: Alyssa Sclafani, MD; E-mail: asclafani1@partners.org; Telephone: (617) 726-1721

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rapid response events and gained input from the IM program leadership to develop a list of 50 acute clinical events that a graduating resident may be expected to manage independently (Box 1, Supplementary Appendix).[7-9] We then developed a survey assessing residents' exposure to and confidence in managing such events. To classify the level of exposure, residents were asked to distinguish whether they had managed these events during a simulation session, inpatient as a part of a team, or inpatient independently. At our institution, IM postgraduate year 1 (PGY-1) interns manage a floor of patients overnight under a senior resident's supervision, PGY-2 residents manage a team of several interns often without attending presence on ward rounds,[10] and senior PGY-3 or -4 residents are expected to lead the hospital's rapid response and code team and triage decompensating patients to the intensive care unit. Therefore, there are ample opportunities for IM residents to manage conditions independently (ie, in a direct leadership role) with attending supervision. House officers' role in medical management, including calling appropriate subspecialty consultation, depends on the clinical condition; for example, a graduating senior resident would be expected to evaluate comprehensively a hypotensive patient and diagnose tension pneumothorax (while calling interventional pulmonary support for needle decompression and chest tube placement) and independently run an ACLS algorithm in the case of an unstable arrhythmia or cardiac arrest.

Residents were also asked to rate their perceived confidence in managing each condition independently on a five-point scale (ranging from "definitely cannot manage this condition independently" to "definitely can manage this condition independently"). We refined the survey instrument through a collaborative, iterative review process, including cognitive interviews and piloting with IM subspecialty fellows.

Participants and Data Collection

All IM residents at the Massachusetts General Hospital were invited to participate in the study. The study was conducted in May 2015 to reflect training throughout the prior academic year(s) and allow us to evaluate graduating residents' exposures across all prior years of training. The instrument was administered anonymously via a web-based survey tool, Qualtrics (Provo, Utah). The study was approved as exempt by the Partners Institutional Review Board.

Data Analysis

Residents' self-reported exposure to hospital acute events was classified into the following six ordinal categories: (1) never seen (have never seen the condition under any circumstances); (2) simulation alone (have managed the condition only during a mannequin-simulated patient case); (3) team alone (have managed the condition inpatient as a part of a team of providers, not in a primary leadership role); (4) team plus simulation; (5) independently (have managed the condition inpatient alone or in a primary leadership role); and (6) independently plus simulation. Residents' self-reported exposure was examined for each postgraduate year (PGY) class both in aggregate and for each individual acute event. We sought to identify events that the majority of residents had managed independently (85% of residents or greater) and less common events that at least 15% of residents had never experienced.

We also examined residents' self-reported confidence for each PGY class in aggregate and for each clinical acute scenario. Confidence was investigated in a dichotomized manner with a "definitely can" rating indicating "Confident" and with "probably can," "neutral," "probably cannot," or "definitely cannot" ratings indicating "Not Confident" to manage the condition independently. Dichotomization thus allowed us to set a high bar for confidence, reflecting the self-perceived ability of the residents to manage the conditions as future independent physicians.

We used logistic regression models with the generalized estimating equations (GEE) approach to take into account the repeated measures of 50 clinical acute clinical events assessed for each resident. We compared the distribution of self-reported exposure and confidence among different PGY classes and examined the relationship between confidence and self-reported exposure stratified by level of training. We also assessed the independent effect of exposure on confidence controlling for level of training in a multivariable logistic regression model.

RESULTS

A total of 140 of 170 IM residents completed the survey (82% overall response rate: 72% of all PGY-1 residents, 86% of PGY-2 residents, and 89% of PGY-3/4 residents). In total, 41 PGY-1 residents (29% of respondents), 50 PGY-2 residents (36%), and 49 PGY-3 or PGY-4 residents (35%) participated. The majority of residents were in the Categorical IM training track (106 residents, 76% of respondents), whereas the remainder of respondents were in various subspecialty training tracks within our IM residency program, including Primary Care (14 residents, 10%), and four-year tracks, including Global Health (six residents, 4%), and Medicine-Pediatrics (14 residents, 10%).

Assessment of Exposure

Residents reported increasingly independent exposures as they progressed through residency training. PGY-1 residents on average had never seen 16.3% of the 50 acute events, whereas PGY-3/4 residents had never seen only 4.0% of the events ($P < .0001$). PGY-1 residents had managed 31.3% of events independently (or both independently and in simulation) as opposed to 71.7% of events for PGY-3/4 residents ($P < .0001$). Simulation alone accounted for a substantial proportion of exposures (16.4%) for PGY-1 residents, but this was significantly lower for PGY-2 or PGY-3/4 residents ($P < .0001$), who reported a greater percentage of exposures in nonsimulation clinical scenarios either independently or as a part of an inpatient team. There were no outlier residents who reported lower exposure compared with their PGY peers.

There was a wide spectrum of resident-reported exposures when individual acute events were examined (Table, full data in Supplementary Appendix Table 1). Events with the highest levels of exposure, which >85% of PGY-1 residents had managed

TABLE. **Hospital Acute Clinical Events with Highest and Lowest Resident Exposure**

	PGY-1				PGY-2				PGY-3/4			
	Never seen/ Sim alone		Independently/ Ind. plus Sim		Never seen/ Sim alone		Independently/ Ind. plus Sim		Never seen/ Sim alone		Independently/ Ind. plus Sim	
Acute Clinical Event	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
High Level of Resident-reported Exposure[a]												
Alcohol withdrawal	0	0%	38	92.7%	0	0%	50	100%	0	0%	49	100%
COPD exacerbation	0	0%	38	92.7%	0	0%	50	100%	0	0%	49	100%
Afib with RVR	0	0%	37	90.2%	1	2%	49	98%	0	0%	49	100%
Agitated delirium	0	0%	37	90.2%	0	0%	49	98%	0	0%	48	98%
Hypertensive urgency	0	0%	35	85.4%	0	0%	50	100%	0	0%	48	98%
Hyperkalemia	0	0%	35	85.4%	0	0%	48	96%	0	0%	48	98%
Low Level of Resident-reported Exposure[b]												
Torsades de pointes	34	82.9%	0	0%	30	60%	6	12%	25	51%	14	28.6%
Acute mechanical valve failure	35	85.4%	0	0%	28	56%	3	6%	24	49%	10	20.4%
Tension pneumothorax	32	78%	2	4.9%	31	62%	5	10%	19	38.8%	12	24.5%
Use of emergency transcutaneous pacing	38	92.7%	0	0%	33	66%	2	4%	19	38.8%	15	30.6%
Elevated ICP/herniation	30	73.2%	0	0%	14	28%	13	26%	12	24.5%	17	34.7%
Aortic dissection	34	82.9%	2	4.9%	22	44%	10	20%	11	22.4%	18	36.7%
Cord compression	26	63.4%	2	4.9%	9	18%	13	26%	8	16.3%	27	55.1%
Use of emergency cardioversion	30	73.2%	0	0%	24	48%	7	14%	8	16.3%	22	44.9%

[a]High level of exposure = greater than 85% of PGY-1 residents had managed the event independently.

[b]Low level of exposure = greater than 15% of PGY-3/4 residents had never seen the event.

Abbreviations: Afib, atrial fibrillation; COPD, chronic obstructive pulmonary disease; ICP, intracranial pressure; Ind, independently; PGY, postgraduate year; RVR, rapid ventricular response ;Sim, simulation.

independently, included alcohol withdrawal, chronic obstructive pulmonary disease exacerbation, rapid atrial fibrillation, agitated delirium, hypertensive urgency, and hyperkalemia. Events with the lowest levels of exposure, which at least 15% of graduating residents had never encountered in the hospital, included the following eight of 50 events (16%): torsades de pointes (51% of PGY-3/4 residents), acute mechanical valve failure (49%), tension pneumothorax (38.8%), use of emergency transcutaneous pacing (38.8%), elevated intracranial pressure (ICP)/herniation (24.5%), aortic dissection (22.4%), cord compression (16.3%), and use of emergency cardioversion (16.3%). Several PGY-3/4 residents had managed several of these events only in mannequin simulations, including torsades de pointes (41%), transcutaneous pacing (33%), and tension pneumothorax (24%).

Assessment of Confidence

Both levels of training and exposure to acute events were associated with increased confidence in managing such events. PGY-1 residents felt confident in managing 24.9% of acute events independently, compared to 48.4% of events for PGY-2 residents and 72.5% of events for PGY-3/4 residents ($P < .0001$). There was considerable variation in confidence among the individual acute events (Supplementary Appendix Table 2). A majority of graduating PGY-3/4 residents did not feel confident in managing the following 10 of the 50 events (20%): use of emergency cardioversion, aortic dissection, thrombotic thrombocytopenic purpura/hemolytic uremic syndrome (TTP/HUS), torsades de pointes, posterior reversible encephalopathy syndrome (PRES), intracranial hemorrhage, use of emergency transcutaneous pacing, tension pneumothorax, elevated ICP/herniation, and acute mechanical valve failure.

Residents' self-reported confidence also correlated with level of exposure. There was a significant increase in resident confidence with increasingly independent exposure stratified by level of training (Figure; all with $P < .0001$). In the multivariable logistic regression model, increasing exposure correlated with increased resident confidence ($P < .0001$) while controlling for PGY year ($P = .001$).

DISCUSSION

We developed an instrument to assess resident exposure to and confidence in managing 50 inpatient acute clinical events.

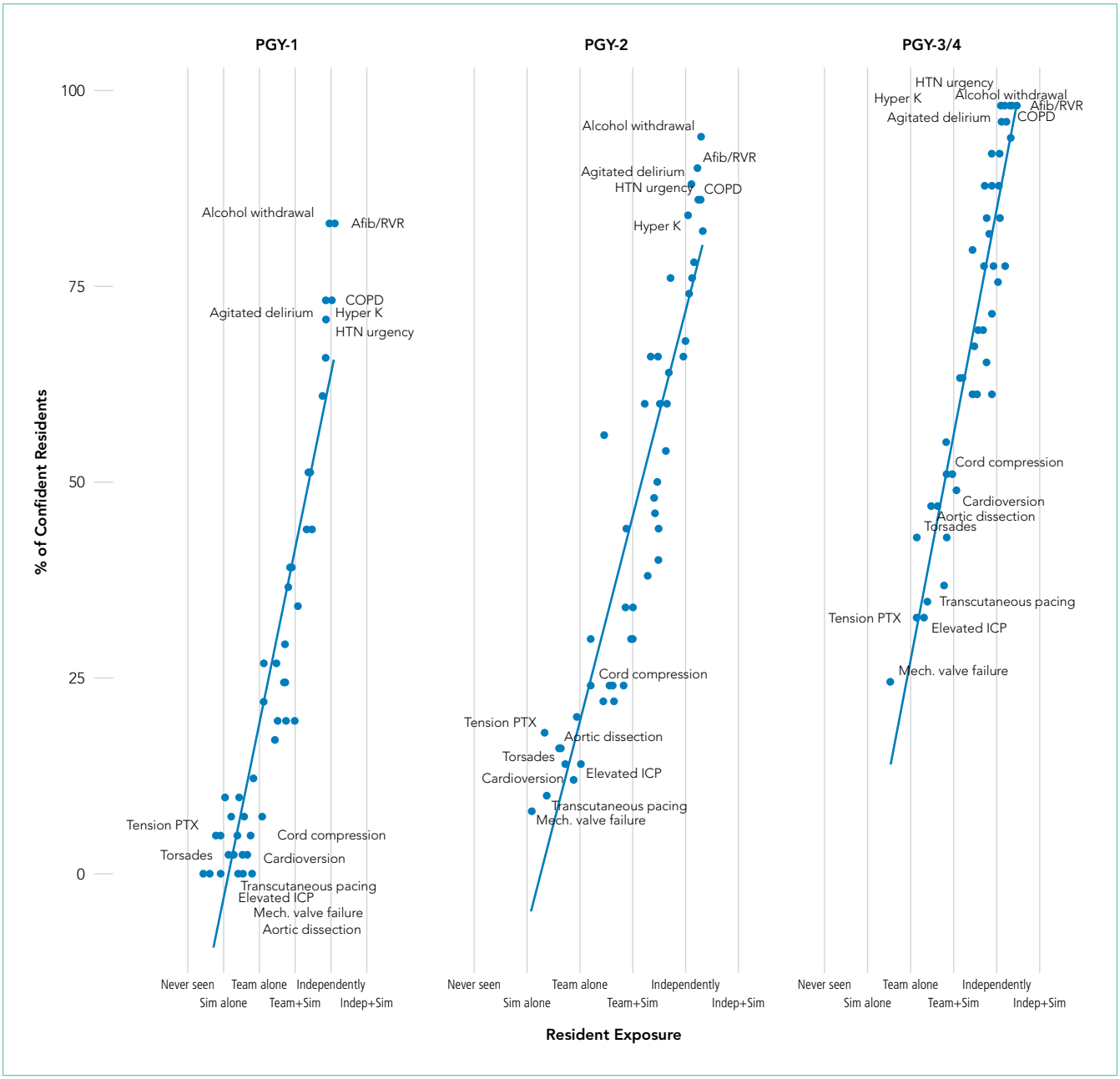

FIG. Resident Confidence and Exposure to Acute Clinical Events

Resident confidence correlated with level of exposure to acute clinical events. There was a significant increase in resident confidence with increasingly independent exposure stratified by level of training ($P < .0001$). Listed are examples of acute events with highest and lowest levels of independent exposure and resident confidence.

Abbreviations: Afib, atrial fibrillation; COPD, chronic obstructive pulmonary disease; HTN, hypotensive, ICP, intracranial pressure; Ind, independently; PGY, postgraduate year; PTX, pneumothorax; RVR, rapid ventricular response ;Sim, simulation

Both exposure and level of training were associated with increasing resident confidence. We identified specific events with low levels of exposure and confidence that could be targeted for educational interventions.

To our knowledge, this is the first study to examine IM residents' exposure to and confidence in managing a wide range of inpatient acute clinical events. A primary goal of residency is to provide physicians-in-training graduated responsibility to prepare them for eventual independent practice. Although our survey confirmed that IM residents' exposure and confidence significantly increased as they advanced through training (a not unexpected finding), our data also show that even after controlling for year in training, independent exposures significantly correlated with increased confidence. This speaks to the importance of preserving opportunities for residents to manage critical events in a supported manner, an admittedly challenging prospect given the oft-competing calls for supervision of and mentored feedback for trainees.[11]

Despite identifying independent exposure as an important factor that impacts resident confidence, we found that there

was still a substantial proportion of events (28.3%) that senior medical residents near the end of their training had not managed independently in a primary leadership role. Although our study was not designed to determine the reasons for this varied resident exposure, possible explanations may include the relative rarity of certain acute clinical events compared with others, or less likely the effect of duty hour limitations, attending supervision of trainees, or programmatic changes in resident leadership responsibilities. Whatever the cause, this finding uniquely identifies an area for improvement to prevent new attending physicians from feeling unprepared to manage potentially critical emergencies.

An important goal of our study was to develop an instrument that would enable training programs to identify their learning needs. Both program-wide and individual assessments of resident case exposure and confidence are essential for identifying such learning needs and areas for curricular development. Program-wide assessments can spur an important debate about program goals and requirements with respect to what scenarios residents must be able to manage competently by graduation.[12] In addition, such assessments can help individualize learning exposures based on a specific learner's needs and career goals. The administration of our survey instrument required minimal resources, and the high response rate in our study suggests that other programs can implement our instrument to accomplish these goals.

Alternative methods, such as electronic learning portfolios (efolios), can be utilized to assess resident case exposure. In comparison to our survey instrument, efolios limit recall bias by utilizing case logs and have additional capabilities such as compiling evaluations and enabling trainees to set learning goals. However, there are considerable barriers to the effective use of efolios, including software cost, learner attitudes, and time constraints.[13] Tools such as our end-of-year assessment offer an alternative method that limits these barriers.

Once educational growth opportunities have been identified through survey-based or other methods, residency programs must determine how to optimize curricula for the needs and career goals of their trainees. We found considerable overlap among conditions that graduating residents had both limited exposure to and low confidence in managing (eg, torsades de pointes, tension pneumothorax, and emergency cardioversion), which are logical topics for future curriculum development. We also identified a few conditions (including PRES, TTP/HUS, and intracranial hemorrhage) that graduating residents did not feel confident in managing despite a relatively higher reported level of exposure. Whether to focus specific educational interventions on the most rare or most commonly encountered acute clinical events is likely to be a topic of debate among individual training programs, but the results of our survey indicate that there is likely to be educational benefit to both strategies.

Residency programs can employ a variety of modalities to enhance learner exposure and confidence in managing clinical scenarios that are deemed important by the program, including didactics, simulation, and changes in program structure. There is a substantial literature on the use of dedicated curricula for crisis management and the use of simulation as a training tool for responding to acute clinical events in multiple specialties[14-24] and in nonmedical domains such as aviation.[25-27] Simulation has been shown to improve residents' clinical skills and comfort level with some acute events[28-30] and may even be superior to traditional clinical medical education.[31] In addition, programs can utilize targeted clinical experiences such as intensive care unit and subspecialty rotations[32,33] in an effort to customize educational interventions to fill identified gaps in learner exposure or confidence.

Our study has several limitations. First, we investigated a single large IM residency program at a quaternary academic medical center, and therefore, our findings may not be externally generalizable to all IM residencies or other medical specialties. Our unique peer-led simulation curriculum, including 16 PGY-1 and 8 PGY-2 cases chosen based on clinical rotations at Massachusetts General Hospital,[7] likely impacted residents' exposure to simulation that is specific to our institution. However, although specific inpatient acute events may vary among other institutions, our finding that graduating residents still reported gaps in their clinical experience is likely generalizable to other programs given the varied and unpredictable nature of ward medicine training. In addition, our survey tool was simple to administer and could be tailored to reflect the acute events and training needs relevant to other residency programs, specialties, and institutions. Second, the retrospective nature of our study may be subject to participants' recall bias. We did not restrict our survey questions to urgent conditions managed only on IM hospital wards and some may have been experienced in the emergency room or intensive care units; however, these exposures are still relevant as key components of IM training. Third, our list of 50 acute clinical events was intentionally broad and included several conditions that require multidisciplinary subspecialist consultation, which could have impacted residents' self-report of "independent" exposures. However, these scenarios are ones that hospitalists may independently recognize and stabilize, engaging appropriate specialists. Fourth, we were not able to validate residents' self-reported exposures against other measures of the frequency of housestaff management of acute events (such as billing data or patient logs) as this information is not routinely collected. We also did not attempt to identify the reasons underlying the variation seen in resident exposure and confidence for individual acute events, but as a needs assessment, this was beyond the scope of our study. Finally, our assessment of resident confidence was subjective and we were not able to assess competence, with prior studies demonstrating conflicting results regarding the relationship between self-reported proficiency and observed competence.[34-36] Future studies are needed to investigate whether case exposure assessment leads to changes in residency curricula and whether such curricula increase resident confidence and competence in managing hospital acute clinical events.

CONCLUSION

We developed an easy-to-administer tool to assess IM residents' exposure to and confidence in managing inpatient acute

events. We found that both significantly increased as residents advanced through training, and self-reported confidence additionally correlated with level of exposure independent of PGY class. We identified several specific inpatient acute clinical events with low levels of resident exposure and confidence that can serve as targets for future IM residency curriculum development. Future studies assessing the impact of such curricula on resident confidence and competence are needed.

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Contemporary Rates of Preoperative Cardiac Testing Prior to Inpatient Hip Fracture Surgery

Michael I Ellenbogen, MD[1]*; Daniel J Brotman, MD[1]; Laura Prichett, PhD, MHS[2]; Ximin Li, ScM[2,3]; Leonard S Feldman, MD[1]

[1]*Department of Medicine, Johns Hopkins School of Medicine, Baltimore, Maryland;* [2]*Biostatistics, Epidemiology, and Data Management (BEAD) Core, Johns Hopkins School of Medicine, Baltimore, Maryland,* [3]*Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland.*

Hip fracture is a common reason for urgent inpatient surgery. In the past few years, several professional societies have identified preoperative echocardiography and stress testing for noncardiac surgeries as low-value diagnostics. We utilized data on hospitalizations with a primary diagnosis of hip fracture surgery between 2011 and 2015 from the State Inpatient Databases (SID) of Maryland, New Jersey, and Washington, combined with data on hospital characteristics from the American Hospital Association (AHA). We found that the rate of preoperative ischemic testing is surprisingly but encouragingly low (stress tests 1.1% and cardiac catheterizations 0.5%), which is consistent with studies evaluating the outpatient utilization of these tests for low- and intermediate-risk surgeries. The rate of echocardiograms was 12.6%, which was higher than other published reports. Our findings emphasize the importance of ensuring that quality improvement efforts are directed toward areas where quality improvement is, in fact, needed. *Journal of Hospital Medicine* 2019;14:224-228. © 2019 Society of Hospital Medicine

Hip fracture is a common reason for unexpected, urgent inpatient surgery in older patients. In 2005, the incidence of hip fracture was 369.0 and 793.5 per 100,000 in men and women respectively.[1] These numbers declined over the preceding decade, potentially as a result of bisphosphonate use. Age- and risk-adjusted 30-day mortality rates for men and women in 2005 were approximately 10% and 5%, respectively.

Evidence suggests that timely surgical repair of hip fractures improves outcomes, although the optimal timing is controversial. Guidelines from the American College of Surgeons Committee on Trauma from 2015 recommend surgical intervention within 48 hours for geriatric hip fracures.[2] A 2008 systematic review found that operative delay beyond 48 hours was associated with a 41% increase in 30-day all-cause mortality and a 32% increase in one-year all-cause mortality.[3] Recent evidence suggests that the rate of complications begins to increase with delays beyond 24 hours.[4]

There has been a focus over the past decade on overuse of preoperative testing for low- and intermediate-risk surgeries.[5-7] Beginning in 2012, the American Board of Internal Medicine initiated the *Choosing Wisely*® campaign in which numerous societies issued recommendations on reducing utilization of various diagnostic tests, a number of which have focused on preoperative tests. Two groups—the American Society of Anesthesiologists (ASA) and the American Society of Echocardiography (ASE)— issued specific recommendations on preoperative cardiac testing.[8] In February 2013, the ASE recommended avoiding preoperative echocardiograms in patients without a history or symptoms of heart disease. In October 2013, the ASA recommended against transthoracic echocardiogram (TTE), transesophageal echocardiogram (TEE), or stress testing for low- or intermediate-risk noncardiac surgery for patients with stable cardiac disease.

Finally, in 2014, the American College of Cardiology (ACC)/American Heart Association (AHA) issued updated perioperative guidelines for patients undergoing noncardiac surgeries.[9] They recommended preoperative stress testing only in a small subset of cases (patients with an elevated perioperative risk of major adverse cardiac event, a poor or unknown functional capacity, or those in whom stress testing would impact perioperative care).

Given the high cost of preoperative cardiac testing, the potential for delays in care that can adversely impact outcomes, and the recent recommendations, we sought to characterize the rates of inpatient preoperative cardiac testing prior to hip fracture surgery in recent years and to see whether recent recommendations to curb use of these tests were temporally associated with changing rates.

METHODS

Overview

We utilized two datasets—the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID) and the American Hospital Association (AHA) Annual Survey—to character-

***Corresponding Author:** Michael I Ellenbogen, MD; E-mail: mellenb6@jhmi.edu; Telephone: 443-287-4362

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ize preoperative cardiac testing. SID data from Maryland, New Jersey, and Washington State from 2011 through September 2015 were used (the ICD coding system changed from ICD9 to ICD10 on October 1, 2015). This was combined with AHA data for these years. We included all hospitalizations with a primary ICD9 procedure code for hip fracture repair—78.55, 78.65, 79.05, 79.15, 79.25, 79.35, 79.45, 79.55, 79.65, 79.75, 79.85, and 79.95. We excluded all observations that involved an interhospital transfer. This study was exempt from institutional review board approval.

Measurement and Outcomes

We summarized demographic data for the hospitalizations that met the inclusion criteria as well as the associated hospitals. The primary outcome was the percentage of patients undergoing TTE, stress test, and cardiac catheterization during a hospitalization with a primary procedure code of hip fracture repair. Random effects logistic regression models for each type of diagnostic test were developed to determine the factors that might impact test utilization. In addition to running each test as a separate model, we also performed an analysis in which the outcome was performance of any of these three cardiac tests. Random effects were used to account for clustering of testing within hospitals. Variables included time (3-month intervals), state, age (continuous variable), gender, length of stay, payer (Medicare/Medicaid/private insurance/self-pay/other), hospital teaching status (major teaching/minor teaching/nonteaching), hospital size according to number of beds (continuous variable), and mortality score. Major teaching hospitals are defined as members of the Council of Teaching Hospitals. Minor teaching hospitals are defined as (1) those with one or more postgraduate training programs recognized by the American Council on Graduate Medical Education, (2) those with a medical school affiliation reported to the American Medical Association, or (3) those with an internship or residency approved by the American Osteopathic Association.

The SID has a specific binary indicator variable for each of the three diagnostic tests we evaluated. The use of the diagnostic test is evaluated through both UB-92 revenue codes and ICD9 procedure codes, with the presence of either leading to the indicator variable being positive.[10] Finally, we performed a sensitivity analysis to evaluate the significance of changing utilization trends by interrupted time series analysis. A level of 0.05 was used to determine statistical significance. Analyses were done in STATA 15 (College Station, Texas).

RESULTS

The dataset included 75,144 hospitalizations with a primary procedure code of hip fracture over the study period (Table). The number of hospitalizations per year was fairly consistent over the study period in each state, although there were fewer hospitalizations for 2015 as this included only January through September. The mean age was 72.8 years, and 67% were female. The primary payer was Medicare for 71.7% of hospitalizations. Hospitalizations occurred at 181 hospitals, the plurality of which (42.9%) were minor teaching hospitals. The proportions of hospitalizations that included a TTE, stress test, and cardiac catheterization were 12.6%, 1.1%, and 0.5%, respectively. Overall, 13.5% of patients underwent any cardiac testing.

There was a statistically significantly lower rate of stress tests (odds ratio [OR], 0.32; 95% CI, 0.19-0.54) and cardiac catheterizations (OR, 0.46; 95% CI, 0.27-0.79) in Washington than in Maryland and New Jersey. Female gender was associated with significantly lower adjusted ORs for stress tests (OR, 0.74; 95% CI, 0.63-0.86) and cardiac catheterizations (OR, 0.73; 95% CI, 0.59-0.91), and increasing age was associated with higher adjusted ORs for each test (TTE, OR, 1.033; 95% CI, 1.031-1.035; stress tests, OR, 1.007; 95% CI, 1.001-1.013; cardiac catheterizations, OR, 1.011; 95% CI, 1.003-1.019). Private insurance was associated with a lower likelihood of stress tests (OR, 0.65; 95% CI, 0.50-0.85) and cardiac catheterizations (OR, 0.67; 95% CI,0.46-0.98), and self-pay was associated with a lower likelihood of TTE (OR, 0.76; 95% CI, 0.61-0.95) and stress test (OR, 0.43; 95% CI, 0.21-0.90), all compared with Medicare.

Larger hospitals were associated with a greater likelihood of cardiac catheterizations (OR, 1.18; 95% CI, 1.03-1.36) and a lower likelihood of TTE (OR, 0.89; 95% CI, 0.82-0.96). An unweighted average of these tests between 2011 and October 2015 showed a modest increase in TTEs and a modest decrease in stress tests and cardiac catheterizations (Figure). A multivariable random effects regression for use of TTEs revealed a significantly increasing trend from 2011 to 2014 (OR, 1.04, $P < .0001$), but the decreasing trend for 2015 was not statistically significant when analyzed according to quarters or months (for which data from only New Jersey and Washington are available).

In the combined model with any cardiac testing as the outcome, the likelihood of testing was lower in Washington (OR, 0.56; 95% CI, 0.31-0.995). Primary payer status of self-pay was associated with a lower likelihood of cardiac testing (OR, 0.73; 95% CI, 0.58-0.90). Female gender was associated with a lower likelihood of testing (OR, 0.93; 95% CI, 0.88-0.98), and high mortality score was associated with a higher likelihood of testing (OR, 1.030; 95% CI, 1.027-1.033). TTEs were the major driver of this model as these were the most heavily utilized test.

DISCUSSION

There has been limited research into how often preoperative cardiac testing occurs in the inpatient setting. Our aim was to study its prevalence prior to hip fracture surgery during a time period when multiple recommendations had been issued to limit its use. We found rates of ischemic testing (stress tests and cardiac catheterizations) to be appropriately, and perhaps surprisingly, low. Our results on ischemic testing rates are consistent with previous studies, which have focused on the outpatient setting where much of the preoperative workup for nonurgent surgeries occurs. The rate of TTEs was higher than in previous studies of the outpatient preoperative setting, although it is unclear what an optimal rate of TTEs is.

A recent study examining outpatient preoperative stress tests within the 30 days before cataract surgeries, knee ar-

TABLE. **Descriptive Statistics, Patient, and Hospital Characteristics**

Overall testing volume, total number (% of patients)				
Echocardiograms	9,441 (12.6)			
Stress tests	801 (1.1)			
Cardiac catheterizations	381 (0.5)			
Patient characteristics	**(n = 75,144 admissions)**			
Age (standard deviation)	72.8 (21.1)			
Gender (female)	67.1%			
Primary payer[a]				
Medicare	53,903	71.7%		
Private insurance	13,753	18.3%		
Medicaid	3,959	5.3%		
Other	1,663	2.2%		
Self-pay	1,613	2.2%		
No charge	248	0.3%		
Hospital characteristics	**(n =75,144 admissions)**		**(n = 181 hospitals)**	
State	Patients		Hospitals[b]	
Maryland	19,283	25.6%	47	26.0%
New Jersey	32,467	43.2%	66	36.5%
Washington	23,394	31.1%	68	37.6%
Bed size[c]				
< 100 beds	4,595	4.5%	48	20.8%
100-199 beds	13,855	18.4%	56	24.2%
200-299 beds	18,185	24.9%	54	23.4%
300-399 beds	12,174	15.8%	34	14.7%
400-499 beds	11,708	16.3%	23	10.0%
> 500 beds	14,487	18.2%	16	6.9%
Teaching status[d]				
Major teaching	15,473	20.6%	21	10.0%
Minor teaching	34,548	46.1%	90	42.9%
Nonteaching	25,002	33.3%	99	47.1%

[a]Missing payer observations by patient = 5

[b]Number of hospitals by bed size and teaching status adds to greater than 181 because of changes in hospital size and teaching status over the study period.

[c]Missing bed size observations = 140

[d]Missing teaching status observations = 121

throscopies, or shoulder arthroscopies found a rate of 2.1% for Medicare fee-for-service patients in 2009 with little regional variation.[11] Another evaluation using 2009 Medicare claims data found rates of preoperative TTEs and stress tests to be 0.8% and 0.7%, respectively.[12] They included TTEs and stress tests performed within 30 days of a low- or intermediate-risk surgery. A study analyzing the rate of preoperative TTEs between 2009 and 2014 found that rates varied from 2.0% to 3.4% for commercially insured patients aged 50-64 years and Medicare-advantage patients, respectively, in 2009.[13] These rates decreased by 7.0% and 12.6% from 2009 to 2014. These studies, like ours, suggest that preoperative cardiac testing has not been a major source of wasteful spending. One explanation for the higher rate of TTEs we observed in the inpatient setting might be that primary care physicians in the outpatient setting are more likely to have historical cardiac testing results compared with physicians in a hospital.

We found that the rate of stress testing and cardiac catheterization in Washington was significantly lower than that in Maryland and New Jersey. This is consistent with a number of measures of healthcare utilization – total Medicare reimbursement in the last six months of life, mean number of hospital days in the last six months of life, and healthcare intensity index—for all of which Washington was below the national mean and Maryland and New Jersey were above it.[14]

Finally, we found evidence of a lower rate of preoperative

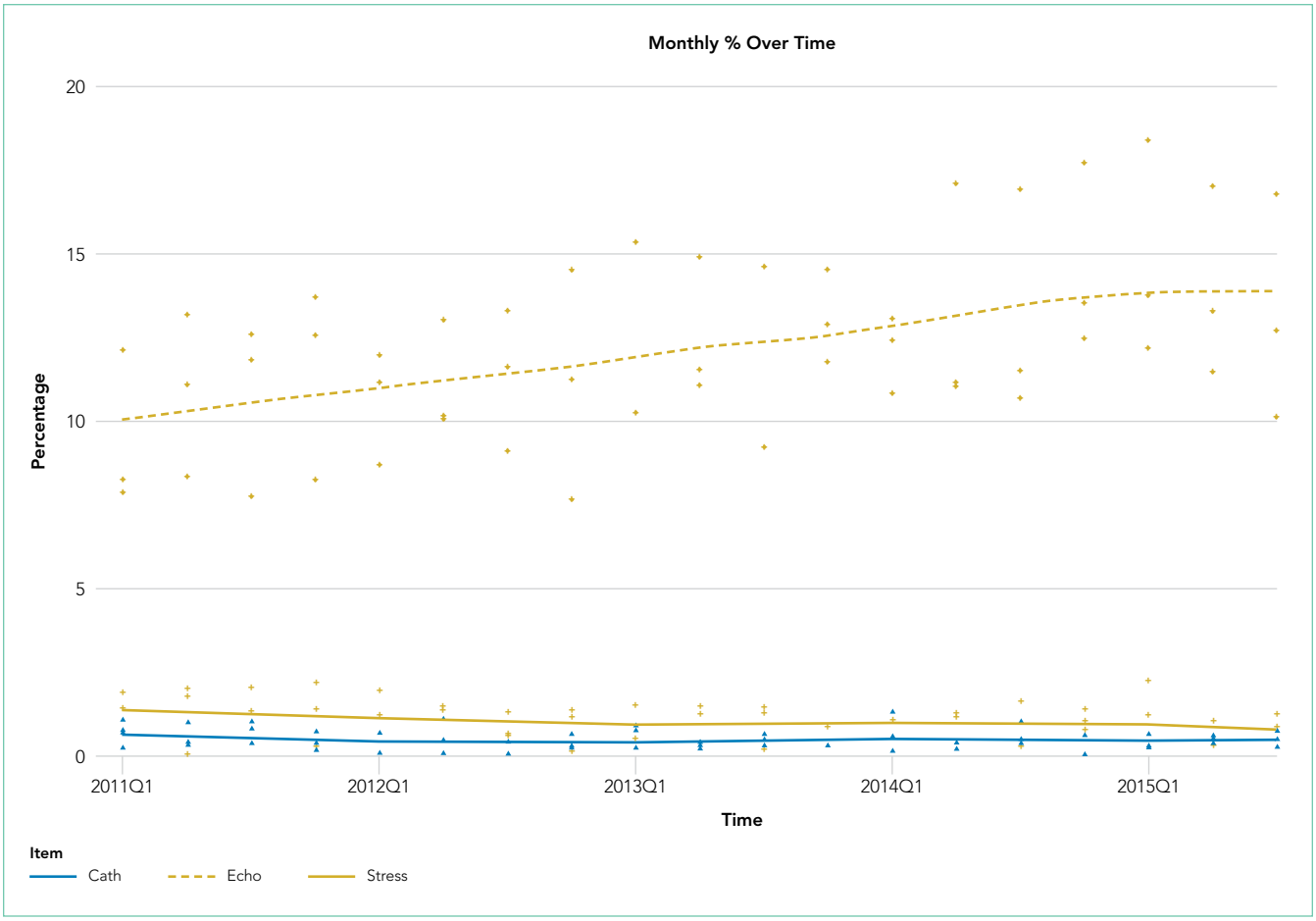

FIG. Unweighted total transthoracic echocardiograms, stress tests, and cardiac catheterizations over time

stress tests and cardiac catheterizations for women despite controlling for age and mortality score. Of course, we did not control directly for cardiovascular comorbidities; as a result, there could be residual confounding. However, these results are consistent with previous findings of gender bias in both pharmacologic management of coronary artery disease (CAD)[15] and diagnostic testing for suspected CAD.[16]

We focused on hospitalizations with a primary procedure code to surgically treat hip fracture. We are unable to tell if the cardiac testing of these patients had occurred before or after the procedure. However, we suspect that the vast majority were completed for preoperative evaluation. It is likely that a small subset were done to diagnose and manage cardiac complications that either accompanied the hip fracture or occurred postoperatively. Another limitation is that we cannot determine if a patient had one of these tests recently in the emergency department or as an outpatient.

We also chose to include only patients who actually had hip fracture surgery. It is possible that the testing rate is higher for all patients admitted for hip fracture and that some of these patients did not have surgery because of abnormal cardiac testing. However, we suspect that this is a very small fraction given the high degree of morbidity and mortality associated with untreated hip fracture.

CONCLUSION

We found a low rate of preoperative cardiac testing in patients hospitalized for hip fracture surgery both in the years before and after the issuance of recommendations intended to curb its use. Although it is reassuring that the volume of low-value testing is lower than we expected, these findings highlight the importance of targeting utilization improvement efforts toward low-value tests and procedures that are more heavily used, since further curbing the use of infrequently utilized tests and procedures will have only a modest impact on overall healthcare expenditure. Our findings highlight the necessity that professional organizations ensure that they focus on true areas of inappropriate utilization. These are the areas in which improvements will have a major impact on healthcare spending. Further research should aim to quantify unwarranted cardiac testing for other inpatient surgeries that are less urgent, as the urgency of hip fracture repair may be driving the relatively low utilization of inpatient cardiac testing.

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Use of Advance Care Planning Billing Codes for Hospitalized Older Adults at High Risk of Dying: A National Observational Study

Amber E Barnato, MD, MPH, MS[1]*; A James O'Malley, PhD[1,2]; Jonathan S Skinner, PhD[1,3]; John D Birkmeyer, MD[1,4]

[1]*The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine at Dartmouth, Lebanon, New Hampshire;* [2]*Department of Biomedical Data Science, Geisel School of Medicine at Dartmouth, Lebanon, New Hampshire;* [3]*Department of Economics, Dartmouth College, Hanover New Hampshire;* [4]*Sound Physicians, Tacoma, Washington.*

We analyzed advance care planning (ACP) billing for adults aged 65 years or above and who were managed by a large national physician practice that employs acute care providers in hospital medicine, emergency medicine and critical care between January 1, 2017 and March 31, 2017. Prompting hospitalists to answer the validated "surprise question" (SQ; "Would you be surprised if the patient died in the next year?") for inpatient admissions served to prime hospitalists and triggered an icon next to the patient's name. Among 113,621 hospital-based encounters, only 6,146 (5.4%) involved a billed ACP conversation: 8.3% among SQ-prompted who answered "no" and 4.1% SQ-prompted who answered "yes" (for non-SQ prompted cases, the fraction was 3.5%; $P < .0001$). ACP conversations were associated with a comfort-focused care trajectory. Low ACP rates among even those with high hospitalist-predicted mortality risk underscore the need for quality improvement interventions to increase hospital-based ACP. *Journal of Hospital Medicine* 2019;14:229-231. © 2019 Society of Hospital Medicine

Advance care planning (ACP) is the process wherein patients, in discussions with their healthcare providers, family members, and other loved ones, make individual decisions about their future healthcare or prepare proxies to guide future medical treatment decisions.[1,2] In 2016, the Centers for Medicare and Medicaid Services (CMS) began paying providers for ACP by using billing codes 99497 (first 30 min of ACP) and 99498 (additional 30 min of ACP). According to the CMS, during the first year after the billing codes were introduced, 22,864 providers billed for ACP conversations with 574,621 patients.[3] While all adults are eligible, common triggers for ACP include advanced age, serious illness, and functional status changes that confer an increased risk of dying. We explored the early uptake of the ACP billing code in a large national physician practice that provided mandatory education in use of the ACP billing code, offered a small financial incentive for ACP documentation, and primed physicians to reflect on the patient's risk of dying in the next year at the time of hospital admission.

METHODS

We analyzed ACP billing for hospitalized adults aged 65 years or above and who were managed by a large national physician practice that employs acute care providers in hospital medicine, emergency medicine and critical care between January 1, 2017 and March 31, 2017. This practice employs approximately 2,500 hospital-based physicians in 250 community hospitals in 38 states. They collect data through handheld and desktop information technology (IT) tools to facilitate coding, billing, and compliance by hospitalists. Hospitalists receive mandatory web-based training in compliance with CMS ACP billing and templated ACP documentation. Additionally, they receive web-based training in serious illness communication skills during the first two years of employment. The training includes didactic content regarding steps for collaborative decision making, words to use during the encounter, and videos of simulated patient encounters demonstrating best practices. Hospitalists also receive a small financial incentive ($20) for each properly documented ACP conversation that meets CMS criteria for ACP code payment.

Beginning in 2017, hospitalists were required to answer the validated Surprise Question[4] (SQ; "Would you be surprised if the patient died in the next year?") for all admitted patients aged 65 years and older. The SQ is useful because it is intuitive and not burdensome for physicians to answer. Moreover, it is predictive of mortality. The pooled prognostic characteristics of the SQ across multiple populations for predicting the outcome of death at 6 months to 18 months include a sensitivity of 67.0% (95% confidence interval [CI] 55.7%-76.7%), a specificity of 80.2% (95% CI 73.3%-85.6%), a positive likelihood ratio of 3.4 (95% CI 2.8–4.1), a negative likelihood ratio of 0.41 (95% CI 0.32-0.54), a positive predictive value of 37.1% (95% CI 30.2%-44.6%), and a negative predictive value of 93.1% (95% CI 91.0%-94.8%).[5] The SQ primed the admitting physician and triggered an "EoL" (end-of-life) icon next to the patient's name on the hospitalists' handheld electronic patient census.

***Corresponding Author:** Amber E. Barnato, MD, MPH; E-mail: amber.barnato@dartmouth.edu; Telephone: 650-653-0829; Twitter: @abarnato

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TABLE 1. **Advance Care Planning Billing by Response to the "Surprise Question"**

	ACP billed (n = 6,146)	No ACP billed (n = 107,466)
"No, I would not be surprised if the patient died in the next year" (n = 41,276)	3,414 (8.3%)	37,862 (91.7%)
"Yes, I would be surprised if the patient died in the next year" (n = 32,441)	1,317 (4.1%)	31,124 (95.9%)
Not prompted to answer SQ[a] (n = 39,881)	1,414 (3.5%)	38,467 (96.5%)

[a]The SQ was not asked of all patients in the first quarter of 2017. This included hospitalizations at sites that had delayed implementation of the SQ during the quarter and all patients who were on observation status

Abbreviations: ACP, advance care planning; SQ, surprise question.

We summarized ACP billing rates and used mixed-effects regression to estimate adjusted ACP rates accounting for patient covariates and clustering at the provider and hospital level. Patient covariates included age; answer to the SQ ["yes," "no," or "missing"]); and the presence or absence of seven comorbidities: dementia, heart failure, chronic obstructive pulmonary disease, renal failure, liver failure, metastatic cancer, and nonmetastatic cancer. We quantified the magnitude of provider and hospital variation in ACP rates by using the intraclass correlation coefficient (ICC).

RESULTS

In the first quarter of 2017, hospitalists admitted 113,612 patients aged 65 years and older. Hospitalists were prompted to answer the SQ for 73,731 (65%) of the patients. They were not prompted to answer the SQ for 39,881 (35%) of the patients (ie, missing data for the SQ). Reasons for not prompting include delayed implementation at a site and the patient not being admitted to the hospital (eg, managed on observation status). When prompted, hospitalists answered "no" to the SQ for 41,276/73,731 (56%) of admissions.

Only 6,146/113,612 (5.4%) of all admissions involved a billed ACP conversation. Rates were highest among SQ-prompted/answer "no" cases (8.3%) compared with SQ-prompted/answer "yes" cases (4.1%) and non-SQ-prompted cases (3.5%), with all pairwise differences being statistically significant (*P* values "yes" vs "no" = .0079, "yes" vs not prompted = .0043, "no" vs not prompted < .0001; see Table 1).

In addition to being more likely to have a "no" response to the SQ, those with a billed ACP conversations were older (80 vs 78, $P < .001$); more likely to be diagnosed with dementia (5.9% vs 3.5%, $P < .001$), congestive heart failure (12.3% vs 9.9%, $P < .001$), and cancer (6.1% vs 3.3%, $P < .001$); more likely to die during the admission (16.5% vs 10.9%, $P < .001$); and, conditional on survival to discharge, more likely to be discharged with hospice (17% vs 3%, $P < .001$) than those without (Table 2).

At the hospital level, ACP rates varied from 0% to 35% (mean 5.2%) of all admissions. In analyses restricted to physicians

TABLE 2. **Characteristics of Patients over the Age of 65 Managed by a National Hospital Physician Practice Management Group During Quarter 1 2017, by Advance Care Planning Billing During the Admission**

Variable	ACP billed (n = 6,146)	No ACP billed (n = 107,466)	*P* Value
Age, mean (SD)	80.26 (8.82)	77.71 (8.44)	<.001
"No" to the SQ*, n (%)	3,414 (55.56)	37,862 (35.24)	<.001
Diagnoses, n (%)			
Dementia	362 (5.89)	3,787 (3.52)	<.001
Congestive heart failure	755 (12.28)	10,604 (9.86)	<.001
Chronic pulmonary disease	650 (10.57)	12,870 (11.98)	.001
Renal failure	7 (0.11)	181 (0.17)	.306
Liver disease	46 (0.75)	564 (0.52)	.020
Metastatic cancer	82 (1.33)	611 (0.57)	<.001
Solid tumor w/o metastasis	269 (4.81)	2,924 (2.72)	<.001
Discharge status, n (%)			
Home	1,973 (32.10)	56,174 (52.27)	<.001
Home with home healthcare	926 (15.07)	15,701 (14.61)	.7004
Skilled nursing facility	1,161 (18.89)	16,627 (15.47)	.002
Inpatient rehabilitation facility	172 (2.80)	3,431 (3.19)	.7758
Long-term acute care hospital	52 (0.85)	616 (0.57)	.8006
Hospice	851 (13.85)	3,233 (3.01)	<.0001
Deceased	1,011 (16.45)	11,684 (10.87)	<.0001

*SQ: "Would you be surprised if the patient died in the next year?" was only asked for 73,731 admitted, nonobservation status hospital-based encounters

Abbreviations: ACP, advance care planning; SD, standard deviation; SQ, surprise question.

seeing at least 30 patients 65 years of age and older during the quarter, physician-level ACP rates varied from 0% to 93% (mean 5.4%). The majority of all ACP discussions were attributable to one-quarter of physicians. One-third of physicians never billed for ACP.

In a hierarchical logistic regression model accounting for observable patient characteristics and clustering at the physician and hospital level, the adjusted ACP rate for an "average" patient (age 77.85 with the most common clinical conditions) was 13.6% if the hospitalist answered "no" to the SQ, 9.6% if the hospitalist answered "yes," and 10.1% if the hospitalist was not asked the SQ (*P* value of difference < .0001). From this model, we also calculated an ICC at the physician level of 0.044 and at the hospital level of 0.079. The physician level ICC corresponds to a 4.5% absolute increase in ACP when one moves from a physician at the mean to a physician 1 SD above the mean (ie, moving 1 SD up the scale of the latent variable underlying the random effect). The hospital level ICC corresponds to a 6.3% absolute increase in ACP when one moves from a hospital at the mean to a hospital 1 SD above the mean. The 4.5% absolute increase in ACP due to physician practice patterns and 6.3% absolute increase in ACP due to hospital practice patterns are both greater than the estimated increase in ACP from the hospitalist answering "no" instead of "yes" to the SQ (3.6%).

DISCUSSION

In this large national hospital-based physician practice group, the rates of ACP among acute care patients 65 years of age and older were very low despite the use of education and IT- and incentive-based strategies to encourage ACP conversations among seriously ill older adults. Priming physicians to reflect on the patient's risk of dying at the time of admission was associated with the doubling of ACP rates.

Despite some lawmakers' concerns that the ACP billing code may be overused and therefore become a financial burden to the Medicare program[6], we find the very low use of ACP billing in a population for whom having goals of care conversations is critical—seriously ill older adults who the physician would not be surprised if they died in the next year. This gap is significant because these ACP conversations, when they did occur, were associated with a comfort-focused trajectory, including a more than four-fold increase in hospice referral at discharge.

Causal inference is limited because of the observational nature of the study. While we hypothesize that priming the physicians to reflect on prognosis activated them to prioritize ACP, based on a prior scenario-based randomized trial,[7] illness severity likely drives ACP conversations. Specifically, patients on observation status (who had missing SQ data) and those for whom the physician answered "yes" to the SQ are less sick than other patients. Additional decision-making heuristics in addition to mortality risk may influence ACP conversations, as suggested by the independent influence of diagnoses, such as dementia or cancer, on ACP. Notably, however, the large amounts of unexplained variation at the physician and the hospital levels exceed the amounts explained by any individual observed patient factor.

Other key limitations of this study include the use of ACP billing as a primary outcome rather than observed and documented ACP conversations and the lack of information on the quality of ACP conversations. These findings reflect the uptake of ACP billing rates soon after the code was introduced. ACP billing rates have likely increased since the first quarter of 2017. Future work should explore diffusion and variation in physician-specific use over time. Finally, despite the nationwide sample, findings may not be generalizable to hospitalists who have not received training and financial incentives for ACP billing.

This study reinforces the possibility that variation in ACP conversations may contribute to variation in end-of-life treatment intensity between providers.[8-10] Low ACP rates among even those with high hospitalist-predicted mortality risk and considerable between-provider variation underscore the need for quality improvement interventions to increase hospital-based ACP.

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Updates in Management and Timing of Dialysis in Acute Kidney Injury

Margaret K Yu, MD, MS[1]*; Fahmeedah Kamal, MD[1]; Glenn M Chertow, MD, MPH[1]

[1]*Division of Nephrology, Department of Medicine, Stanford University School of Medicine, Stanford, California*

Acute kidney injury (AKI) is a common complication in hospitalized patients and is associated with mortality, prolonged hospital length of stay, and increased healthcare costs. This paper reviews several areas of controversy in the identification and management of AKI. Serum creatinine and urine output are used to identify and stage AKI by severity. Although standardized definitions of AKI are used in research settings, these definitions do not account for individual patient factors or clinical context which are necessary components in the assessment of AKI. After treatment of reversible causes of AKI, patients with AKI should receive adequate volume resuscitation with crystalloid solutions. Balanced crystalloid solutions generally prevent severe hyperchloremia and could potentially reduce the risk of AKI, but additional studies are needed to demonstrate a clinical benefit. Intravenous albumin may be beneficial in patients with chronic liver disease either to prevent or attenuate the severity of AKI; otherwise, the use of albumin or other colloids (eg, hydroxyethyl starch) is not recommended. Diuretics should be used to treat volume overload, but they do not facilitate AKI recovery or reduce mortality. Nutrition consultation may be helpful to ensure that patients receive adequate, but not excessive, dietary protein intake, as the latter can lead to azotemia and electrolyte disturbances disproportionate to the patient's kidney failure. The optimal timing of dialysis initiation in AKI remains controversial, with conflicting results from two randomized controlled trials. *Journal of Hospital Medicine* 2019;14:232-238. Published onfline first February 20, 2019.

Acute kidney injury (AKI) is a common complication in hospitalized patients, affecting one in five inpatients[1,2] and more than half of patients in intensive care units (ICU).[3] The incidence of AKI appears to be increasing over time.[4] Potential contributing factors include an aging population, rising prevalence of comorbid conditions such as heart failure and chronic kidney disease (CKD), using nephrotoxic agents, and increasing complexity of surgical procedures.[5,6] AKI during a hospital stay is associated with a two- to 10-fold increased risk of inhospital mortality,[1,2,7-10] longer hospital length of stay,[7,10] higher risk for hospital readmissions,[11] and higher healthcare costs.[7] Patients who survive an episode of AKI have a higher risk for CKD and dialysis-dependence,[9] even after an episode of reversible AKI.[12] Despite its clinical importance, several areas of controversy remain regarding the management of AKI and, in particular, the optimal timing of renal replacement therapy (RRT) in patients with AKI. The purpose of this manuscript is to review the approaches to diagnosis and management of AKI in hospitalized patients. We also review recent evidence regarding the timing of dialysis in patients with AKI. This journal recently reviewed the differential diagnosis and diagnostic evaluation of AKI, which is not covered here.[13]

***Corresponding Author:** Margaret Yu, MD, MS; E-mail: mkyu@stanford.edu.

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DEFINITION OF ACUTE KIDNEY INJURY

AKI refers to an acute change in kidney function characterized by an increase in serum creatinine and/or a reduction in urine output. It is a clinical syndrome caused by a broad range of etiologies and may be related to primary kidney pathology and/or systemic illness. Until 2004, there was no standard definition for AKI and over 30 different definitions were found in the literature, which resulted in wide variation in the reported incidence and outcomes of AKI and made it challenging to apply an evidence-based approach to patient care. In 2004, the Risk, Injury, Failure, Loss, and End-stage kidney disease (RIFLE)[14] criteria for AKI were proposed, which were modified to the Acute Kidney Injury Network (AKIN)[15] criteria in 2007 (Table 1). Multiple studies show that the RIFLE and AKIN criteria for AKI are associated with higher mortality[1,2,8,10] and increased risk for requiring RRT.[1,10]

International clinical practice guidelines for AKI were released by Kidney Disease: Improving Global Outcomes (KDIGO) in 2012, which included a standardized definition of AKI that was adapted from the previously validated RIFLE and AKIN definitions.[16] Patients are considered to have AKI when the serum creatinine rises by as little as 0.3 mg/dL. It is notable that when the baseline serum creatinine is high, there is more inherent variability in the serum creatinine measurement; thus, patients with CKD have a higher risk of being misclassified as having AKI.[17] Although the KDIGO definition for AKI is commonly used in research settings, components of this definition have not been well validated, and it is not widely used in clinical practice. Other renal professional societies still recommend an individualized approach to the diagnosis of AKI, taking into

TABLE 1. **Serum Creatinine and Urine Output Criteria for Acute Kidney Injury**

	Serum Creatinine Criteria						Urine Output Criteria
	RIFLE		**AKIN[b]**		**KDIGO**		**(Common to All)**
Definition	≥50% increase from baseline or GFR decline >25% over 7 days[a]		Increase ≥0.3 mg/dL or ≥50% increase from baseline over 48 hours		Increase ≥0.3 mg/dL over 48 hours or ≥50% increase from baseline over 7 days		<0.5 mL/kg/hour for 6 hours
Staging	Risk	≥50% increase or GFR decline >25%	1	Increase ≥0.3 mg/dL or ≥50% increase	1	Increase ≥0.3 mg/dL or ≥50% increase	<0.5 mL/kg/hour for 6 hours
	Injury	≥100% increase or GFR decline >50%	2	≥100% increase	2	≥100% increase	<0.5 mL/kg/hour for 12 hours
	Failure	≥200% increase or GFR decline >75% or sCr ≥4 mg/dL with acute rise ≥0.5 mg/dL	3	≥200% increase or sCr ≥4 mg/dL with acute rise ≥0.5 mg/dL or RRT	3	≥200% increase or sCr ≥4 mg/dL[c] or RRT	<0.3 mL/kg/hour for 24 hours or Anuria for 12 hours
	Loss	RRT for ≥4 weeks					
	End-stage kidney disease	RRT for ≥3 months					
Strengths	Validated criteria and staging system; higher stages are associated with higher mortality and RRT dependence		Validated criteria and staging system; higher stages are associated with higher mortality and RRT dependence Incorporates smaller changes in serum creatinine Less reliant on knowledge of baseline creatinine		Uses components of previously validated criteria from RIFLE and AKIN		Urine output may be more sensitive than serum creatinine
Weaknesses	Creatinine-based measure is limited in certain populations (catabolic states or sarcopenia) Need to know baseline creatinine or GFR Assumption of baseline GFR results in misclassification Serum creatinine change does not correlate with GFR change from the same stage Creatinine and urine output criteria from the same stage do not have similar mortality risk		Creatinine-based measure is limited in certain populations (catabolic states or sarcopenia) Small changes in serum creatinine in patients with CKD may result in misclassification Need two separate creatinine measures within 48 hours		Creatinine-based measure is limited in certain populations (catabolic states or sarcopenia) Small changes in serum creatinine in patients with CKD may result in misclassification		Urine output criteria are less well validated than creatinine-based criteria for acute kidney injury

[a]If baseline renal function is unknown and there is no known history of CKD, then the baseline GFR of 75 mL/min/1.73 m^2 is used.

[b]Apply diagnostic criteria after adequate fluid resuscitation. Rule out urinary tract obstruction before making the diagnosis based on urine output criteria alone.

[c]Must also fulfill the creatinine-based definition of acute kidney injury (creatinine ≥0.3 mg/dL over 48 hours or ≥50% increase from baseline over 7 days).

Abbreviations: AKIN, Acute Kidney Injury Network[14]; CKD, chronic kidney disease; GFR, glomerular filtration rate; KDIGO, Kidney Disease: Improving Global Outcomes[15]; RIFLE, Risk, Injury, Failure, Loss, End-stage kidney disease[13]; RRT, renal replacement therapy; sCr, serum creatinine.

account other factors such as trajectories in kidney function, fluid balance, electrolyte abnormalities, comorbid conditions, and clinical context.[18,19] While we endorse the KDIGO approach to the categorization of AKI severity, in practice, a more patient-centered approach is generally required to guide the optimal approach to determining the etiology of AKI and guiding management.

GENERAL MANAGEMENT OF ACUTE KIDNEY INJURY

All patients with AKI should have close monitoring of their serum creatinine and urine output. Noninvasive diagnostic studies (urine microscopy, postvoid residual, and renal ultrasound) should be considered based on the clinical scenario. General management strategies include treatment of the reversible causes of AKI and optimization of volume status, hemodynamics, and nutritional status (Table 2).

Reversible Causes of Acute Kidney Injury

The first step in the treatment of AKI is to identify and treat readily reversible causes of AKI such as volume depletion, hypotension, infection, and urinary obstruction. Nephrotoxins should be avoided and all medications should be reviewed and adjusted for kidney function, particularly those that may affect mental status. Avoid opiates with noxious or active metabolites, including meperidine and morphine. Instead, hydro-

TABLE 2. **Summary of Management Considerations in Acute Kidney Injury**

AKI Management	Comments	Recommendations
Identify and treat reversible causes of Acute Kidney Injury	Obtain detailed history and examination. Review all medications.	Identify and treat hypovolemia, hypotension, infection, and urinary obstruction. Avoid nephrotoxins. Renally dose medications.
Intravenous fluids	For most patients, albumin has an unproven benefit compared with crystalloid solutions. Hydroxyethyl starch is not recommended. Balanced crystalloid solutions reduce the risk of severe hyperchloremia and acidosis and may be associated with a lower risk of AKI.	Volume resuscitate with crystalloid solutions. Consider balanced crystalloid solutions to avoid severe hyperchloremia and acidosis in large volume (>2 L) resuscitation, particularly in critically ill patients.
Diuretics	Diuretics do not directly affect AKI recovery or survival. Patients with AKI may need high doses of diuretics to respond.	Only use diuretics as needed for volume overload.
Nutrition	Patients in catabolic states may have high protein requirements. Excess protein intake may contribute to azotemia out of proportion to renal failure.	Nutrition consultation is recommended to ensure adequate, but not excessive, protein intake.
Renal replacement therapy	Optimal timing of renal replacement therapy is not known. No evidence for mortality benefit of continuous renal replacement therapy over intermittent hemodialysis.	Medical management of fluid and electrolyte abnormalities in nonoliguric patients with AKI should be attempted while assessing renal replacement therapy needs.

morphone, fentanyl, and methadone are preferred in patients with AKI. Other commonly used medications that require dose adjustment include gabapentin, baclofen, metoclopramide, H2 antagonists, many commonly prescribed antibiotics (penicillins, most cephalosporins, carbapenems, quinolones, and sulfa drugs), many hypoglycemic agents, and insulin. For patients on RRT, dosing is dependent on dialysis modality. Consultation with a hospital pharmacist is recommended when RRT modalities are initiated or changed.

Intravenous Fluids

Patients with AKI should have their volume status assessed and receive adequate resuscitation with intravenous fluids to promote renal perfusion. However, the optimal type and volume of fluid to give in AKI remains controversial. Colloid-containing solutions are theoretically confined to the intravascular space and should pose a lower risk for pulmonary edema compared with crystalloids. However, these solutions are costly, are not associated with any meaningful benefit,[20-22] and may even be associated with potential harm.[22-27]

The most commonly used colloid worldwide is hydroxyethyl starch (HES). Its potential adverse effects include anaphylactoid reactions, coagulopathy, and AKI. HES is cleared by the kidneys and can cause osmotic nephrosis, a form of AKI characterized by vacuole formation and proximal renal tubular damage.[28] Randomized controlled trials have shown an increased risk of AKI, RRT use, and mortality in critically ill patients who were resuscitated with HES.[22,26,27] HES is not currently recommended in patients who are critically ill or have impaired kidney function and sepsis guidelines advise against its use.[29]

In the United States, albumin is the most common colloid-containing solution used for intravascular volume resuscitation. Albumin has been shown to be safe for volume resuscitation in critically ill patients,[20] but there is no proven advantage to using albumin over saline with respect to mortality, length of hospital stay, duration of mechanical ventilation, duration of RRT, or number of organ systems failure.[20,21] Furthermore, albumin may be harmful in certain patient populations. In patients with traumatic brain injury, albumin resuscitation is associated with higher mean intracranial pressures[23] and long-term mortality.[24] In a retrospective study of patients undergoing cardiac surgery, albumin administration was associated with more than twice the risk of AKI compared with crystalloids.[25] In contrast, in patients with cirrhosis, intravenous albumin lowers the rate of AKI when administered in the setting of a large volume paracentesis[30] or spontaneous bacterial peritonitis.[31] Outside of these narrow settings, current evidence does not support the use of intravenous albumin to prevent AKI and we would not endorse the use of intravenous albumin as a part of the treatment paradigm for established AKI.

Many renal and critical care guidelines recommend initial fluid resuscitation with isotonic crystalloids except in specific circumstances (ie, hemorrhagic shock), with consideration of albumin in select cases (ie, severe sepsis or cirrhosis).[16,18,19,29] That stated, the optimal type of crystalloid solution that should be used in resuscitation remains unclear. Because of its low cost, normal (0.9%) saline is the most commonly used solution, but it can result in hyperchloremic metabolic acidosis, which can cause renal vasoconstriction and may be associated with mortality in critically ill patients.[32] A prospective study found that administration of chloride-liberal fluids (including normal saline) to critically ill patients was associated with nearly twice the risk of AKI and RRT use compared with chloride-restrictive fluids,[33] but a subsequent trial found no difference in AKI or mortality among patients receiving saline versus a balanced crystalloid (Plasma-Lyte 148).[34] A recent pair of large, random-

TABLE 3. **Potential Indications for Renal Replacement Therapy and Medical Treatment Alternatives**

	Medical Treatment Alternatives to RRT	Comments
Volume Overload	Diuretics	RRT may be considered in nonoliguric patients with pulmonary edema or severe heart failure.
Hyperkalemia	Insulin/glucose Beta 2 agonists Sodium bicarbonate Diuretics Binding resins	Binding resins are avoided in patients with recent abdominal surgery.
Acidemia	Sodium bicarbonate Balanced crystalloid solutions	Generally not needed if pH >7.20, but there is no consensus regarding when to start RRT for acidemia.
Uremic Symptoms or Complications	Not applicable	RRT is generally started before severe complications (pericarditis and seizures) are observed.

Abbreviations: AKI, acute kidney injury; RRT, renal replacement therapy.

ized control trials compared outcomes in patients at a single center who were resuscitated with normal saline versus balanced crystalloid solutions (Lactated Ringer's or Plasma-Lyte A).[35,36] In critically ill patients, the use of balanced crystalloid solutions was associated with a lower risk of the composite outcome of mortality, new RRT, or persistent kidney impairment, but there were no differences in any of the individual components of the composite outcome.[35] In noncritically ill patients, there were no differences in the number of hospital-free days based on the type of crystalloid solution used.[36] In the absence of compelling evidence for using balanced crystalloid solutions, we continue to use normal saline for initial fluid resuscitation, but to avoid severe hyperchloremia and acidosis, we will consider switching to a balanced solution (Lactated Ringer's, Plasma-Lyte, or Normosol) for large volume resuscitation (>2 L), particularly in critically ill patients.

Diuretics

As above, volume status is a key component in the management of patients with AKI. In patients with AKI and hypervolemia, loop diuretics are often given prior to the initiation of RRT. Loop diuretics act on the sodium-potassium-chloride cotransporters in the thick ascending limb of the loop of Henle to increase urinary losses of these ions and urine volume. Loop diuretics are dose-dependent, and often, higher doses are needed (eg, furosemide 100 mg intravenous dose) in patients with AKI, since the diuretic effect depends on the proximal tubular secretion of the drug into the urine. The role of diuretics in AKI is controversial and some observational data suggest an increased mortality risk with diuretic use in patients with AKI.[37] In critically ill patients with acute lung injury, diuretic use improved survival, which was attributed to better control of volume overload.[38] But, a meta-analysis of 11 randomized controlled trials failed to demonstrate that diuretics directly improved survival or recovery of AKI.[39] Moreover, randomized controlled trials found that diuretics given to a patient with AKI requiring RRT did not improve recovery of kidney function.[40,41] The KDIGO guidelines recommend that diuretics should not be routinely used for AKI except in the management of volume overload.[16]

Nutritional Targets in Acute Kidney Injury

Critically ill patients have high protein catabolic rates, which put them at increased risk for malnutrition, which in turn is associated with mortality. Patients who receive continuous RRT (CRRT) may lose 5-10 g of protein and 10-15 g of amino acids daily, and these patients may have protein requirements that are twice the usual recommended daily protein intake.[16] But excess protein administration can result in high urea generation and azotemia unrelated to the patient's kidney function. Blood urea nitrogen may also be disproportionately elevated in conditions where tubular reabsorption of urea is increased, such as in volume depletion, diuretic use, corticosteroid use, and gastrointestinal bleeding. Interpretation of blood urea nitrogen results must be made in the appropriate clinical context, with recognition that azotemia alone may not be a good surrogate marker of the patient's underlying kidney function. We recommend dietary consultation in critically ill patients with AKI to ensure that adequate, but not excessive, protein is administered.

RENAL REPLACEMENT THERAPY IN ACUTE KIDNEY INJURY

In patients with AKI, RRT is initiated for control of volume overload, electrolyte abnormalities, acidemia, or uremic symptoms or complications that are refractory to medical management (Table 3). In a nonoliguric patient, fluid and electrolyte abnormalities can oftentimes be managed medically. Patients with oligoanuria (generally defined as urine output less than 400 mL/day or <20 mL/hour), however, require nephrology evaluation for consideration of RRT. Early nephrology consultation (within 48 hours of AKI diagnosis) may be associated with lower dialysis dependence and mortality in critically ill patients with AKI.[42] The decision to initiate dialysis is individualized based on the patient's comorbid conditions, urine output, and trajectory of kidney function.

TABLE 4. **Comparison of Randomized Trials of Early Versus Late Dialysis in Patients with AKI**

	ELAIN	AKIKI	IDEAL-ICU	STARRT-AKI
Study design	Randomized controlled trial	Randomized controlled trial	Randomized controlled trial	Randomized controlled trial
Country/Setting	Germany Single center ICU	France 31 ICUs	France 27 ICUs	15 countries, 111 ICUs
Patient population	231 patients with critical illness and at least stage 2 AKI Mostly surgical ICU (47% cardiac surgery)	620 patients with critical illness and stage 3 AKI Mostly medical ICU	864 patients with septic shock and AKI (RIFLE stage failure)	2,866 patients with severe AKI
Intervention (early dialysis initiation)	Within 8 hours of stage 2 AKI	Within 6 hours of stage 3 AKI	Within 12 hours after diagnosis of AKI	Within 12 hours of study eligibility
Control (delayed dialysis initiation)	Within 12 hours of stage 3 AKI	Standard indications for RRT	At least 48 hours after diagnosis of AKI	>12 hours of study eligibility
Dialysis modality	Continuous venovenous hemodiafiltration	Provider discretion (47% intermittent RRT only)	Provider discretion	Provider discretion
Primary outcome	Mortality at 90 days	Mortality at 60 days	Mortality at 90 days	Mortality at 90 days
Results	20-hour difference between groups Lower mortality in early dialysis group (HR 0.66, 95% CI 0.45-0.97) Greater renal recovery at 90 days, shorter duration of RRT, and shorter hospital length of stay with early dialysis	55-hour difference between groups No difference in mortality between groups (P = .79) 49% of the delayed dialysis group did not get dialysis A higher rate of catheter-related bloodstream infections in the early dialysis group (10% vs 5%, P =.03)	To be determined	To be determined

Abbreviations: AKI, acute kidney injury; AKIKI, Artificial Kidney Initiation in Kidney Injury Study; ELAIN, Early vs Late Initiation of Renal Replacement Therapy in Critically Ill Patients with AKI; ICU, intensive care unit; IDEAL-ICU, Initiation of Dialysis Early Versus Delayed in ICU; RIFLE, Risk, Injury, Failure, Loss, and End-stage kidney disease; RRT, renal replacement therapy; STARRT-AKI, Standard versus Accelerated Initiation of RRT in AKI.

Timing of Renal Replacement Therapy

The optimal timing of dialysis initiation in patients with AKI is not known. Theoretically, earlier initiation of dialysis could allow for better volume and electrolyte control and prevent the development of more serious complications of kidney failure such as uremic seizures, encephalopathy, and pericarditis. However, RRT is associated with its own risks and earlier initiation may expose the patient to unnecessary procedures and complications that might delay renal recovery. A meta-analysis of predominantly observational data found that earlier initiation of RRT in AKI was associated with lower 28-day mortality, greater renal recovery, decreased duration of RRT, and decreased ICU length of stay.[43] Subsequently, two prospective trials reported conflicting results regarding associations between dialysis timing and outcomes in patients with severe AKI (Table 4).[44,45]

The Early vs Late Initiation of Renal Replacement Therapy in Critically Ill Patients with Acute Kidney Injury (ELAIN) was a prospective, single-center randomized trial in Germany of 231 critically ill, predominantly surgical ICU patients (about half postcardiac surgery) with at least KDIGO stage 2 AKI.[44] Patients were randomized to early (within eight hours of developing KDIGO stage 2 AKI) or delayed (within 12 hours of developing KDIGO stage 3 AKI) RRT initiation; patients in the early RRT group initiated dialysis on average 20 hours earlier than the patients in the late group. All patients were treated with continuous venovenous hemodiafiltration. Early RRT initiation was associated with a 34% lower risk of mortality at 90 days, shorter hospital length of stay, and shorter RRT duration compared with delayed RRT initiation. There was no difference between groups in dialysis dependence at 90 days, but there was a lower risk of dialysis dependence at one year.[46]

The Artificial Kidney Initiation in Kidney Injury Study (AKIKI)[45] was a prospective, multicenter randomized trial in France that compared early versus delayed strategies of RRT initiation in 620 critically ill, mostly medical ICU patients with severe AKI (KDIGO stage 3). The median time between randomization and RRT initiation was two hours for the early and 57 hours for the delayed strategy groups. There were no differences between groups in length of hospital or ICU stay, vasopressor use, dialysis dependence, or 60-day survival. The early strategy group had a higher incidence of catheter-related bloodstream infections (10% vs 5%) and hypophosphatemia (22% vs 15%) compared with that of the delayed strategy group. Patients in the delayed strategy group regained normal urine output sooner than in the early strategy group. Approximately half of the patients in the delayed strategy group avoided RRT altogether. The authors of AKIKI concluded that there was no benefit to the early strategy of RRT in critically ill patients with severe AKI, and a delayed strategy of RRT initiation may avoid unnecessary RRT and reduce catheter-related infectious complications.

How can we interpret these discrepant results? Although ELAIN found a benefit to earlier RRT initiation in AKI, it has lim-

ited generalizability to medical ICU patients, who have higher mortality and whose outcomes might be less affected by dialysis timing. Patients in ELAIN had a high prevalence of congestive heart failure and CKD; it is possible that select patient populations may derive greater benefit from earlier RRT initiation. Although both ELAIN and AKIKI used the standardized criteria for RRT initiation, neither study could incorporate important clinical factors such as trajectory of kidney function, comorbid conditions, or symptoms, which play a significant role in the decision-making process in real-world clinical practice. Additional large-scale, multicenter trials are needed to guide the timing of RRT in critically ill patients with AKI. The Initiation of Dialysis Early Versus Delayed in the ICU (IDEAL-ICU)[47] and Standard versus Accelerated Initiation of RRT in Acute Kidney Injury (STARRT-AKI)[48] studies are currently underway and hope to provide clearer guidance regarding the optimal timing of RRT initiation in AKI (Table 4). Until further evidence is available, experts recommend taking into consideration the trajectory of kidney disease, concurrent organ dysfunction, and expected need for fluid and solute control when making decisions regarding RRT initiation in AKI.[16]

DIALYSIS MODALITIES IN ACUTE KIDNEY INJURY

When RRT is required in patients with AKI, the dialysis modality is often determined by local availability. CRRT and sustained low-efficiency dialysis (SLED) are thought to be better tolerated than intermittent hemodialysis in hemodynamically unstable patients, although a randomized controlled trial could not demonstrate a survival difference between these modalities.[49] In general, in settings where CRRT or SLED is available, these modalities are favored for patients with hemodynamic instability, but practice patterns vary widely.

CONCLUSION

Among hospitalized patients, AKI is common and associated with a higher risk of mortality. Although serum creatinine and urine output criteria are used to define AKI, other clinical factors (comorbid conditions, volume status, and trajectory of kidney function decline) can inform the assessment and management of patients with AKI. General strategies for AKI management include treatment of reversible conditions, optimization of volume status, hemodynamics, and nutritional status. The optimal timing of RRT in critically ill patients with AKI is not known, with unclear mortality benefit of earlier dialysis initiation. Two large-scale randomized controlled trials regarding early versus delayed dialysis timing in AKI are currently underway and will hopefully provide clarity in the near future.

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Things We Do for No Reason: Prealbumin Testing to Diagnose Malnutrition in the Hospitalized Patient

Mary Lacy, MD*, Justin Roesch, MD, Jens Langsjoen, MD

Department of Internal Medicine, University of New Mexico School of Medicine, Albuquerque, New Mexico.

Inspired by the ABIM Foundation's Choosing Wisely® campaign, the "Things We Do for No Reason" series reviews practices which have become common parts of hospital care but which may provide little value to our patients. Practices reviewed in the TWDFNR series do not represent "black and white" conclusions or clinical practice standards, but are meant as a starting place for research and active discussions among hospitalists and patients. We invite you to be part of that discussion.

CASE PRESENTATION

A 34-year-old man is admitted for a complicated urinary tract infection related to a chronic in-dwelling Foley catheter. The patient suffered a spinal cord injury at the C4/C5 level as a result of a motor vehicle accident 10 years ago and is confined to a motorized wheelchair. He is an engineer and lives independently but has caregivers. His body mass index (BMI) is 18.5 kg/m^2, and he reports his weight has been stable. He has slight muscle atrophy of the biceps, triceps, interosseous muscles, and quadriceps. The patient reports that he eats well, has no chronic conditions, and has not had any gastrointestinal symptoms (eg, anorexia, nausea, diarrhea) over the last six months. You consider whether to order a serum prealbumin test to assess for possible malnutrition.

BACKGROUND

The presence of malnutrition in hospitalized patients is widely recognized as an independent predictor of hospital mortality.[1] According to the American Society for Parenteral and Enteral Nutrition (ASPEN), malnutrition is defined as "an acute, subacute or chronic state of nutrition, in which varying degrees of overnutrition or undernutrition with or without inflammatory activity have led to a change in body composition and diminished function."[2] In one large European study, patients screening positive for being at risk of malnutrition had a 12-fold increase in hospital mortality.[1]

Inpatient malnutrition is remarkably underdocumented. Studies using chart reviews have found a prevalence of malnutrition in hospitalized patients of between 20% and 50%, and only 3% of hospital discharges are associated with a diagnostic code for malnutrition.[3–5] Appropriate diagnosis and documentation of malnutrition is important given the profound prognostic and management implications of a malnutrition diagnosis. Appropriate documentation benefits health systems as malnutrition documentation increases expected mortality, thereby improving the observed-to-expected mortality ratio.

Serum prealbumin testing is widely available and frequently ordered in the inpatient setting. In a query we performed of the large aggregate Cerner Electronic Health Record database, HealthFacts, which includes data from inpatient encounters for approximately 700 hospitals in the United States, prealbumin tests were ordered 129,152 times in 2015. This activity corresponds to estimated total charges of $2,562,375 based on the 2015 clinical laboratory fee schedule.[6]

WHY YOU MIGHT THINK PREALBUMIN DIAGNOSES MALNUTRITION

Prealbumin is synthesized in the liver and released into circulation prior to excretion by the kidneys and gastrointestinal tract. Prealbumin transports thyroxine, triiodothyronine, and holo-retinol binding protein and, as a result, is also known as transthyretin.[7] It was first proposed as a nutritional marker in 1972 with the publication of a study that showed low levels of prealbumin in 40 children with kwashiorkor that improved with intensive dietary supplementation.[8] The shorter half-life of prealbumin (2.5 days) as compared with other identified nutritional markers, such as albumin, indicate that it would be suitable for detecting rapid changes in nutritional status.

WHY PREALBUMIN IS NOT HELPFUL FOR DIAGNOSING MALNUTRITION

Prealbumin Is Not Specific

An ideal nutritional marker should be specific enough that changes in this marker reflect changes in nutritional status.[9] While there are many systemic factors that affect nutritional markers, such as prealbumin (Table 1), the acute phase response triggered by inflammation is the most significant confounder in the acutely ill hospitalized patient.[9] This response to infection, stress, and malignancy leads to an increase in proinflammatory cytokines, increased liver synthesis of inflammatory proteins, such as C-reactive protein (CRP), and increased vascular permeability. Prealbumin is a negative acute phase reactant that decreases in concentration during the stress response due to slowed synthesis and extravasation.[9] In a study of 24 patients with severe sepsis and trauma, levels of prealbumin in-

***Corresponding Author:** Mary Lacy, MD, MSC; E-mail: melacy@salud.unm.edu; Telephone: 505-925-0660.

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TABLE 1. **Factors Affecting Prealbumin**[7]

Increased by:	Decreased by:
Exogenous corticosteroids	Acute phase response
NSAIDs	Malnutrition
Renal failure	Liver disease
Dehydration	Thyroid disease
	Hemodilution
	Nephrotic syndrome
	Protein-losing enteropathy
	Acute blood loss

Abbreviation: NSAIDs, nonsteroidal anti-inflammatory drugs

versely correlated with CRP, a reflection of the stress response, and returned to normal when CRP levels normalized. Neither prealbumin nor CRP, however, correlated with total body protein changes.[10] Unfortunately, many studies supporting the use of prealbumin as a nutritional marker do not address the role of the acute phase response in their results. These studies include the original report on prealbumin in kwashiorkor, a condition known to be associated with a high rate of infectious diseases that can trigger the acute phase response.[9] A consensus statement from the Academy of Nutrition and Dietetics (AND) and ASPEN noted that prealbumin is an indicator of inflammation and lacks the specificity to diagnose malnutrition.[11]

Prealbumin Is Not Sensitive

A sensitive laboratory test for malnutrition should allow for detection of malnutrition at an early stage.[9] However, patients who demonstrate severe malnutrition without a coexisting inflammatory state do not consistently show low levels of prealbumin. In a systematic review of 20 studies in nondiseased malnourished patients, only two studies, both of which assessed patients with anorexia nervosa, had a mean prealbumin below normal (<20 mg/dL), and this finding corresponded to patient populations with mean BMIs less than 12 kg/m^2. More importantly, normal prealbumin levels were seen in groups of patients with a mean BMI as low as 12.9 kg/m^2.[12] Analysis by AND found insufficient evidence to support a correlation between prealbumin and weight loss in anorexia nervosa, calorie restricted diets, or starvation.[13] The data suggest that prealbumin lacks sufficient sensitivity to consistently detect cases of malnutrition easily diagnosed by history and/or physical exam.

Prealbumin Is Not Consistently Responsive to Nutritional Interventions

An accurate marker for malnutrition should improve when nutritional intervention results in adequate nutritional intake.[9] While some studies have shown improvements in prealbumin in the setting of a nutritional intervention, many of these works are subject to the same limitations related to specificity and lack of control for concurrent inflammatory processes. In a retrospective study, prealbumin increased significantly in 102 patients receiving TPN for one week. Unfortunately, patients with renal or hepatic disease were excluded, and the role of inflammation was not assessed.[14] Institutionalized patients with Alzheimer's disease and normal CRP levels showed a statistically significant increase in weight gain, arm muscle circumference, and triceps skin-fold thickness following a nutritional program without a notable change in prealbumin.[15] In a study assessing the relationship of prealbumin, CRP, and nutritional intake, critically ill popu-

TABLE 2. **Comparison of Diagnostic Tools for Malnutrition**[a]

	AND/ASPEN[11]	ESPEN[18]
Historical Variables		
Change in weight	Weight loss (% over time)	Weight loss >10% indefinite of time or >5% over the last 3 months
Intake behaviors	Insufficient energy intake	NA
Physical Examination Variables		
Body fat	Loss of body fat	Fat-free mass index (FFMI) <15 (women) or 17 kg/m^2 (men)
Muscle mass	Loss of muscle mass	NA
BMI	NA	BMI <20 kg/m^2 if <70 years of age, or <22 kg/m^2 if >70 years of age
Other exam findings	Fluid accumulation	NA
Functional capacity impairment	Reduced grip strength	NA
Additional information	Graded by severity and acuity	Graded by acuity
Criteria for diagnosis	Two of 6 criteria required	BMI <18.5 kg/m^2[b] Or Weight changes combined with either body fat or BMI

[a]Elements of diagnostic criteria are discussed. Each guideline or assessment tool requires a certain number of criteria to be met to establish a diagnosis

[b]BMI <18.5 kg/m^2 is a solitary criterion based on World Health Organization recommendations

Abbreviations: AND, Academy of Nutrition and Dietetics; ASPEN, American Society for Parenteral and Enteral Nutrition; BMI, body mass index; ESPEN, European Society for Clinical Nutrition and Metabolism; NA, not applicable.

lations receiving less than or greater than 60% of their estimated caloric needs showed no significant difference in prealbumin. In fact, prealbumin levels were only correlated with CRP levels.[16] This finding argues against the routine use of prealbumin for nutrition monitoring in the acutely ill hospitalized patient.

Prealbumin Is Not Consistently Correlated with Health Outcomes

Even if prealbumin increased consistently in response to nutritional intervention, whether this change corresponds to an improvement in clinical outcomes has yet to be demonstrated.[9] In 2005, Koretz reviewed 99 clinical trials and concluded that even when changes in nutritional markers are seen with nutritional support, the "changes in nutritional markers do not predict clinical outcomes."[17]

WHAT YOU SHOULD DO INSTEAD: USE NON-BIOLOGIC METHODS FOR SCREENING AND DIAGNOSING MALNUTRITION

Given the lack of a suitable biologic assay to identify malnutrition, dieticians and clinicians must rely on other means to assess malnutrition. Professional societies, including ASPEN and the European Society for Clinical Nutrition and Metabolism, have proposed different guidelines for the screening and assessment of malnutrition (Table 2).[11,18] In 2016, these organizations, along with the Latin American Federation of Nutritional Therapy, Clinical Nutrition, and Metabolism and the Parenteral and Enteral Nutrition Society of Asia, formed The Global Leadership Initiative on Malnutrition (GLIM). In 2017, the GLIM taskforce agreed on clinically relevant diagnostic variables for the screening and assessment of malnutrition, including reduced food intake (anorexia), nonvolitional weight loss, (reduced) lean mass, status of disease burden and inflammation, and low body mass index or underweight status.[19]

RECOMMENDATIONS

- Do not use prealbumin to screen for or diagnose malnutrition.
- Consult with local dietitians to ensure that your institutional approach is in agreement with consensus recommendations.

CONCLUSION

In revisiting the case above, the patient does not have clear evidence of malnutrition based on his history (stable weight and good reported nutritional intake), although he does have a low BMI of 18.5 kg/m^2. Rather than prealbumin testing, which would likely be low secondary to the acute phase response, he would better benefit from a nutrition-focused history and physical exam.

The uncertainties faced by clinicians in diagnosing malnutrition cannot readily be resolved by relying on a solitary laboratory marker (eg, prealbumin) or a stand-alone assessment protocol. The data obtained reflect the need for multidisciplinary teams of dieticians and clinicians to contextualize each patient's medical history and ensure that the selected metrics are used appropriately to aid in diagnosis and documentation. We advocate that clinicians not routinely use prealbumin to screen for, confirm the diagnosis of, or assess the severity of malnutrition in the hospitalized patient.

Do you think this is a low-value practice? Is this truly a "Thing We Do for No Reason?" Share what you do in your practice and join in the conversation online by retweeting it on Twitter (#TWDFNR) and liking it on Facebook. We invite you to propose ideas for other "Things We Do for No Reason" topics by emailing TWDFNR@hospitalmedicine.org.

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Things We Do for No Reason: Routine Echocardiography in Hemodynamically Stable Patients with Acute Pulmonary Embolism

Paul A Bergl, MD[1]*; Adrian Umpierrez de Reguero, MD[2]; Jayshil J Patel, MD[1]

[1]Division of Pulmonary, Critical Care, and Sleep Medicine, Medical College of Wisconsin, Milwaukee, Wisconsin; [2]Section of Hospital Medicine, Division of General Internal Medicine, Medical College of Wisconsin, Milwaukee, Wisconsin.

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CLINICAL SCENARIO

A 28 year-old woman presents to the emergency department with acute onset bilateral chest pain and dyspnea. She has a respiratory rate of 28, a heart rate of 106, blood pressure of 110/65 mm Hg, and pulse oximetry of 92% saturation on room air. She has no history of cardiac or pulmonary disease and no personal history of venous thromboembolism. She takes an estrogen-containing oral contraceptive. On examination, she has no jugular venous distention, normal cardiac tones without murmur, and no lower extremity swelling. D-dimer is elevated at 3.4 mg/L (normal < 0.5 mg/L), and she undergoes computed tomography (CT) of the chest, which demonstrates acute segmental pulmonary emboli (PE) in the right upper and middle lobes as well as multiple bilateral subsegmental PEs. The CT suggests right ventricular dysfunction (RVD), and her troponin T is 0.06 ng/mL (normal < 0.01 ng/mL). Bilateral lower extremity venous Doppler ultrasonography demonstrates no acute thrombus.

BACKGROUND

Acute pulmonary embolism (PE) accounts for more than 300,000 inpatient admissions annually in the United States.[1] The vast majority of patients with acute PE who receive adequate anticoagulation will have favorable outcomes.[2,3] In the past two decades, for example, mortality has decreased significantly among patients admitted with acute PE,[2] with 30-day all-cause mortality falling to approximately 5%.[3] The risk-adjusted rate of recurrent venous thromboembolism (VTE) within 30 days has concomitantly dropped below 1%.[3]

***Corresponding Author:** Paul A. Bergl, E-mail: pbergl@mcw.edu; Telephone: 414-955-7047; Twitter: @paulberglMD.

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Acute PE severity was previously classified as massive or high risk, submassive or intermediate risk, and low risk.[4] Massive PE was defined by RVD and persistent hypotension or shock requiring vasopressors.[4] Intermediate-risk or submassive PE typically referred to normotensive patients with RVD and/or myocardial necrosis (eg, elevated troponin).[4,5] Low-risk PEs had neither hemodynamic instability nor RVD. This classification scheme, however, has fallen out of favor as PE severity exists on a risk spectrum.[6] Instead, recent guidelines from the European Society of Cardiology and the American College of Chest Physicians recommend first parsing PE severity by the presence or absence of hypotension (Figure 1).[6,7] Risk assessment can be subsequently enhanced by validated clinical risk prediction scores, imaging-based assessment of RVD, and cardiac biomarker testing.[6]

In acute PE, hypotension and/or shock are associated with a 12%-35% risk of short-term mortality.[2,3,8] Accordingly, patients with high-risk PE, who comprise 3%-12% of hospitalizations for PE,[2,3,8] typically receive more intensive monitoring and treatment.[2,8,9] In addition to systemic anticoagulation, thrombolysis is generally recommended for hypotensive patients with PE and no contraindications.[6,7]

Between 7% and 59% of patients with acute PE are hemodynamically stable but have objective evidence of myocardial necrosis and/or RVD.[8,10,11] Among these patients, fewer than 10% will have a complicated course as defined by all-cause death, hemodynamic collapse, or recurrent PE in the first month after diagnosis,[11] and short-term PE-related mortality rates range from approximately 2%-5%.[5,8,11]

WHY YOU MIGHT THINK ECHOCARDIOGRAPHY IS HELPFUL IN HEMODYNAMICALLY STABLE ACUTE PE

Echocardiography is a common method for evaluating RVD, and echocardiographic RVD confers an increased risk of adverse outcomes in PE.[10-12] In the earliest meta-analysis to evaluate this association, Sanchez et al. combined data from five studies that included 623 patients from emergency room and inpatient settings. They found that echocardiographic RVD conferred an unadjusted relative risk for short-term mortality of 2.53 (95%CI 1.17-5.50).[12] A subsequent meta-analysis by Cho et al. pooled data from both prospective and retrospective cohorts to examine short-term mortality in a total of 3,283 hemodynamically stable patients with PE, of whom 1,223 (37.3%) had RVD diagnosed by echocardiogram.[10] In this population, RVD was associated with an odds ratio of 2.29 (95%CI 1.61-3.26) for

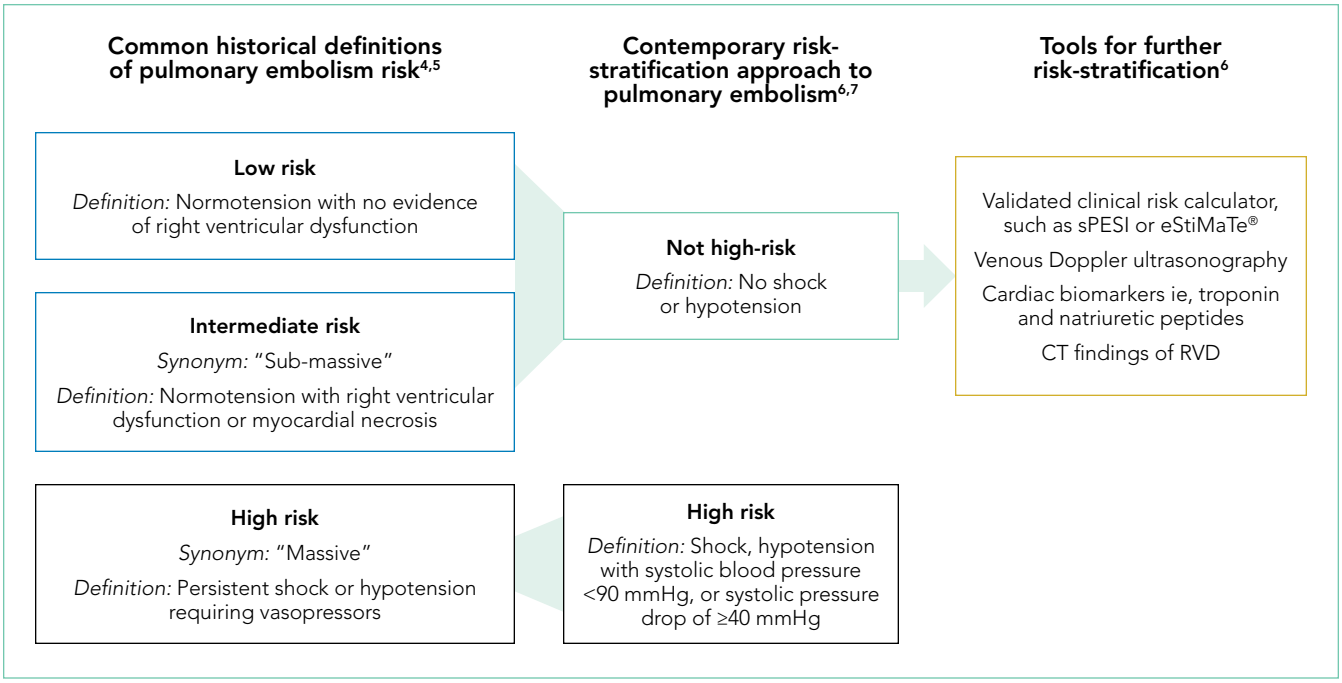

FIG. Summary of Evolving Approaches to Risk Stratification in Acute PE

Abbreviations: CT, computed tomography; RVD, right ventricular dysfunction; sPESI, Simplified Pulmonary Embolism Severity Index.

short-term death. Thus, echocardiography could be viewed as a risk stratification tool, even in hemodynamically stable PE.

WHY ECHOCARDIOGRAPHY IN HEMODYNAMICALLY STABLE ACUTE PE IS NOT AS HELPFUL AS YOU THINK

For most hemodynamically stable patients, echocardiographic findings will not enhance prognostication and/or have a therapeutic impact. The following four reasons explain why echocardiography adds little value to the care of these patients.

First, phenotypic expression of RVD varies from asymptomatic, despite abnormalities on diagnostic testing, to obstructive shock. Unfortunately, available prognostic models classify echocardiographic RVD in a binary fashion (present/absent)[4,7,10] whereas RVD exists on a continuum. Consequently, RVD is commonly feStiMaound in acute PE[8,10,11] and has been identified in more than half of patients hospitalized with PE referred for echocardiography.[8] Existing data do not allow clinicians to judge the clinical impact of the severity of echocardiographic RVD,[8] and only the phenotypic expression of refractory hypotension has clear therapeutic implications.[6,7]

Second, while echocardiographic RVD is associated with short-term mortality,[10-12] absolute rates of adverse outcomes are quite low when RVD is identified. For example, in a study merging multiple prospective cohorts, Becattini et al. demonstrated that RVD diagnosed by echocardiography or CT occurred in 41% of hospitalized patients stratified to low-risk PE by the simplified Pulmonary Embolism Severity Index (sPESI).[8] For these patients, the 30-day mortality was 1.2%,[8] which approximates the expected mortality from a low-risk sPESI score alone (1.1%).[13] Even among intermediate-risk acute PE patients with RVD and/or elevated troponin enrolled in thrombolysis trials, the overall risk of death at 30 days was approximately 2%-3%, irrespective of the treatment arm.[5,14,15]

Third, RVD identified by echocardiography does not inform or enhance prognostication as compared with cardiac biomarker testing. In a meta-analysis by Sanchez et al., echocardiographic RVD predicted death with a risk ratio of 2.53 (95% CI 1.17-5.50).[12] However, both elevated cardiac troponin and brain natriuretic peptide indicated a significantly worse outcome than imaging findings, with risk ratios of 8.3 (95% CI 3.6-19.3) and 9.5 (95% CI 3.2-28.6), respectively.[13] More recently, Jiménez derived and validated a multivariable risk prediction model for stable PE.[11] In their data, echocardiographic RVD had an unadjusted odds ratio of 2.62 (95% CI 1.54-4.45) for predicting a 30-day complicated course. After multivariable adjustment that included sPESI scores, lower extremity ultrasound results, and cardiac biomarker testing, these odds became insignificant.[11] In other words, identifying echocardiographic RVD did not improve prognostication in hemodynamically stable PE patients when other commonly available variables were used.

Finally, in hemodynamically stable patients, echocardiographic RVD might create patient anxiety and cause harm. In a recent retrospective cohort study of 64,037 stable patients with PE, exposure to echocardiography was associated with a five-fold increase in likelihood of having received thrombolysis without any significant differences in risk-adjusted mortality.[16] These data suggest that when faced with an abnormal echocardiogram, clinicians and patients may opt for more aggressive, time-sensitive therapies. Basing thrombolysis decisions on echocardiographic RVD potentially subjects patients to harm without decreasing mortality.[5,14,15] For example, the

PEITHO study, which was the largest randomized trial evaluating thrombolysis in intermediate-risk acute PE, enrolled 1,006 patients and demonstrated that treating 29 intermediate-risk patients with thrombolysis prevented one case of hemodynamic decompensation.[5] These benefits were counterbalanced by a number needed to harm of 14 to cause stroke or major bleeding. Ominous echocardiographic findings may also bias clinicians toward more intensive monitoring. Rates of echocardiogram utilization in hemodynamically stable PE are linked to higher rates of ICU admission and longer hospital stays without significant impact on patient outcomes.[16]

WHEN ECHOCARDIOGRAPHY MIGHT BE HELPFUL IN HEMODYNAMICALLY STABLE PATIENTS WITH PE

Echocardiography should be used to exclude other causes of hypotension in patients with presumed PE-related shock[7,9] and to improve clinicians' confidence prescribing systemic thrombolytics in the face of hemodynamic instability.[6,7] Otherwise, echocardiography should be reserved for highly selected intermediate-risk patients with acute PE. Among patients with intermediate-risk PE, those most likely to decompensate or die typically satisfy all of the following conditions: (1) highest-risk PESI or sPESI scores, (2) elevated natriuretic peptides, (3) elevated troponin, and (4) proximal deep vein thrombosis (DVT) on lower extremity ultrasound.[11,13] In such patients, the echocardiogram may reveal a critical "tipping point," such as a right atrial or ventricular thrombus-in-transit, that may warrant more intensive monitoring and multidisciplinary input into the most appropriate treatment plan.

Echocardiography could aid therapeutic decisions when the benefits from thrombolysis may outweigh the risks, such as for patients with minimal physiologic reserve and/or a low risk of major bleeding complications. Prognostic models like sPESI utilize binary variables, such as the presence/absence of chronic cardiopulmonary disease or oxygen saturation above/below 90%. Clearly, these variables exist on a spectrum; intuitively, patients with severe comorbidities and more alarming vital signs have a higher risk of death or decompensation than predicted by sPESI. Analogously, echocardiographic findings of RVD also encompass a spectrum. Because prognostic models and clinical trials cannot guide decisions for each individual patient, clinicians could justify using echocardiography to "fine tune" prognostication and to provide a personalized approach for carefully selected patients.

WHAT SHOULD YOU DO INSTEAD?

Clinicians should use a risk prediction model for all hemodynamically stable patients with confirmed PE.[6,7] Validated risk calculators include the sPESI,[6,7,14] which relies exclusively on the patient's history and vital signs, and the eStiMaTe© tool (www.peprognosis.org), which enhances prognostication from sPESI by incorporating troponin, natriuretic peptide, and lower- extremity Doppler results.[11] For patients with symptoms or physical signs of RVD, chest CT and cardiac biomarkers (ie, troponin and/or natriuretic peptides) are sufficient for prognostication.[11,14] In intermediate-risk patients with the highest risk for decompensation based on risk prediction scores, the echocardiogram should represent a part of a comprehensive clinical evaluation, not the sole criterion for intensive monitoring and aggressive treatment.

RECOMMENDATIONS

- Clinicians should use a validated tool, such as the sPESI, for initial risk stratification of hemodynamically stable patients with acute pulmonary embolism.
- Hemodynamically unstable patients with confirmed or suspected acute PE may benefit from early echocardiography to confirm RVD as the cause of shock.[6,7,9]
- The majority of normotensive adults with acute PE should not undergo echocardiography. To identify the patients at the greatest risk for decompensation, clinicians may consider using the eStiMaTe© tool (www.peprognosis.org), which augments risk stratification afforded by sPESI.
- For hemodynamically stable patients with PE who have already undergone echocardiography, clinicians should avoid being biased by the finding of RVD, particularly if other prognostic markers are reassuring.

CONCLUSION

In evaluating the patient described earlier, echocardiography has no clear prognostic implications. Her admission sPESI score equals zero, predicting a 30-day mortality of 1.1%. Including her lower extremity ultrasound and troponin T results into the eStiMaTe© calculator (www.peprognosis.org) surprisingly predicts an even lower rate of 30-day mortality (0.4%) and low risk of a complicated course (2.4%). Assessing for RVD on echocardiography may increase her risk of unnecessary and potentially injurious interventions.

Do you think this is a low-value practice? Is this truly a "Thing We Do for No Reason?" Share what you do in your practice and join in the conversation online by retweeting it on Twitter (#TWDFNR) and liking it on Facebook. We invite you to propose ideas for other "Things We Do for No Reason" topics by emailingTWDFNR@hospitalmedicine.org.

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The Right Frame

Daniel J Minter, MD[1*]; Rabih M Geha, MD[1,2]; Bryn A Boslett, MD[3]; Sharon A Chung, MD, MAS[4]; Biswarathan Ramani, MD[5]; Reza Manesh, MD[6]

This icon represents the patient's case. Each paragraph that follows represents the discussant's thoughts.

[1]*Department of Medicine, University of California, San Francisco, San Francisco, California;* [2]*Medical Service, San Francisco VA Medical Center, San Francisco, California;* [3]*Division of Infectious Diseases, University of California, San Francisco, San Francisco, California;* [4]*Russell/Engleman Rheumatology Research Center, University of California, San Francisco, San Francisco, California;* [5]*Department of Pathology, University of California, San Francisco, San Francisco, California;* [6]*Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland.*

A 65-year-old man was transferred to a tertiary academic medical center with one week of progressive shortness of breath, dry cough, and fevers. He reported no weight loss or night sweats but had experienced mild right upper quadrant pain and anorexia for the preceding three weeks. Several years had passed since he had consulted a physician, and he did not take any medications. He immigrated to the United States from Mexico four decades prior. He traveled back frequently to visit his family, most recently one month before his presentation. He worked as a farming supervisor in the Central Valley of California. He smoked tobacco and had a 30 pack-year history. He drank alcohol occasionally and denied any drug use.

Causes of subacute cough and dyspnea include bronchitis, pneumonia, heart failure, and asthma. Pneumonia and heart failure might cause right upper quadrant pain from diaphragmatic irritation and hepatic congestion, respectively. Metastatic cancer or infection may lead to synchronous pulmonary and hepatic involvement. The patient is at increased risk of lung cancer, given his extensive smoking history.

The patient's place of residence in the Southwestern United States places him at risk of respiratory illness from coccidioidomycosis. His exact involvement with animals and their products should be further explored. For example, consumption of unpasteurized milk might result in pneumonia, hepatitis, or both from *M. bovis*, *Brucella* species, or *C. burnetii*. His travel to Mexico prompts consideration of tuberculosis, histoplasmosis, and paracoccidiomycosis as causes of respiratory and possible hepatic illness.

Two weeks prior, the patient had initially presented to another hospital with one week of intermittent right upper quadrant pain unrelated to eating. An abdominal ultrasound and hepatobiliary iminodiacetic acid (HIDA) scan were normal. Computed tomography (CT) of the chest, abdomen, and pelvis with contrast demonstrated a left upper lobe lung mass measuring 5.5 × 4.4 × 3.7 cm^3 and scattered right-sided pulmonary nodules (Figure 1). He underwent CT-guided biopsy of the mass and was discharged with a presumed diagnosis of primary pulmonary malignancy with plans for outpatient follow-up.

Over the next four days, the patient developed progressive dyspnea with cough and subjective fevers. The patient was readmitted with a diagnosis of postobstructive pneumonia and acute kidney injury (creatinine increased from 0.7 mg/dL to 2.9 mg/dL between admissions), and this finding was attributed to contrast-induced nephropathy from his recent CT scan. He was treated with vancomycin and piperacillin/tazobactam for two days but wished to transfer to a tertiary care hospital for a second opinion.

Postobstructive pneumonia, pulmonary embolism, and pleural effusion are common causes of dyspnea in patients with lung cancer. The patient's travel and occupational history, lung nodules, acute renal insufficiency, and rapidly progressive respiratory symptoms prompt consideration for radiographic mimickers of lung cancer. Tuberculosis might present as a lung mass (pulmonary tuberculoma) during primary infection or reactivation. Noninfectious causes of pulmonary masses and nodules include metastatic cancer (eg, colon cancer), sarcoidosis, IgG4-related disease, and granulomatous polyangiitis (GPA).

Contrast-induced nephropathy is unusual in patients with normal renal function. More probable explanations include hypovolemia or acute tubular necrosis (ATN) from underlying inflammation. The patient's CT-negative right upper quadrant pain may be a distinct process or represent another facet of a disseminated illness such as hepatic infiltration from lymphoma.

Upon arrival, the patient's temperature was 38°C, heart rate (HR) 107 beats per minute, blood pressure (BP) 159/89 mm Hg, respiratory rate 25 breaths per minute, and oxygen saturation 92% on 2 L of oxygen per minute. He showed no signs of distress. Mild scleral icterus was noted. The cardiac exam was normal. Auscultation revealed scat-

*Corresponding Author: Daniel Minter, MD; E-mail: daniel.minter@ucsf.edu; Telephone: 253-948-2047

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tered wheezes and crackles in the left upper lobe. Mild right upper quadrant tenderness without hepatosplenomegaly was noted on the abdominal exam. The patient's lower extremities exhibited bilateral trace edema. No rash was observed, and his neurologic exam was normal.

The white blood cell (WBC) count was 28,300 per cubic millimeter (87% neutrophils, 3.6% lymphocytes, and 0.03% eosinophils), hemoglobin 11.1 g per deciliter, and platelet count 789,000 per cubic millimeter. Sodium was 127 mmol per liter, potassium 4.6 mmol per liter, chloride 101 mmol per liter, bicarbonate 13 mmol per liter, blood urea nitrogen 60 mg per deciliter, and creatinine 3.4 mg per deciliter. Aspartate aminotransferase and alanine aminotransferase levels were normal. Alkaline phosphatase was 283 units per liter (normal range, 31-95), and total bilirubin was 4.5 mg per deciliter (normal range, 0.2-1.3) with a direct bilirubin of 2.7 mg per deciliter. Urinalysis demonstrated urine protein of 30 mg/dL, specific gravity of 1.013, negative nitrites, 10-21 white cells per high-powered field (normal, < 5), and 21-50 red cells per high-powered field (normal, < 3). Urine microscopy revealed muddy brown casts but no cellular casts or dysmorphic red cells. A chest radiograph (CXR) showed patchy consolidations in the bilateral upper lobes and left lower lobe along with Kerley B lines, a small left pleural effusion, and thickened right horizontal fissure; the left upper lobe mass was re-demonstrated. Vancomycin, piperacillin-tazobactam, and azithromycin were administered.

At this point, the most likely source of sepsis is multifocal pneumonia. The patient is at risk for *S. aureus* and *P. aeruginosa* given his recent hospitalization. A severe form of leptospirosis (Weil's disease) is associated with pulmonary disease, hyperbilirubinemia, and renal failure. Repeat abdominal imaging is necessary to evaluate for cholangitis given the patient's right upper quadrant pain, fever, and jaundice. It would also help categorize his cholestatic pattern of liver injury as intrahepatic or extrahepatic (eg, stricture). An infiltrative disease such as sarcoidosis may cause both intrahepatic cholestasis and parenchymal lung disease, although the pleural pathology is uncommon.

His normal cardiac exam does not exclude cardiogenic pulmonary edema, a common cause of interstitial edema and pleural effusion. In this setting of systemic inflammation (neutrophilia, thrombocytosis, and hypoalbuminemia), the thickened right horizontal fissure and interlobular septa might represent an infiltrative process, such as lymphangitic carcinomatosis, lymphoma, or sarcoidosis.

Muddy brown casts are characteristic of ATN. The patient's risk factors for ATN include sepsis and previously administered iodinated contrast. Fluid retention from oliguric renal failure is likely contributing to his hyponatremia and lower extremity edema. Pathology isolated to the tubules, however, would not cause hematuria and pyuria and suggests glomerular or interstitial disease. The lack of cellular casts on a single urinary specimen does not eliminate the likelihood of either disease. Hematuria and diffuse parenchymal lung disease prompt consideration of pulmonary-renal syndromes, such as anti-glomerular basement membrane disease, GPA, and systemic lupus erythematosus, which can all be triggered by infection.

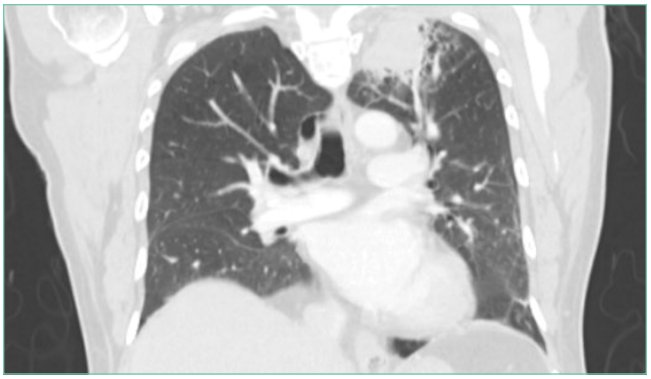

FIG 1. Computed tomography of the lungs demonstrating a left upper lobe mass measuring 5.5 × 4.4 × 3.7 cm3 and scattered right-sided pulmonary nodules.

On the night of transfer, the patient experienced acute respiratory distress. Heart rate was 130 beats per minute, BP 170/95 mm Hg, respiratory rate 40 breaths per minute, and oxygen saturation 88% on six liters of supplemental oxygen by nasal cannula. His arterial blood gas demonstrated a pH of 7.23, $PaCO_2$ of 32 mm Hg, and PaO_2 of 65 mm Hg. He was emergently intubated for progressive hypoxemic respiratory failure. A small amount of blood was noted in the endotracheal tube. A noncontrast CT of the chest demonstrated multifocal airspace opacities and bilateral pleural effusions. The previously noted left upper lobe mass was unchanged.

Rapid respiratory decline and diffuse alveolar disease commonly result from aspiration, flash pulmonary edema, and acute respiratory distress syndrome (ARDS). Necrotizing pneumonia (eg, *S. aureus*) and trauma during intubation are possible causes of blood in his endotracheal tube. However, in the setting of multifocal airspace opacity, renal insufficiency, hematuria, and rapid respiratory decline, the blood might represent diffuse alveolar hemorrhage (DAH). Bronchoscopy with bronchioalveolar lavage to evaluate for pulmonary edema, infection, and hemorrhage would be indicated.

The patient subsequently developed oliguria, requiring continuous renal replacement therapy. An echocardiogram demonstrated impaired left ventricular relaxation and a reduced ejection fraction of 45% without segmental wall motion abnormalities or valvular disease, and a right ventricular systolic pressure of 36 mm Hg. Over the next 12 hours, his respiratory status improved, and he was extubated to 15 L per minute of supplemental oxygen by high-flow nasal cannula (HFNC).

The pathology report of the lung biopsy from the other hospital disclosed chronic inflammation and fibrosis with ill-defined areas of necrosis and myxoid degeneration surrounded by nuclear palisading suggestive of granulomatous inflammation. Staining for acid-fast bacilli (AFB) and fungal organisms was negative.

The rapid pulmonary recovery is inconsistent with multifocal pneumonia or ARDS. Flash pulmonary edema might result in sudden hypoxemic respiratory failure that resolves with positive pressure ventilation and ultrafiltration. However, this condition would not explain the biopsy results. Granulomatous lung pathology often results from mycobacterial or fungal disease. Tuberculosis and fungal pneumonia are not excluded with negative staining alone. However, neither would cause self-limited respiratory failure. Histologic evidence of necrosis lessens the likelihood of sarcoidosis, which rarely causes fulminant pulmonary disease. Lymphoma can result in granulomatous inflammation but would not cause transient pulmonary disease. GPA, a cause of necrotizing granulomatous lung disease, might result in a lung mass and worsened hypoxemia through DAH.

The patient continued to require 15 L of oxygen per minute by HFNC. He had persistent bilateral perihilar alveolar and interstitial opacities on CXR. Repeat WBC count was 29,200 per cubic millimeter, hemoglobin 7.8 g per deciliter, and platelets 656,000 per cubic millimeter. The C-reactive protein was 300 mg per L (normal range, <6.3) and erythrocyte sedimentation rate 100 mm per hour (normal range, <10). *Legionella* urinary antigen, serum immunodiffusion for *Coccidiodes imitus*, human immunodeficiency virus antibody, respiratory viral panel, and beta-D glucan were negative. Rare acid-fast bacilli were visualized in one out of three concentrated AFB sputum smears. He was started on empiric antituberculous therapy with rifampin, isoniazid, pyrazinamide, and ethambutol.

The sputum sample is suggestive of pulmonary tuberculosis. The salient features of this case include systemic inflammation, pulmonary nodules and mass, necrotizing granulomatous lung pathology, renal insufficiency, and hematuria. Disseminated tuberculosis might explain all these findings. However, a positive AFB smear may signal the presence of a nontuberculous mycobacteria, which is less likely to cause this clinical syndrome.

M. tuberculosis complex polymerase chain reaction (MTB PCR) assay returned negative for _M. tuberculosis_. Antiproteinase 3 antibody was 1,930 units (normal range, <20). Antimyeloperoxidase and antiglomerular basement membrane antibodies were negative.

Tuberculosis and GPA share several overlapping features, such as necrotizing lung pathology and less commonly antineutrophil cytoplasmic autoantibody (ANCA)-associated antibodies. However, the lung mass, acute renal and respiratory failure, hematuria, and the degree of anti-proteinase 3 level elevation are highly suggestive of GPA. The negative MTB PCR raises the possibility that a nontuberculous mycobacterium was detected on the sputum smear. Nevertheless, continued treatment until finalization of culture results is appropriate given that tuberculosis is endemic in Mexico.

The patient's presenting features of right upper quadrant tenderness, jaundice, and cholestatic hepatitis remain poorly explained by either of these diagnoses. Neither tuberculosis nor GPA commonly presents with accompanying hepatic involvement, though both have been occasionally described as causing hepatitis. As the greatest concern in this patient remains his progressive renal failure and accompanying pulmonary hemorrhage, a renal biopsy to assess for glomerulonephritis associated with GPA is warranted before further investigation into the cause of his cholestatic hepatitis.

A core renal biopsy demonstrated pauci-immune focal crescentic and necrotizing glomerulonephritis with mixed tubulointerstitial inflammation (Figure 2). In conjunction with the pulmonary syndrome and positive antiproteinase 3 serology, a diagnosis of granulomatosis with polyangiitis was made. The patient was treated with pulse dose steroids, rituximab, and plasma exchange. Two weeks later, the sputum mycobacterial culture returned positive for *Mycobacterium llatzerense* and anti-tuberculous treatment was discontinued.

Over the following weeks, the patient improved and was transitioned off dialysis prior to hospital discharge. By six months later, he had resolution of his hemoptysis, shortness of breath, liver biochemical test abnormalities, and significant improvement in his renal function. Repeat sputum mycobacterial cultures were negative.

DISCUSSION

A 65-year-old man from Mexico with a significant smoking history presented with an apical lung mass and cough, prioritizing tuberculosis and pulmonary malignancy. As the case unfolded, renal failure, multifocal lung opacities, conflicting tuberculosis test results, positive anti-proteinase 3 antibody, and ultimately a renal biopsy led to the diagnosis of granulomatosis with polyangiitis (GPA).

The correct interpretation of occasionally conflicting mycobacterial testing is crucial. Mycobacterial cultures remain the gold standard for diagnosing tuberculosis. However, results take weeks to return. Rapid tests include acid-fast bacilli (AFB) smear microscopy and nucleic acid-amplification tests (NAAT) of sputum or bronchoalveolar samples.[1] When three sputum smears are performed, the sensitivity of AFB smear microscopy for tuberculosis in immunocompetent hosts is 70%.[1] The AFB smear does not distinguish between different mycobacterial organisms. Thus, a positive result must be interpreted with the relative prevalence of tuberculosis and nontuberculous mycobacteria (NTM) in mind. The addition of NAAT-based assays has allowed for enhanced sensitivity and specificity in the diagnosis of tuberculosis, such that a negative NAAT in a patient with a positive AFB smear strongly argues for the presence of a NTM.[2-4]

NTM are widely prevalent environmental microbes, with over 140 species described, and careful consideration is required to determine if an isolate is pathogenic.[5] Given their ubiquitous nature, a high rate of asymptomatic respiratory and cutaneous colonization occurs. Correspondingly, the diagnosis of NTM disease requires multiple positive cultures or pathologic features on tissue biopsy, compatible clinical findings, and diligent exclusion of other causes.[5] A retrospective study of all NTM isolates in

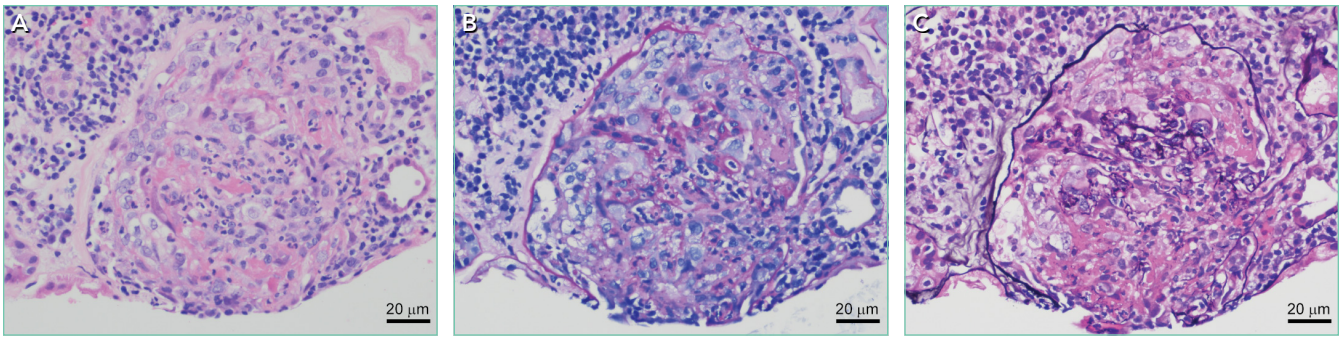

FIG 2. Histopathology of the renal biopsy. Hematoxylin-eosin (left), Periodic acid-Schiff (middle), and Jones' silver (right) stains highlight a compressed glomerulus with a prominent cellular crescent with necrotizing features. There is also significant interstitial inflammation.

Oregon from 2005-2006 revealed that only 47% of patients met the guideline criteria for having symptomatic NTM disease.[6] In our case, the patient's sputum grew *M. llatzerense*, an aerobic, nonfermenting mycobacterium found in water sources that has only infrequently been implicated as a human pathogen.[7,8] Subsequent AFB sputum cultures were negative, and serial imaging showed resolution of the pulmonary findings without additional antimycobacterial therapy, suggesting that this organism was not responsible for the disease process.

Along with microscopic polyangiitis (MPA) and eosinophilic granulomatosis with polyangiitis (EGPA), GPA is an antineutrophil cytoplasmic autoantibody (ANCA)-associated vasculitis that predominantly affects small to medium sized vessels. Although it can occur at any age, GPA most commonly afflicts older adults, with men and women being diagnosed at roughly equal rates.[9] GPA is a multisystem disease with a wide array of clinical manifestations. The most frequently involved sites of disease are the respiratory tract and kidneys, although virtually any organ can be affected. Sino-nasal disease, such as destructive sinusitis, or ear involvement are nearly universal. Lower respiratory manifestations occur in 60% of patients, but are highly diverse and reflect the inherent difficulty in diagnosing this condition.[9-11] Additionally, GPA is a frequent cause of the pulmonary-renal syndromes, with glomerulonephritis occurring in 80% of patients.[9]

The diagnosis of GPA in this case was delayed, in part, due to features suggestive of malignancy and pulmonary tuberculosis. While sino-nasal disease was not noted during this hospitalization, the patient had many different respiratory manifestations, including a dominant pulmonary mass, diffuse nodules, and hypoxemic respiratory failure due to suspected diffuse alveolar hemorrhage (DAH), all of which have been reported in GPA.[12] Dysmorphic red cells and red blood cell casts are not sensitive for renal involvement in GPA; their absence does not exclude the possibility of an ANCA-associated vasculitis.[13] Hematuria and rapid progression to oliguric renal failure are characteristic of a vasculitic process and should sway clinicians away from a working diagnosis of ATN.

The diagnosis of GPA involves the synthesis of clinical data, radiographic findings, serologic testing, and histopathology. ANCA testing is an essential step in the diagnosis of GPA but has limitations. Patients with GPA more commonly have ANCAs targeting the enzyme proteinase-3 (PR3-ANCA), with MPA being more closely associated with myeloperoxidase (MPO-ANCA), although cross-reactivity and antibody-negative disease can occur.[14] Although 90% of patients with GPA with multiorgan involvement will have a positive ANCA, a negative test is more common in localized upper airway disease, where only 50% have a positive ANCA.[15] A number of drugs, medications, infections, and nonvasculitic autoimmune diseases have been associated with positive ANCA serologies in the absence of systemic vasculitis.[14,16,17] As such, pathologic demonstration of vasculitis is necessary for establishing the diagnosis. Typical sites for biopsy include the kidneys and lungs.[9]

This case illustrates how clinicians often find themselves at a diagnostic crossroads—being forced to choose which clinical elements to prioritize. At various points, our patient's presentation could have been framed as "a man from a Tb-endemic country with hemoptysis and an apical opacity," "an elderly man with extensive smoking history and lung mass," or "a patient with elevated inflammatory markers and pulmonary-renal syndrome". In such situations, it is incumbent on the clinician to evaluate how well a given problem representation encompasses or highlights the salient features of a case. As with painting or photography, an essential aspect of appreciating the whole picture involves carefully selecting the right frame.

KEY TEACHING POINTS

- The diagnosis of tuberculosis relies on smear microscopy, nucleic-acid amplification testing (NAAT), and cultures. A positive AFB smear with negative NAAT suggests the presence of a nontuberculous mycobacteria (NTM).
- NTM are common environmental organisms and often exist as nonpathogenic colonizers.[6] The diagnosis of NTM disease requires exclusion of other causes and careful clinical, microbiologic, and radiographic correlation.
- Granulomatosis with polyangiitis is a multisystem disease often involving the respiratory track and kidney. Pulmonary disease can present with airway involvement, parenchymal nodules, opacities, pleural findings, and diffuse alveolar hemorrhage.[12]

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Reimagining Inpatient Care in Canadian Teaching Hospitals: Bold Initiatives or Tinkering at the Margins?

Peter Cram, MD, MBA[1,2]*; Vineet Chopra, MD, MSc[3]; Christine Soong, MD, MSc[1,2]; Robert Wu, MD, MSc[1,2]

[1]Division of General Internal Medicine and Geriatrics, Sinai Health System and University Health Network, Toronto, Ontario; [2]Faculty of Medicine, University of Toronto, Toronto, Ontario; [3]Division of Hospital Medicine, Department of Medicine, University of Michigan, Ann Arbor, Michigan.

Canada's 17 medical schools and their affiliated teaching hospitals are instrumental in serving local communities and providing regional and national access to specialized therapies. Akin to many other countries, patients in Canadian teaching hospitals typically receive care from trainees supervised by attending physicians on teams that Canadians refer to as clinical teaching units (CTUs).[1] For more than 50 years, the CTU model has served trainees, attendings, and patients well.[2] The success of the CTU model has been dependent on several factors including the crucial balance between the number of trainees and volume of patients. However, Canadian teaching hospitals are increasingly challenged by an imbalance in the trainee-to-patient volume equilibrium spurred by increasing patient volumes and declining house staff availability. The challenges we are facing today in Canada are similar to those teaching hospitals in the United States have faced and adapted to over the last 15 years. Can we build a new, sustainable model of inpatient care through attending-directed inpatient services much as has happened in the US?

Canada's population of 36 million people is growing by approximately 1% per year, largely driven by immigration.[3] At the same time, Canada's population is aging and becoming increasingly medically complex; the percentage of Canadians age 65 years and older is anticipated to rise from approximately 17% today to 25% in 2035.[4] Canada's healthcare system historically functioned with relatively few inpatient beds, encouraging efficiency particularly with respect to which patients require hospital admission and which do not.[5] Although data suggest that the number of hospital admissions declined in Canada between 1980 and 1995, recent data documented that General Internal Medicine admissions increased by 32% between 2010 and 2015 and accounted for 24% of total hospital bed days.[6,7] The effects of population growth and aging on admission volumes might be mitigated to some extent by innovations in healthcare delivery such as improved access to primary care (largely family physicians in Canada). However, even with these innovations, a growing and aging population is likely to have a disproportionate effect on the types of undifferentiated illnesses that are typically admitted to General Internal Medicine in Canadian teaching hospitals.

Increasing volumes and complexity are occurring at the same time that residency training in Canada is undergoing an extraordinary shift, mirroring trends in other countries.[8] CTUs in Canada typically have a census of 20 or more patients and are staffed by an attending, one senior resident, two to three junior residents, and medical students. Recognition that physician fatigue is associated with patient safety events and physician burnout has led to shorter resident shifts, though Canadian hospitals typically operate without concrete work hour limits or "hard" caps on team size.[8] To fulfill accreditation standards set by the Royal College of Physicians and Surgeons of Canada, residency programs have required increases in formal teaching sessions during working hours, further reducing resident presence at the bedside. Many specialty training programs (eg, anesthesiology and ophthalmology) that traditionally required trainees to rotate through General Medicine have eliminated this requirement. Moreover, postgraduate training now requires additional time be spent in ambulatory and community hospital settings to better prepare residents for practice.[9] There is little enthusiasm for increasing the number of residents, as postgraduate training spots increased by 85% between 2000 and 2013, before stabilizing in recent years.[10]

These factors are leading to a substantial decline in resident availability on CTUs, shifting increasing amounts of direct patient care to attending physicians in Canadian teaching hospitals across virtually all specialties. Unsurprisingly, increased rates of burnout and decreases in job satisfaction have been reported.[11] The Royal College has yet to impose hard caps on team size, but many see this on the horizon.

Canadian teaching hospitals currently find themselves facing a confluence of factors nearly identical to those faced by teaching hospitals in the United States during 2003 when the Accreditation Council for Graduate Medical Education instituted resident duty hour restrictions to address concerns over trainee wellness, shift length, and patient safety.[8] Instantly, hundreds of US teaching hospitals faced uncertainty over who would provide patient care when residents were unavailable. Virtually all US teaching hospitals responded with a creativity and speed that we are unaccustomed to in academic medicine. Hospitals reallocated money to finance attending-directed services where patient care was provided directly by attending physicians often working without trainees[12] but frequently supported by nurse

***Corresponding Author**: Peter Cram, MD MBA; E-mail: peter.cram@uhn.ca; Telephone: 416-340-4800 x 8097; Twitter: @PMCram

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TABLE. **Challenges Facing Canadian Teaching Hospitals and Proposed Action Plan**

Challenge	Champions to Mitigate Challenge	Stakeholders to Engage	Anticipated Resistance	Response
Unsafe patient volumes	• Residency directors • Hospital quality directors	• Hospital CEOs • Patient advocacy groups • Patient safety organizations • Government payers	• Cost	• Cost of patient harms including economic, medicolegal, and reputational damage to hospitals and staff
Reduced efficiency because of high volumes	• Division heads • Chairs • Service line chiefs • Hospital senior administrators	• Hospital finance and operations staff	• Cost	• Costs of excess length of stay and delayed discharges
Costs of a "fix"	• Hospital CEOs • Deans • Chairs	• Government payers	• Cost	• We are already bearing the costs in terms of patient safety events, delayed discharges, and physician dissatisfaction • Canada spends a relatively modest amount of budget on healthcare compared with other developed countries
Staff Physician/ Faculty burnout	• Hospital CEOs • Deans • Chairs	• Government payers	• Cost • Not our responsibility	• Cost of physician burnout is well quantified and tangible

practitioners or physician assistants.[13] Despite the differences between US and Canadian healthcare, 15 years later, we in Canada can and should learn from the US experience.[14]

Attending-directed services offer several advantages. First, attending-directed services offer patient outcomes including ICU transfer, mortality, readmissions, and satisfaction that are similar, if not modestly improved, when compared with traditional teaching services.[15] Results also suggest potential reductions in hospital length of stay and diagnostic testing.[16] Attending-directed services can enhance trainee education by insuring attending physician presence and oversight in-hospital 24-hours per day.[17] Although not well studied, attending-directed services may reduce variation in CTU patient census so that excess volumes can be absorbed by attending-directed teams even with seasonal surges (eg, influenza). Recognizing that many specialties were experiencing the same challenges as General Medicine in 2003, attending-directed services in the US have been designed to care for a wide spectrum of patients drawn from an array of different specialties with evidence of improved outcomes.[12] Building attending-directed services in Canadian teaching hospitals may expand to include patients from multiple specialties and subspecialties (surgery, orthopedics, and cardiology) where patient volumes are increasing and resident coverage is increasingly scarce.

The challenges that accompany the implementation of attending-directed teams must be acknowledged. First, while attending-directed teams solve many problems for teaching hospitals, physician billings may not generate sufficient income to be self-sustaining and require additional financial support.[18] Without investment from hospitals or government, attending-directed models cannot flourish in teaching hospitals. US hospitals typically provide substantial financial support ($50,000-$100,000 per physician) to hospitalist programs, but Canadian teaching hospitals have been reluctant to follow suit.

Second, attending-directed services require a sustainable workforce. In Canada, inpatient care is provided predominately by family physician hospitalists in community hospitals, whereas internists typically fulfill these roles in teaching hospitals.[19] Family physician hospitalists are commonly represented by the Canadian Society for Hospital Medicine, which is the Canadian branch of the Society of Hospital Medicine. Hospital medicine in Canada is typically organized around physician training (family physician vs internist) rather than clinical focus (outpatient vs inpatient). Collaborative models of care that unite hospitalists from all training streams (family physician, internist, and pediatrics) are only just emerging in Canadian teaching hospitals. How these programs are developed will be critical to the successful growth of attending-directed services. Third, if attending-directed services expand in teaching hospitals, the physicians who staff these services must come from somewhere. Either the "production" of physicians will need to increase or physicians will migrate to attending-directed services from outpatient practice or from community hospitals.[20] Canadian teaching hospitals can also explore nurse practitioners and physician assistants, a previously underutilized resource. Though the costs of such programs can be significant,[21] the payoff in safety, quality, and efficiency may be worth it—as demonstrated in the US system. Fourth, teaching hospitals and medical schools must create academic homes to support and mentor the physicians working on attending-directed services. Although physicians hired for attending-directed services primarily provide direct patient care, few will join academic medical centers solely for this purpose. Teaching hospitals and medical schools need to carefully consider job descriptions, mentoring, and career advancement opportunities as they build attending-directed services. Finally, the interactions between teaching and attending-directed services are complex. There is an inevitable learning curve as clinical operations and protocols are built and developed. For example, decisions need to be made about how patients are divided between

services and whether nocturnists are responsible for teaching overnight residents.[17] Successful programs have the potential to benefit hospitals, patients, learners, and faculty alike.

The risks associated with the status quo in Canada must also be addressed. Patient volumes and complexity in Canada are likely to continue to slowly increase, while the number of trainees in Canadian teaching hospitals will remain stable at best. Forcing more patients onto already overtaxed teaching services is likely to worsen hospital efficiency, patient outcomes, and educational experiences.[22] Forcing additional patient care onto overstretched faculty will slowly erode the academic work (teaching and research) that has characterized excellence in Canadian medicine.

The changes we propose to overcome the challenges facing Canadian teaching hospitals are neither cheap nor easy (Table). We expect resistance on many fronts. Implementing them will likely require concerted advocacy from a diverse group of champions shining a bright spotlight on the sizable challenges Canadian teaching hospitals are confronting. We believe that each challenge maps to a discrete group of champions with discrete targets within hospital leadership, medical school administration, and government who will need to be engaged. In our opinion, organizing around these challenges offers the best opportunity to overcome the perpetual resistance around costs. Canadian teaching hospitals and their CTUs are under unprecedented pressure. Do we act boldly and embrace attending-directed models of care or continue tinkering at the margins?

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Leadership & Professional Development: Be the Change You Want to See

Michelle H Moniz, MD, MSc[1,2]*; Sanjay Saint, MD, MPH[3,2,4]

[1]*Department of Obstetrics and Gynecology, University of Michigan, Ann Arbor, Michigan;* [2]*University of Michigan Institute for Healthcare Policy and Innovation, Ann Arbor, Michigan;* [3]*VA Ann Arbor Healthcare System, Ann Arbor, Michigan;* [4]*University of Michigan Department of Internal Medicine, Ann Arbor, Michigan.*

"…a truly strong, powerful man isn't threatened by a strong, powerful woman. Instead, he is challenged by her, he is inspired by her, he is pleased to relate to her as an equal."

—Michelle Obama

Mentorship is essential to success in hospital medicine and may be particularly important for women. Cross-gender mentorship is especially salient since roughly equal proportions of women and men enter the medical pipeline, but men occupy over 75% of senior leadership roles in healthcare companies.

Cross-gender mentorship poses challenges but can be done successfully.[1] We've made cross-gender mentoring work well in our own mentoring relationship. We describe three practices for effective mentoring that are especially important for men who mentor women given how common the female mentee-male mentor dyad is in medicine. We make generalizations that don't apply universally but illustrate the social context in which such mentorship resides.

BE MINDFUL OF GENDER SCRIPTS

Gender scripts refer to social norms relating to gender identities and behaviors. Archetypal scripts include the father/daughter relationship and the knight/damsel-in-distress. Gender scripts often frame women as powerless—waiting to be rescued. By unconsciously activating a gender script, a mentor may reinforce a stereotype that women need rescuing (eg, "She's really upset—I'll email her Division Chief and help fix it for her") or underestimate a mentee's readiness for independence (eg, "She's written four papers on this, but she's still not ready to be senior author"). Astute mentors use reflection to combat gender scripts, asking themselves, "Am I allowing latent biases to affect my judgement?" They also consider when to intervene and when to let the mentee "rescue" herself (eg, "This is challenging, but I trust your judgement. What do you think you should do next?").

PROMOTE RECIPROCAL LEARNING

Many women value collaborative behaviors and gravitate towards egalitarian learning environments at odds with a traditional, "top-down" mentorship model. Additionally, women may be penalized for demonstrating competitive behaviors, while identical behaviors are chalked up to confidence in men. A critical task, then, is for mentors to coach women to hone their natural leadership style, whether it be more commanding or more communal. A mentor can provide key feedback to the mentee about how her approach might be perceived and how to tweak it for optimal success. Mentors may wish to share missteps and even ask the mentee for advice. Pointing to her competence promotes "relational mentoring" and reciprocal learning, where mentor and mentee can learn positive behaviors from each other.

BE THE CHANGE YOU WANT TO SEE

Mentors will ideally wield their social capital to advance policies that promote gender equity—including fair recruiting, promotion, salary, paid leave, and breastfeeding policies. Exceptional mentors recognize that women may generally have less social capital than men in many organizations, and they proactively make women's accomplishments more visible.[2] They broadcast women's strengths and nominate women for talks, national committees, honorific societies, and leadership positions. Effective mentors recognize that 30% of female medical faculty report experiencing sexual harassment at work,[3] and thus maintain extremely high standards for professional integrity, for both themselves and others who interact with their mentees. They call out sexist remarks in the workplace as unacceptable, making it clear that such behavior won't be tolerated. As Mohandas Gandhi said: "Be the change that you wish to see in the world."

Cross-gender mentorship is critical to get right—nearly half our medical workforce depends on it. Men who mentor women help their organizations and gain satisfaction from playing a pivotal role in women's advancement. When women succeed, we all do.

***Corresponding Author**: Michelle H. Moniz, MD, MSc; E-mail: mmoniz@med.umich.edu; Telephone: 734-936-3110

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See None, Do None, Teach None? The Idiosyncratic Nature of Graduate Medical Education

Melissa Plesac, MD[1]*; Andrew PJ Olson, MD[1,2]

[1]*Department of Medicine, University of Minnesota Medical School, Minneapolis, Minnesota;* [2]*Department of Pediatrics, University of Minnesota Medical School, Minneapolis, Minnesota.*

Graduate medical education (GME) is heavily reliant on experiential learning. Most of a resident's time is spent in progressively independent delivery of patient care, which is associated with decreasing supervision. Attainment and demonstration of competence in patient care is the goal and responsibility of GME training programs. What happens, then, if the medicine resident never has the experience necessary to enable experiential learning? What if she never "sees one," let alone "does one"?

In this month's *Journal of Hospital Medicine*, Sclafani et al[1] examine how exposure to urgent clinical situations impacts residents' confidence in managing these ward emergencies. They astutely reveal the idiosyncratic nature of residency training and consequent gaps created when an educational delivery model predicated on experience lacks certain experiences. How can a resident without certain key experiences be ready for independent practice?

The ACGME's Next Accreditation System is intended to ensure that residents are prepared for independent practice. The educational outcomes that learners must attain are comprised of six core competencies, with milestones intended to operationalize the measurement and reporting of learner progression toward competence.[2,3] It is challenging to apply general competencies to assessment of day to day clinical activities. This challenge led to the development of 16 Entrustable Professional Activities (EPAs). These allow the direct observation of concrete clinical activities that could then infer the attainment (or not) of multiple competencies. Ideally, EPAs are paired with and mapped to curricular milestones which describe a learner's trajectory within the framework of competencies and determine if a resident is prepared for independent practice.[4,5]

In Sclafani et al.[1] the authors characterize resident exposure to, and confidence in, 50 urgent clinical situations. Both level of training and exposure were associated with increased confidence. However, the most important finding of this paper is the wide variation of resident exposures and confidence with respect to specific urgent clinical events. At least 15% of graduating residents had never seen 16% of the 50 emergency events, and a majority of graduating residents did not feel confident managing 20% of the 50 events, highlighting the idiosyncratic nature of GME training.[1] Of course, while certain entities on the list of clinical emergencies were not identified as final diagnoses, it is possible they were still considered in the process of caring for patients in different situations.

Several factors account for the idiosyncratic nature of medical training, including the rarity of certain clinical events, seasonal variation in conditions, and other variables (ie, learner elective choices). In addition, the scheduling of most residency programs is based on patient care needs instead of individual trainees' educational needs. Other areas of medicine have attempted to standardize experience and ensure specific exposure and/or competence using strategies such as surgical case logs and case-based certifying examinations. There are very important recently described projects in undergraduate medical education aimed at using longitudinal assessment of EPAs in multiple contexts to make entrustment decisions.[6] However, Internal Medicine residencies do not routinely employ these strategies.

It must be noted that Sclafani et al. surveyed residents from only one site, and examined only self-reported exposure and confidence, not competence. The relationship between confidence and competence is notoriously problematic[7] and there is a risk of familiarity creating an illusion of knowledge and/or competence. Ultimately, a competency-based medical system is intended to be dynamic, adaptive, and contextual. Despite the extensive competency-based framework in place to track the development of physicians, data about the contexts in which competency is demonstrated are lacking. There is no reason to think that the key gaps identified in Sclafani et al are unique to their institution.

Given the ultimate goal of developing curricula that prepare residents for independent practice coupled with robust systems of assessment that ensure they are ready to do so, educators must implement strategies to identify and alleviate the idiosyncrasy of the resident experience. The survey tool in the present work could be used as a needs assessment and would require minimal resources, but is limited by recall bias, illusion of knowledge, and lack of data regarding actual competence. Other potential strategies include case logs or e-folios, although these tools are also limited by the understanding that familiarity and exposure do not necessarily engender competence.

One potential strategy suggested by Warm et al. is the addition of the "Observable Practice Activities" (OPA), "a collection of learning objectives/activities that must be observed in daily practice in order to form entrustment decisions."[8] The

***Corresponding Author:** Melissa Plesac, MD; Email: plesac01@umn.edu; Telephone: 612-625-3651.

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intention is to more granularly define what residents actually do and then map these activities to the established competency-based framework. Using these observable activities as an assessment unit may allow for identification of individual experience gaps, thereby improving the dynamicity and adaptiveness of GME training. Certainly, there are very real concerns about further complicating an already complex and abstract system and using a reductionist approach to define the activities of a profession. However, the findings of Sclafani et al with respect to the wide range of resident experience elucidates the need for continued study and innovation regarding the manner in which the medical education community determines our trainees are prepared for independent practice.

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Transthyretin (Prealbumin) and the Ambiguous Nature of Malnutrition

Jessica L Lee, MD, MS[1*]; Thomas E Finucane, MD, MACP[2]

[1]*Assistant Professor, The University of Texas Health Science Center at Houston, Houston, Texas;* [2]*Emeritus Professor of Medicine, Johns Hopkins Bayview Medical Center, Baltimore, Maryland.*

Lacy and colleagues identify an important "Thing We Do For No Reason"—prealbumin testing to diagnose malnutrition in hospitalized patients.[1] They highlight the frequency and costs of ordering prealbumin tests although prealbumin is neither specific nor sensitive as a "marker of nutritional status," shows no response to nutritional interventions, and has not been shown to correlate with clinical outcomes. We strongly support their analysis. A core problem in the process of nutrition assessment underlies this meaningless and costly practice. The term "malnutrition" is perfectly ambiguous. In one common usage, the term means that "markers of nutritional status" are abnormal. This usage allows a circular reasoning process where prealbumin is defined as a marker of nutritional status, and people with low prealbumin are then diagnosed as malnourished.

The term is also used to mean a condition where evidence shows better patient outcomes when improved nutrition is provided. Distinguishing between these two meanings is essential, as numerous patients with inflammatory illness will present abnormal "markers" when good evidence shows that they cannot benefit from nutritional support.

For example, a patient with advanced untreated human immunodeficiency virus (HIV) is likely to be considered malnourished because all of her "markers of nutritional status" are abnormal. She barely eats, has lost weight, and has low anthropometric, immunologic, and serologic measures, poor functional status, extreme vulnerability, and very poor prognosis. In this way she resembles a person in a famine situation. However, the patient is not malnourished in the sense that improved nutrient intake will lead to better patient outcomes. A Cochrane review of "nutritional interventions for reducing morbidity and mortality in people with HIV" found "no evidence that such supplementation translates into reductions in disease progression or HIV-related complications, such as opportunistic infections or death."[2] The patient is dying of an inflammatory, cachectic illness. The same is true in managing patients with advanced cancer or several other serious illnesses.

Low prealbumin measures are associated with poor outcomes, which are then attributed to "malnutrition." However, as Lacy and colleagues argue, prealbumin is a negative acute phase reactant and is thus a marker of the inflammatory effects of sickness/injury; it also responds variably to nutritional support. Citing Koretz, they note that "even when changes in nutritional markers are seen with nutritional support, the 'changes in nutritional markers do not predict clinical outcomes.'"[1,3] We know of no evidence from randomized controlled trials that prealbumin measurements help identify patients who can benefit from nutrition support.

By contrast, we and our colleagues have shown that in people who barely eat but show no inflammatory disease, eg, prison hunger-strikers and patients with anorexia nervosa, prealbumin level remains normal down to a body mass index below 13. The same is generally true for albumin.[4] These measures fail to identify "malnutrition" in people who are starving.

Despite the complete lack of clinical trial evidence of benefit, prealbumin is widely used as an indicator of malnutrition. The National Institutes of Health's Medline Plus website for the general public lists low prealbumin levels as a possible sign of malnutrition, for example, and advises that the prealbumin test may be used to "find out if you are getting enough nutrients, especially protein, in your diet" and to "check to see if you are getting enough nutrition if you are in the hospital."[5] Unjustified assertions such as these contribute to the dramatic overuse of nutritional interventions.

However, as a rule, things do occur for a reason. Using the term "prealbumin" conjures a certain relationship, perhaps as a precursor, to albumin, a venerable (but valueless) "marker of nutrition status." In fact, the term refers only to a difference in electrophoretic mobility (prealbumin migrates faster). If prealbumin were called it by its proper name, transthyretin, it would probably have languished in obscurity among serum proteins until, in recent years, drug suppression of transthyretin synthesis has been shown to benefit patients with hereditary transthyretin amyloidosis.[6] Using a name that references albumin, this protein has found the limelight as a marker of nutritional status.

The close similarity in appearance between starvation and wasting illness enables the strong, largely evidence-free[7] emphasis on nutrition support. Many families and individuals suffer when a loved one loses weight. As a prominent reminder of serious illness, this wasted appearance can be painful to bear. Several caregivers may fear that they will be judged as neglectful by outside observers. Other individuals also wish to maintain their body weight for social reasons (as weight loss may be interpreted as a sign of illness, especially HIV). Nutrition maintains a special status in various contexts during the care of

***Corresponding Author:** Jessica L Lee; E-mail: Jessica.lee@uth.tmc.edu; Telephone: 713-500-5457

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sick patients, and the drive to provide food to individuals who appear undernourished seems fundamental in humans.

A third reason for the frivolous, widespread overdiagnosis of "malnutrition" is that it leads directly to favorable consequences for the multibillion-dollar nutritional support industry. A consistent rational approach to the use of nutritional support products for sick people would lead to multibillion-dollar harm for that industry. For now, however, no self-respecting clinician could fail to provide nutritional support to a patient diagnosed as "malnourished" regardless of evidence.

The consistent rational approach in caring for patients is to search for good evidence of benefit before initiating a treatment course. Although sending blood tests for "nutritional markers" to diagnose nutritional needs may be easier and more popular, we caution against such over-simplification. Using prealbumin as a marker for malnutrition could lead to overlooking potentially treatable inflammatory or infectious illness. On the other hand, the use of prealbumin could also lead to unnecessary and potentially dangerous treatments, such as feeding tube placement and/or total parental nutrition. Thus, with one small amendment, we fully support Lacy and colleagues' conclusion that prealbumin testing to identify malnutrition in hospitalized patients is a "Thing We Do For No (good) Reason."

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Practical Application of Pediatric Hospital Medicine Workforce Data. In Reference to: "Pediatric Hospitalist Workload and Sustainability in University-Based Programs: Results from a National Interview-Based Survey"

Lindsey C Douglas, MD, MSCR[1,2]*, Karen M Wilson, MD, MPH[1,2]

[1]*Department of Pediatrics, Icahn School of Medicine at Mount Sinai, New York, New York;* [2]*Kravis Children's Hospital, New York, New York.*

As leaders of a new Pediatric Hospital Medicine program in New York City, we were pleased to read the Brief Report from Dr. Fromme and colleagues, "Pediatric Hospitalist Workload and Sustainability in University-Based Programs: Results from a National Interview-Based Survey."

Although the study has greatly assisted us in developing our program, the manuscript lacked some data necessary for workforce planning. The authors report census caps for a majority of programs, but neither the actual number of patients in each cap nor whether programs with caps reported an association with patient safety or program sustainability. In addition, although overnight pager calls were calculated in median hours, there were no data on whether nights were weighted or alternate staffing models were used for overnight pager calls.

While the article will help guide our field's continued understanding of our workforce, without additional detailed data, we found that we were unable to apply staffing models practically in the real world to our new program. Pediatric Hospital Medicine is one of the fastest growing fields in medicine; however, support of new programs and sustainability of existing ones, require benchmark details to create proposals that are acceptable to both hospital and university administrators while maintaining workforce sustainability.

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***Corresponding Author**: Lindsey C. Douglas, MD; E-mail: lindsey.douglas@mssm.edu; Telephone: 212-241-1251.

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In Reply to: "Practical Application of Pediatric Hospital Medicine Workforce Data: In Reference to 'Pediatric Hospitalist Workload and Sustainability in University-Based Programs: Results from a National Interview-Based Survey'"

H Barrett Fromme, MD, MHPE[1]; Christina O Chen, MD[2]; Bryan R Fine, MD, MPH[3]; Craig Gosdin, MD, MSHA[4]; Erin E Shaughnessy, MD, MSHCM[5]*

[1]Department of Pediatrics, University of Chicago Pritzker School of Medicine, Chicago, Illinois; [2]Department of Pediatrics, Rush University, Chicago, Illinois; [3]Children's Hospital of the King's Daughters, Norfolk, Virginia; [4]Department of Pediatrics, University of Cincinnati, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; [5]Phoenix Children's Hospital, Phoenix, Arizona.

We appreciate the query by Drs. Douglas and Wilson. We hereby supply additional information that is critical for creating and administering sustainable staffing models.

For programs with a census cap, the majority cited 16 or fewer patients as the trigger for that cap. Nearly all programs with back-up used a census of 16 or fewer. Over 80% of programs cited a "safe 7 AM census" as 16 or fewer. These data suggest that a census over 16 is appropriate to trigger additional clinical support.

Regarding clinical weighting of nights, nighttime shifts were often more heavily weighted than day shifts, but approaches to weighting varied and have not been validated. Alternate staffing models for overnight pager calls varied greatly by individual program.

This is a time of significant growth for pediatric hospital medicine, and national workforce data are essential to hospitalists, administrators, and most importantly, patients. Our study[1] provides pediatric hospital medicine leaders with data for discussions regarding appropriate FTE and staffing model considerations. The insights generated by our study are particularly relevant in expanding programs and solving problems related to recruitment and retention.

Corresponding Author: H. Barrett Fromme, MD, MHPE; E-mail: hfromme@peds.bsd.uchicago.edu; Telephone: 773-834-9043.

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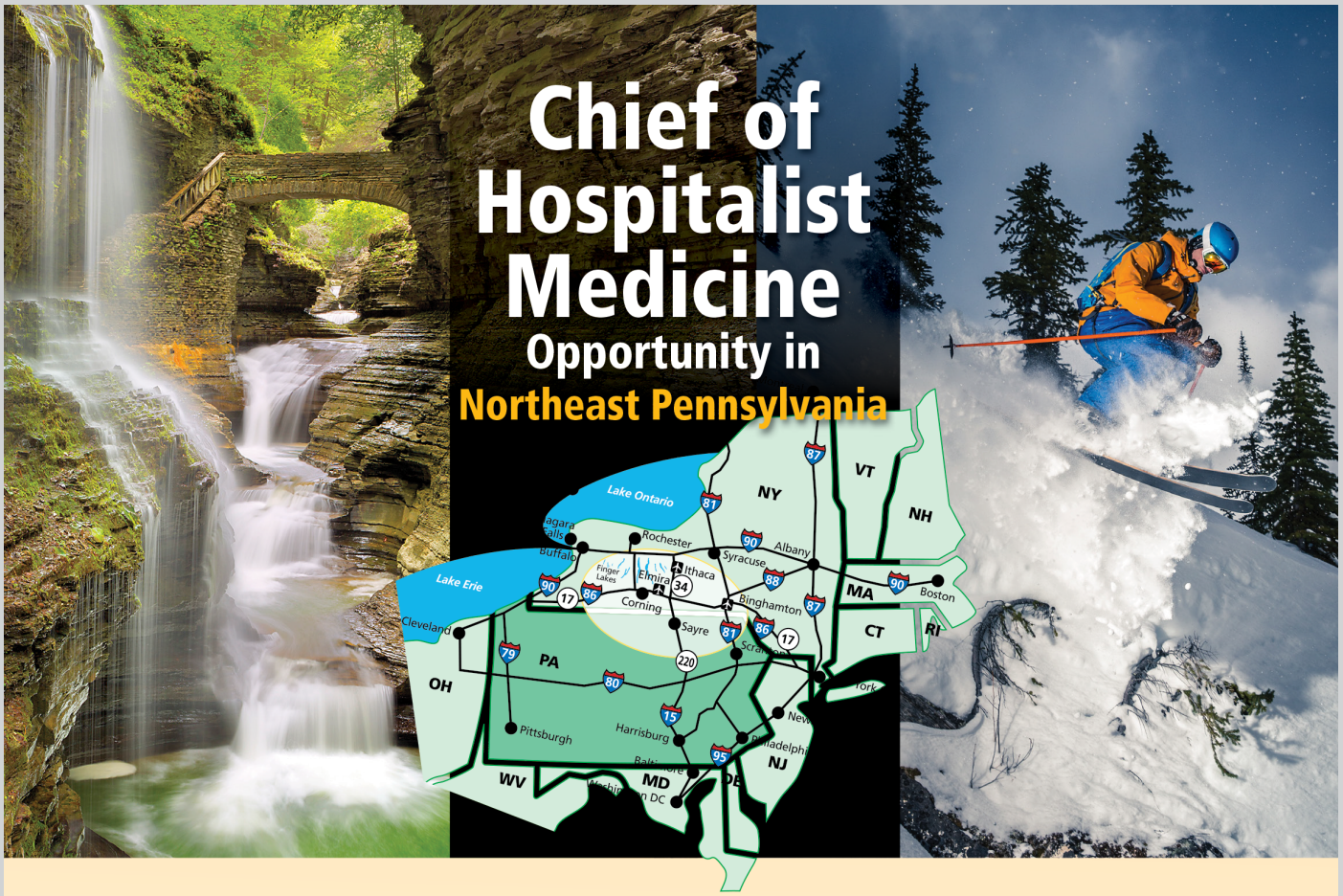

Job description:
Guthrie Clinic, a non-profit, physician-led, integrated health care delivery system is seeking candidates for Chief, Section of Hospitalist Medicine. The Chief will oversee 24 Hospitalists and 9 Advanced Practice Providers, located in 4 regional hospitals. The Chief has responsibility for quality, leadership, scheduling and overall program strategy.

Position details and requirements:
- Ensures the Section functions in an integrated system of care, improving performance, growing depth of clinical programs, and enhancing quality outcomes.
- Serves as mentor, guide and support for Hospitalists system wide.
- Leads recruitment/retention of physicians and APPs to actively grow the Section.
- Position is 50% Administrative and 50% clinical.

Clinical
- Participates in quality and system improvement within group and across hospital.
- Participates in all group clinical decisions with the goal of high quality care.
- Participates in group performance reviews with regard to quality of care, satisfaction, and efficiency metrics.
- Coordinates schedule with group to maintain 24/7 coverage at all hospitals within the integrated health system.
- Ensures coverage of shifts.

Administrative
- Participates in strategic plan for hospital medicine group, including marketing, growth/recruiting, service, and quality.
- Establish annual goals for quality, efficiency growth and satisfaction.
- Responsible for developing, updating and maintaining clinical standards and care paths.
- Participates in utilization review and peer review activities as they relate to the Hospitalist program.

- Oversees the development of the annual budget and key operating indicators for the Department and monitors the Department's performance in relation to these annual targets.
- Works collaboratively with the Program Director for the Internal Medicine Residency Program, the Fellowship Directors and the Director of Medical Education to ensure that the quality of the residency and fellowship(s).
- M.D. or D.O.; BC in Internal Medicine. Advanced degree (MBA, MHA, MMM) desirable.
- Five or more years of successfully leading a Hospitalist program.
- Strong commitment to the patient care and future academic missions of Guthrie Clinic.
- Possession of, or eligibility for, a medical license in Pennsylvania.

Guthrie, founded in 1910, provides comprehensive team-based care to patients from an 11-county service area. Guthrie Clinic is comprised of four hospitals, 500 physicians and advanced practice providers in a regional office network made up of 45 sub-specialty and primary care sites in 21 communities. In addition, we offer a wide range of services and programs including home health and home care services, GME and a research institute. Guthrie was the first system to implement EPIC EMR, in 2002, with the go-live of Epic CPOE (Certified Physician Order Entry).

Guthrie's (main) Sayre campus is situated in a beautiful valley in north-central PA, located just a few miles from the NY border. Guthrie's service area stretches from Corning and Ithaca, NY to Wellsboro, PA (home of PA Grand Canyon) down to Tunkhannock, PA and is less than 30 minutes from the Finger Lakes region.

For more information about this leadership opportunity, please contact **Krisi VanTassel at krisi.vantassel@guthrie.org or (570) 887-5203.**

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