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Out with the Old, in with the New

Andrew Auerbach, MD, MPH, SFHM

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A new year often comes with resolutions to jettison old tendencies, increase emphasis on what has been successful, and develop new habits. For 2018, the *Journal of Hospital Medicine*'s year begins with resolutions that span these same areas.

The journal has been incredibly successful over the last 5 years, with a near doubling in the volume of manuscripts we have been receiving; the rise in submissions has been paralleled by the increased quality of submissions. *JHM* has moved on from our old approach of seeking out authors and research to having great research and authors seek us. In 2018, we expect that the challenges of our startup days will continue to recede into the past.

Many of *JHM*'s old habits have been incredibly successful, and we recommit ourselves to these areas. *JHM* is committed to providing the best possible service to its authors in the form of the rapid processing of papers under our charge and, most importantly, the highest quality peer and editorial review. Our internal mantra of "making papers better whether we accept them or not" remains a cornerstone of our efforts. The journal has been innovative in developing new and influential series, such as the Things We Do For No Reason and the *Choosing Wisely*®: Next Steps series. *JHM*'s focus on digital dissemination and social media grew further in 2017, with the #JHMChat Twitter journal clubs engaging hundreds of participants and generating literally millions of impressions.

For 2018, *JHM* will continue to develop and innovate in areas that reflect the field of Hospital Medicine as well as trends in peer-reviewed publishing. I am particularly excited to see the launch of a new series entitled "In the Hospital," a series of papers that will highlight the role of connectedness, humanism, and resilience in creating the social fabric of the hospital workplace. We have renewed our relationship with the American Board of Internal Medicine Foundation to support both the Things We Do For No Reason series as well as *Choosing Wisely*®: Next Steps, series that will help flesh out aspects of healthcare that remain central to our practice as policies and payment models change.

As our practices become nearly wholly contained within digital workspaces, *JHM* will begin to highlight digital health papers in newsletters while also developing increased expertise internally. The transition to digital platforms for clinical care will be reflected in the revisiting of *JHM*'s digital dissemination strategy, in which we will be working to more rapidly publish papers online, often online only and with more frequent accompaniment by blogs, tweets, and the ability for readers to comment.

Our editorial sensibilities will not change; *JHM*'s goal is to reflect Hospital Medicine's traditional focus areas on health-systems improvement as a discipline. But beginning in 2018 and for the future, we will also push the field and Hospital Medicine practice by publishing papers that change how we care for patients and suggest fundamental changes in how we manage diseases.

Finally, all of these efforts will be contained within a brilliant new layout and design schema, the first new design for *JHM* since its first issue more than 12 years ago.

JHM's past successes and future initiatives are the result of old habits we hope to renew: a deep commitment from *JHM*'s editors, to whom I am deeply thankful, and from our authors, peer reviewers, and readers who help us put forward a journal that continues to grow in excellence and influence. We look forward to renewing these commitments during 2018 and welcome your help.

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Characterizing Hospitalist Practice and Perceptions of Critical Care Delivery

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BACKGROUND: Intensivist shortages have led to increasing hospitalist involvement in critical care delivery.

OBJECTIVE: To characterize the practice of hospitalists practicing in the intensive care unit (ICU) setting.

DESIGN: Survey of hospital medicine physicians.

SETTING: This survey was conducted as a needs assessment for the ongoing efforts of the Critical Care Task Force of the Society of Hospital Medicine Education Committee.

PARTICIPANTS: Hospitalists in the United States.

INTERVENTION: An iteratively developed, 25-item, web-based survey.

MEASUREMENTS: Results were compiled from all respondents then analyzed in subgroups. Various items were examined for correlations.

RESULTS: A total of 425 hospitalists completed the survey. Three hundred and twenty-five (77%) provided critical care services, and 280 (66%) served as primary physicians in the ICU. Hospitalists were significantly more likely to serve as primary physicians in rural ICUs (85% of rural respondents vs 62% of nonrural; $P < .001$ for association). Half of the rural hospitalists who were primary physicians for ICU patients felt obliged to practice beyond their scope, and 90% at least occasionally perceived that they had insufficient support from board-certified intensivists. Among respondents serving as primary physicians for ICU patients, 67% reported at least moderate difficulty transferring patients to higher levels of ICU care. Difficulty transferring patients was the only item significantly correlated with the perception of being expected to practice beyond one's scope ($P < .05$ for association).

CONCLUSIONS: Hospitalists frequently deliver critical care services without adequate training or support, most prevalently in rural hospitals. Without major changes in intensivist staffing or patient distribution, this is unlikely to change. Journal of Hospital Medicine 2018;13:6-12. Published online first December 6, 2017 © 2018 Society of Hospital Medicine

Despite calls for board-certified intensivist physicians to lead critical care delivery,[1-3] the intensivist shortage in the United States continues to worsen,[4] with projected shortfalls of 22% by 2020 and 35% by 2030.[5] Many hospitals currently have inadequate or no board-certified intensivist support.[6] The intensivist shortage has necessitated the development of alternative intensive care unit (ICU) staffing models, including engagement in telemedicine,[7] the utilization of advanced practice providers,[8] and dependence on hospitalists[9] to deliver critical care services to ICU patients. Presently, research does not clearly show consistent differences in clinical outcomes based on the training of the clinical provider, although optimized teamwork and team rounds in the ICU do seem to be associated with improved outcomes.[10-12]

In its 2016 annual survey of hospital medicine (HM) leaders, the Society of Hospital Medicine (SHM) documented that most HM groups care for ICU patients, with up to 80% of hospitalist groups in some regions delivering critical care.[13] In many United States hospitals, hospitalists serve as the primary if not lone physician providers of critical care.[6,14] HM, with its team-based approach and on-site presence, shares many of the key attributes and values that define high-functioning critical care teams, and many hospitalists likely capably deliver some critical care services.[9] However, hospitalists are also a highly heterogeneous work force with varied exposure to and comfort with critical care medicine, making it difficult to generalize hospitalists' scope of practice in the ICU.

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Because hospitalists render a significant amount of critical care in the United States, we surveyed practicing hospitalists to understand their demographics and practice roles in the ICU setting and to ascertain how they are supported when doing so. Additionally, we sought to identify mismatches between the ICU services that hospitalists provide and what they feel prepared and supported to deliver. Finally, we attempted to elucidate how hospitalists who practice in the ICU might respond to novel educational offerings targeted to mitigate cognitive or procedural gaps.

METHODS

We developed and deployed a survey to address the aforementioned questions. The survey content was developed iteratively by the Critical Care Task Force of SHM's Education Committee and subsequently approved by SHM's Education Committee and Board of Directors. Members of the Critical Care Task Force include critical care physicians and hospitalists. The survey included 25 items (supplemental Appendix A). Seventeen questions addressed the demographics and practice roles of hospitalists in the ICU, 5 addressed cognitive and procedural practice gaps, and 3 addressed how hospitalists would respond to educational opportunities in critical care. We used conditional formatting to ensure that only respondents who deliver ICU care could answer questions related to ICU practice. The survey was delivered by using an online survey platform (Survey Monkey, San Mateo, CA).

The survey was deployed in 3 phases from March to October of 2016. Initially, we distributed a pilot survey to professional contacts of the Critical Care Task Force to solicit feedback and refine the survey's format and content. These contacts were largely academic hospitalists from our local institutions. We then distributed the survey to hospitalists via professional networks with instructions to forward the link to interested hospitalists. Finally, we distributed the survey to approximately 4000 hospitalists randomly selected from SHM's national listserv of approximately 12,000 hospitalists. Respondents could enter a drawing for a monetary prize upon completion of the survey.

None of the survey questions changed during the 3 phases of survey deployment, and the data reported herein were compiled from all 3 phases of the survey deployment. Frequency tables were created using Tableau (version 10.0; Tableau Software, Seattle, WA). Comparisons between categorical questions were made by using χ^2 and Fischer exact tests to calculate *P* values for associations by using SAS (version 9.3; SAS Institute, Cary, NC). Associations with *P* values below .05 were considered statistically significant.

RESULTS

Objective 1: Demographics and Practice Role

Four hundred and twenty-five hospitalists responded to the survey. The first 2 phases (pilot survey and distribution via professional networks) generated 101 responses, and the third phase (via SHM's listserv) generated an additional 324 responses. As the survey was anonymous, we could not determine which hospitals or geographic regions were represented. Three hundred and twenty-five of the 425 hospitalists who completed the survey (77%) reported that they delivered care in the ICU. Of these 325 hospitalists, 45 served only as consultants, while the remaining 280 (66% of the total sample) served as the primary attending physician in the ICU. Among these primary providers of care in the ICU, 60 (21%) practiced in rural settings and 220 (79%) practiced in nonrural settings (Figure 1).

The demographics of our respondents were similar to those of the SHM annual survey,[13] in which 66% of respondents delivered ICU care. Forty-one percent of our respondents worked in critical access or small community hospitals, 24% in academic medical centers, and 34% in large community centers with an academic affiliation. The SHM annual survey cohort included more physicians from nonteaching hospitals (58.7%) and fewer from academic medical centers (14.8%).[13]

Hospitalists' presence in the ICU varied by practice setting (Table 1). Seventy-eight percent of respondents practicing outside of academic medical centers served as primary ICU physicians, compared with less than 30% of hospitalists practicing at an academic medical center. Hospitalists reported substantial variability in their volumes of ICU procedures (eg, central lines, intubation), the number of mechanically ventilated patients for whom they delivered care, and who was responsible for making ventilator management decisions (Table 1).

Hospitalists were significantly more prevalent in rural ICUs than in nonrural settings (96% vs 73%; Table 2). Rural hospitalists were also more likely to serve as primary physicians for ICU patients (85% vs 62%) and were more likely to deliver all critical care services (55% vs 10%). Seventy-five percent of respondents from rural settings reported that hospitalists manage all or most ICU patients in their hospital as opposed to 36% for nonrural respondents. The associations between hospitalist roles in the ICU care and practice setting were significantly different for rural and nonrural hospitalists (χ^2 *P* value for association <.001). Intensivist availability (measured both in hours per day and by perception of whether such support was sufficient) was significantly lower in rural ICUs (Table 2).

We found similar results when comparing academic hospitalists (those working in an academic medical center or academic-affiliated hospital) with nonacademic hospitalists (those working in critical access or small community centers). Specifically, hospitalists in nonacademic settings were significantly more prevalent in ICUs (90% vs 67%; Table 2), more likely to serve as the primary attending (81% vs 55%), and more likely to deliver all critical care services (64% vs 25%). Sixty-four percent of respondents from nonacademic settings reported that hospitalists manage all or most ICU patients in their hospital as opposed to 25% for academic respondents (χ^2 *P*value for association <.001). Intensivist availability was also significantly lower in nonacademic ICUs (Table 2).

We also sought to determine whether the ability to transfer critically ill patients to higher levels of care effectively mitigated shortfalls in intensivist staffing. When restricted to hospitalists who served as primary providers for ICU patients, 28% of all respondents and 51% of rural hospitalists reported transferring patients to a higher level of care.

TABLE 1. **Practice Setting and Specialty Management Practices for Hospitalist Respondents**

Practice Setting[a]	**Primary Physician in the ICU**				
	Number (%) of Respondents from that Setting				
Critical access	11 (84.6)				
Small community	131 (80.4)				
Large community	108 (74.0)				
AMC	30 (29.1)				
Specialty Patient[b]	**Care for Subspecialty Patients in the ICU**				
	Number (%) of all HM in the ICU				
Cardiology/cardiac surgery	163 (50.2)				
General surgery	163 (50.2)				
Neurology/neurosurgery	159 (48.9)				
Orthopedic/trauma	130 (40.0)				
No specialty patients	92 (28.3)				
	Average Procedures per Month[b]				
	Number (%) of all HM in the ICU				
Procedure	**0**	**1-5**	**6-10**	**11-20**	**>20**
CVC insertion	172 (52.9)	69 (21.2)	28 (8.6)	15 (4.6)	41 (12.6)
Paracentesis	203 (62.5)	66 (20.3)	27 (8.3)	14 (4.3)	15 (4.6)
Arterial line insertion	205 (63.1)	67 (20.6)	18 (5.5)	15 (4.6)	20 (6.2)
Intubation	207 (63.7)	54 (16.6)	28 (8.6)	14 (4.3)	22 (6.8)
Thoracentesis	229 (70.5)	52 (16.0)	18 (5.5)	13 (4.0)	13 (4.0)
Diagnostic ultrasound	242 (74.5)	31 (9.5)	16 (4.9)	8 (2.5)	28 (8.6)
Chest tube	286 (88.0)	25 (7.7)	4 (1.2)	4 (1.2)	6 (1.9)
Flexible bronchoscopy	311 (95.7)	5 (1.5)	3 (0.9)	2 (0.6)	4 (1.2)
	Average Ventilated Patients[b]				
	Number (%) of all HM in the ICU				
0-1	**2**	**3**	**4**	**5 or more**	
159 (48.9)	69 (21.2)	40 (12.3)	22 (6.8)	35 (10.80000)	
	Ventilator Management Decisions[c]				
	Number (%) of all HM in the ICU				
RT independently managed ventilators	**BCI manage all ventilators**	**Hospitalists manage some ventilators, BCI manage complex or prolonged cases**	**Only hospitalists with specialized interest and/or training manage vents**	**Hospitalists manage all ventilators**	
9 (2.9)	151 (49.0)	73 (23.7)	23 (7.5)	52 (16.9)	

[a]Percentages indicate percent of respondents from each practice setting.

[b]Percentages indicate percent of the 325 respondents who have a role in delivering ICU care.

[c]Percentages indicate percent of the 308 respondents who have a role in delivering ICU care who completed this item.

NOTE: Values shown are number of respondents. Abbreviations: AMC, academic medical center; BCI, board-certified intensivist; CVC, central venous catheter; HM, hospital medicine; ICU, intensive care unit; RT, respiratory therapy.

TABLE 2. **Comparison of Rural and Nonrural Responses Related to Practice Role**

Responses	Rural	Nonrural	Nonacademic	Academic
Do you manage ICU patients?				
No, I do not have a role in the ICU	4.2%	27.4%	10.2%	32.9%
Yes, as a consultant only for selected medical issues	11.3%	10.5%	9.1%	11.6%
Yes, as the attending of record or primary physician during the hospitalization	84.5%	62.1%	80.7%	55.4%
What role do BCIs play in managing ICU patients in your hospital?				
Hospitalists provide all critical care services without on-site intensivist input (telemedicine excepted)	54.7%	9.5%	33.1%	5.1%
Intensivists are primarily consultants; hospitalist make major decisions throughout the day	25.0%	33.3%	31.1%	32.1%
Major decisions are made by an intensivist during daytime only; hospitalists provide the majority of care after hours	9.4%	30.9%	21.2%	31.4%
All major decisions are made by an intensivist 24:7	10.9%	26.3%	14.6%	31.4%
How many hours per day are board-certified intensivists immediately available (physically present in the ICU or nearby, not in clinic or out of the hospital)?				
0-4 hours	62.5%	19.3%	46.4%	10.9%
5-8 hours	10.9%	22.2%	19.2%	20.5%
9-14 hours	10.9%	26.7%	17.2%	29.5%
15-23 hours	3.1%	3.3%	3.3%	3.2%
24 hours	12.5%	28.4%	13.9%	35.9%

NOTE: *P* values (χ^2 or Fisher exact tests) for associations comparing rural versus nonrural and nonacademic versus academic were <.001 for all items shown. Abbreviations: BCI, board-certified intensivists; ICU, intensive care unit.

Sixty-seven percent of hospitalists who served as primary physicians for ICU patients in any setting reported at least moderate difficulty arranging transfers to higher levels of care.

Objective 2: Identifying the Practice Gap

Hospitalists' perceptions of practicing critical care beyond their skill level and without sufficient board-certified intensivist support varied by both practice location and practice type (Table 3). In marked contrast to nonrural hospitalists, 43% of rural hospitalists reported feeling expected to practice beyond their perceived scope of expertise at least some of the time, and 31% reported never having sufficient board-certified intensivist support. Both these results were statistically significantly different when compared with nonrural hospitalists. When restricted to rural hospitalists who are primary providers for ICU patients, 90% reported that board-certified intensivist support was at least occasionally insufficient.

There were similar discrepancies between academic and nonacademic respondents. Forty-two percent of respondents practicing in nonacademic settings reported being expected to practice beyond their scope at least some of the time, and 18% reported that intensivist support was never sufficient. This contrasts with academic hospitalists, of whom 35% reported feeling expected to practice outside their scope, and less than 4% reported the available support from intensivists was never sufficient. For comparisons of academic and nonacademic respondents, only perceptions of sufficient board-certified intensivist support reached statistical significance (Table 3).

The role of intensivists in making management decisions and the strategy for ventilator management decisions correlated significantly with perception of intensivist support ($P < .001$) but not with the perception of practicing beyond one's scope. The number of ventilated patients did not correlate significantly with either perception of intensivist support or of being expected to practice beyond scope.

Difficulty transferring patients to a higher level of care was the only attribute that significantly correlated with hospitalists' perceptions of having to practice beyond their skill level ($P < .05$; Table 3). Difficulty of transfer was also significantly associated with perceived adequacy of board-certified intensivist support ($P < .001$). Total hours of intensivist coverage, intensivist role in decision making, and ventilator management arrangements also correlated significantly with the perceived adequacy of board-certified intensivist support ($P < .001$ for all; Table 3).

Objective 3: Assessing Interest in Critical Care Education

More than 85% of respondents indicated interest in obtaining additional critical care training and some form of certification short of fellowship training. Preferred modes of content delivery included courses or precourses at national meetings, academies, or online modules. Hospitalists in smaller communities indicated preference for online resources.

DISCUSSION

This survey of a large national cohort of hospitalists from diverse practice settings validates previous studies suggesting that hospitalists deliver critical care services, most notably in community and rural hospitals.[13] A substantial subset of our respondents represented rural practice settings, which allowed us to compare rural and nonrural hospitalists as well as those practicing in academic and nonacademic settings. In assessing both the objective services that hospitalists provided as

TABLE 3. **Factors Associated with Feeling Expected to Practice out of Scope and Sufficiency of Intensivist Support**

	I feel I am expected to practice beyond my scope of expertise when caring for ICU patients:					The intensity of board-certified intensivist support in my hospital is sufficient to support my care of ICU patients:				
Factors	**Never**	**Rarely**	**Sometimes**	**Most times**	**All of the time**	**Never**	**Rarely**	**Sometimes**	**Most times**	**All of the time**
Practice setting			**NS**					***P* value for association <.001**		
Rural	16.4%	41.0%	39.3%	3.3%	0%	31.1%	4.9%	16.4%	36.1%	11.5%
Nonrural	22.0%	40.5%	26.3%	6.5%	4.7%	5.2%	4.3%	15.5%	44.0%	31.0%
Practice type			**NS**					***P* value for association <.001**		
Nonacademic	17.9%	40.0%	33.1%	6.9%	2.1%	17.9%	5.5%	17.2%	39.3%	20.0%
Academic	23.6%	41.2%	25.0%	4.7%	5.4%	3.4%	3.4%	14.2%	45.3%	33.8%
Intensivist hours per day			**NS**					***P* value for association <.001**		
0-4 hours	15.3%	19%	17.1%	37.5%	30.6%	32.9%	4.7%	22.4%	30.6%	9.4%
5-8 hours	19.0%	41.4%	25.9%	5.2%	8.6%	1.7%	5.2%	17.2%	51.7%	24.1%
9-14 hours	17.1%	44.3%	28.6%	7.1%	2.9%	0%	2.9%	21.4%	50.0%	25.7%
15-23 hours	37.5%	50.0%	12.5%	0%	0%	12.5%	0%	0%	75.0%	12.5%
All 24 hours	30.6%	34.7%	22.2%	8.3%	4.2%	1.4%	5.6%	2.8%	37.5%	52.8%
Intensivist management decisions			**NS**					***P* value for association <.001**		
No on-site intensivist	25.5%	35.4%	63.4%	3.6%	0%	50.9%	7.3%	9.1%	21.8%	10.9%
Intensivist are primarily consultants, hospitalists make major decisions	19.1%	42.6%	29.8%	4.3%	4.3%	1.1%	6.4%	23.4%	45.7%	23.4%
Major decisions made by intensivist during daytime; hospitalists provide care after hours	15.6%	42.9%	32.5%	5.2%	3.9%	1.3%	3.9%	18.2%	55.8%	20.8%
All major decisions by intensivists 24:7	24.5%	40.3%	17.9%	10.4%	6.0%	1.5%	0%	7.5%	38.8%	52.2%
Ventilator management			**NS**					***P* value for association <.001**		
RT independently manage vents	37.5%	37.5%	25.0%	0%	0%	50.0%	0%	0%	50.0%	0%
BCI manage all vents	24.1%	43.3%	24.8%	4.3%	3.5%	2.1%	2.1%	13.5%	47.5%	34.8%
Hospitalists manage some vents	18.1%	38.9%	30.6%	11.1%	1.4%	1.4%	4.2%	26.4%	47.2%	20.8%
Only hospitalist with specialized interest and/or training manage vents	21.7%	39.1%	30.4%	4.3%	4.3%	13.0%	4.3%	21.7%	39.1%	21.7%
Hospitalists manage all ventilators	12.2%	36.7%	38.8%	4.1%	8.2%	40.8%	12.2%	6.1%	20.4%	20.4%
Difficulty of transfer			***P* value for association =.039**					***P* value for association <.001**		
Easy	17.8%	53.3%	24.4%	4.4%	0%	11.1%	0%	4.4%	48.9%	35.6%
Moderately difficult	16.2%	35.3%	38.2%	5.9%	4.4%	17.6%	8.8%	25.0%	33.8%	14.7%
Difficult	8.3%	25.0%	41.7%	12.5%	12.5%	16.7%	12.5%	25%	33.3%	12.5%

NOTE: *P* values are χ^2 Fisher exact test for associations. Abbreviations: BCI, board-certified intensivists; ICU, intensive care unit; NS, not significant; RT, respiratory therapists.

well as their subjective perceptions of how they practiced, we could correlate factors associated with the sense of practicing beyond one's skill or feeling inadequately supported by board-certified intensivists.

More than a third of responding hospitalists who practiced in the ICU reported that they practiced beyond their self-perceived skill level, and almost three-fourths indicated that they practiced without consistent or adequate board-certified inten-

sivist support. Rural and nonacademic hospitalists were far more likely to report delivering critical care beyond their comfort level and having insufficient board-certified intensivist support.

Calls for board-certified intensivists to deliver critical care to all critically ill patients do not reflect the reality in many American hospitals and, either by intent or by default, hospitalists have become the major and often sole providers of critical care services in many hospitals without robust intensivist support. We suspect that this phenomenon has been consistently underreported in the literature because academic hospitalists generally do not practice critical care.[15]

Many potential solutions to the intensivist shortage have been explored. Prior efforts in the United States have focused largely on care standardization and the recruitment of more trainees into existing critical care training pathways.[16] Other countries have created multidisciplinary critical care training pathways that delink critical care from specific subspecialty training programs.[17] Another potential solution to ensure that critically ill patients receive care from board-certified intensivists is to regionalize critical care such that the sickest patients are consistently transferred to referral centers with robust intensivist staffing.[1,18] While such an approach has been effectively implemented for trauma patients[7], it has yet to materialize on a systemic basis for other critically ill cohorts. Moreover, our data suggest that hospitalists who attempt to transfer patients to higher levels of critical care find doing so burdensome and difficult.

Our surveyed hospitalists overwhelmingly expressed interest in augmenting their critical care skills and knowledge. However, most existing critical care educational offerings are not optimized for hospitalists, either focusing on very specific skills or knowledge (eg, procedural techniques or point-of-care ultrasound) or providing entry-level or very foundational education. None of these offerings provide comprehensive, structured training schemas for hospitalists who need to evolve beyond basic critical care skills to manage critically ill patients competently and consistently for extended periods of time.

Our study has several limitations. First, we estimate that about 10% of invited participants responded to this survey, but as respondents could forward the survey via professional networks, this is only an estimate. It is possible but unlikely that some respondents could have completed the survey more than once. Second, because our analysis identified only associations, we cannot infer causality for any of our findings. Third, the questionnaire was not designed to capture the acuity threshold at which point each respondent would prefer to transfer their patients into an ICU setting or to another institution for assistance in critical care management. We recognize that definitions and perceptions of patient acuity vary markedly from one hospital to the next, and a patient who can be comfortably managed in a floor setting in one hospital may require ICU care in a smaller or less well-resourced hospital. Practice patterns relating to acuity thresholds could have a substantial impact both on critical care patient volumes and on provider perceptions and, as such, warrant further study.

Finally, as respondents participated voluntarily, our sample may have overrepresented hospitalists who practice or are interested in critical care, thereby overestimating the scope of the problem and hospitalists' interest in nonfellowship critical care training and certification. However, this seems unlikely given that, relative to SHM's annual survey, we overrepresented hospitalists from academic and large community medical centers who generally provide less critical care than other hospitalists.[13] Provided that roughly 85% of the estimated 50,000 American hospitalists practice outside of academic medical centers,[13] perhaps as many as 37,000 hospitalists regularly deliver care to critically ill patients in ICUs. In light of the evolving intensivist shortage,[4,5] this number seems likely to continue to grow. Whatever biases may exist in our sample, it is evident that a substantial number of ICU patients are managed by hospitalists who feel unprepared and undersupported to perform the task.

Without a massive and sustained increase in the number of board-certified intensivists or a systemic national plan to regionalize critical care delivery, hospitalists will continue to practice critical care, frequently with inadequate knowledge, skills, or intensivist support. Fortunately, these same hospitalists appear to be highly interested in augmenting their skills to care for their critically ill patients. The HM and critical care communities must rise to this challenge and help these providers deliver safe, appropriate, and high-quality care to their critically ill patients.

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Transitioning from General Pediatric to Adult-Oriented Inpatient Care: National Survey of US Children's Hospitals

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BACKGROUND: Hospital charges and lengths of stay may be greater when adults with chronic conditions are admitted to children's hospitals. Despite multiple efforts to improve pediatric-adult healthcare transitions, little guidance exists for transitioning inpatient care.

OBJECTIVE: This study sought to characterize pediatric-adult inpatient care transitions across general pediatric services at US children's hospitals.

DESIGN, SETTING, AND PARTICIPANTS: National survey of inpatient general pediatric service leaders at US children's hospitals from January 2016 to July 2016.

MEASUREMENTS: Questionnaires assessed institutional characteristics, presence of inpatient transition initiatives (having specific process and/or leader), and 22 inpatient transition activities. Scales of highly correlated activities were created using exploratory factor analysis. Logistic regression identified associations between institutional characteristics, transition activities, and presence of an inpatient transition initiative.

RESULTS: Ninety-six of 195 children's hospitals responded (49.2% response rate). Transition initiatives were present at 38% of children's hospitals, more often when there were dual-trained internal medicine–pediatrics providers or outpatient transition processes. Specific activities were infrequent and varied widely from 2.1% (systems to track youth in transition) to 40.5% (addressing potential insurance problems). Institutions with initiatives more often consistently performed the majority of activities, including using checklists and creating patient-centered transition care plans. Of remaining activities, half involved transition planning, the essential step between readiness and transfer.

CONCLUSIONS: Relatively few inpatient general pediatric services at US children's hospitals have leaders or dedicated processes to shepherd transitions to adult-oriented inpatient care. Across institutions, there is a wide variability in performance of activities to facilitate this transition. Feasible process and outcome measures are needed. *Journal of Hospital Medicine* 2018;13:13-20.

Over 90% of children with chronic diseases now survive into adulthood.[1,2] Clinical advances overcoming diseases previously fatal in childhood create new challenges for health systems with limited capacity to manage young adults with complicated and unfamiliar childhood-onset conditions. Consequently, improving the transition from pediatric to adult-oriented care has become a national priority.

Although major pediatric-adult transition initiatives—such as the Six Core Elements Framework,[3] a technical brief from the Agency for Healthcare Research and Quality,[4] and joint statements from major medical societies[5,6]—outline key transition recommendations generally and for outpatients, they contain limited or no guidance specifically devoted to transitioning inpatient hospital care from pediatric to adult-oriented settings. Key unknowns include whether, when, and how to transition inpatient care from children's to nonchildren's hospitals and how this can be integrated into comprehensive youth-adult transition care.

Nevertheless, the number of discharges of 18- to 21-year-old patients with chronic conditions admitted to children's hospitals is increasing at a faster rate than discharges of other age groups,[7] suggesting both that the population is growing in size and that there are important barriers to transitioning these patients into nonchildren's hospital settings. Spending on adult patients 18 years or older admitted to children's hospitals has grown to $1 billion annually.[8] Hospitalizations are a commonly proposed outcome measure of pediatric-adult transition work.[1,9,10] For example, higher rates of avoidable hospitalizations during early adulthood have been observed for 15- to 22-year-olds with kidney

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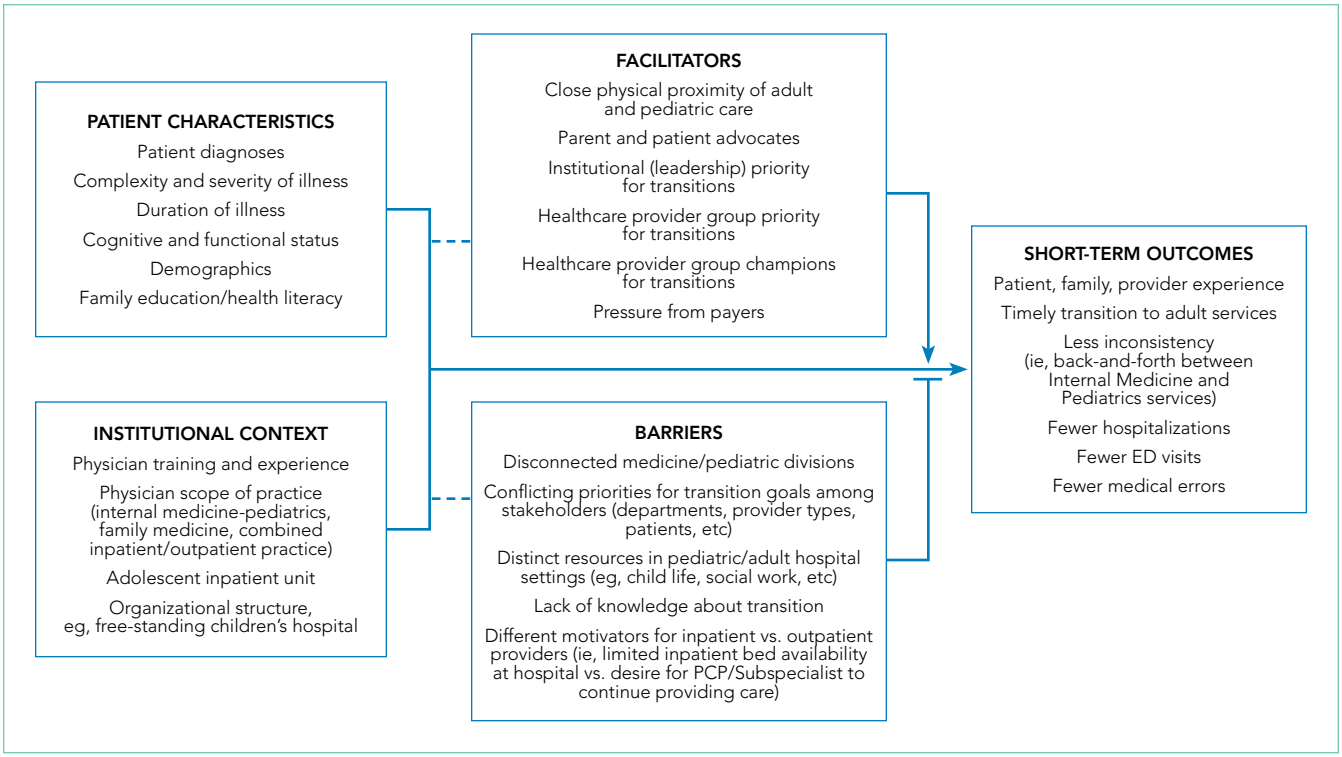

FIG. Conceptual framework of factors influencing pediatric to adult inpatient transition initiative—design and implementation. As a part of an institutional quality improvement initiative, a multidisciplinary team of pediatric and internal medicine healthcare providers, as well as parents and patients, developed a consensus-based conceptual framework of key patient and institutional determinants of a formal inpatient transition initiative within a children's hospital. Abbreviation: ED, emergency department.

failure cared for exclusively in adult-oriented facilities and during the years immediately after transfer to adult care.[11]

While research is beginning to describe outcomes of adult-aged patients with childhood-onset chronic conditions admitted to children's hospitals,[7,12,13] there has been no comprehensive description of efforts within children's hospitals to transition such patients into adult-oriented inpatient settings. This information is necessary to outline institutional needs, delineate opportunities for improvement, and help clinicians strategically organize services for patients requiring this transition.

We sought to characterize the current state of the transition from pediatric- to adult-oriented inpatient care across general pediatric inpatient services at US children's hospitals. We hypothesized that only a limited and inconsistent set of activities would be practiced. We also hypothesized that institutions having formal outpatient transition processes or providers with specialization to care for this age group, such as dual-trained internal medicine–pediatrics (med–peds) physicians, would report performing more activities.

METHODS

Study Design, Setting, Participants

We conducted a national survey of leaders of inpatient general pediatrics services at US children's hospitals from January 2016 to July 2016. Hospitals were identified using the online Children's Hospital Association directory. Hospitals without inpatient general pediatrics services (eg, rehabilitation or subspecialty-only facilities) were excluded.

We identified a single respondent from each of the 195 remaining children's hospitals using a structured protocol. Phone numbers and e-mail addresses of potential respondents were gathered from hospital or medical school directories. Following a standard script, study team members contacted potential respondents to describe the purpose of the study and to confirm their contact information. Hospitals were also allowed to designate a different individual with more specific expertise to participate, when relevant (eg, specific faculty member leading a related quality improvement initiative). The goal was to identify a leader of inpatient care with the most knowledge of institutional practices related to the transition to adult inpatient care. Examples of respondent roles included director of inpatient pediatrics, chief of hospital medicine or general pediatrics, medical director, and similar titles.

Survey Elements

As part of a larger quality improvement initiative at our institution, a multidisciplinary team of pediatric and internal medicine healthcare providers (physicians, nurse practitioners, nurses, case managers, social workers, child life specialists), as well as parents and patients, developed an "ideal state" with this transition and a consensus-based conceptual framework of key patient and institutional determinants of a formal inpatient transition initiative for children with chronic conditions within a children's hospital (Figure). Based on this model, we developed a novel survey instrument to assess the current state of inpatient transition from general services across US children's hospi-

TABLE 1. **Inpatient Transition Activities[a] Assessed across US Children's Hospitals**

Six Core Elements	Specific Inpatient Transition Activities
Policy	Transition policy that includes the inpatient transition
Tracking and monitoring	Proactive identification of patients anticipated to need inpatient transition Proactive identification of patients overdue for inpatient transition Presence of a system to track and monitor youth in the inpatient transition process
Readiness	Formal assessment of transition readiness Transition timing discussed with families Transition education provided to families Communication differences between pediatric and internal medicine providers reviewed with families
Planning	Transition care plan created with needs and long-term therapeutic goals Transition care plan provided to the patient/family Care conference between pediatric and internal medicine providers Agreement on inpatient transition timing achieved between primary care and subspecialists Agreement on inpatient transition timing achieved among subspecialists Ability for medical decision-making established Insurance problems addressed Patient/family informed subsequent stays will be at adult inpatient facility Adult inpatient facility toured
Transfer of care	Standardized handoff communicated between pediatric and internal medicine providers Transition checklist used to complete tasks Patient/family meet inpatient adult care team
Transfer completion	Pediatric providers and patient/family interaction during first nonpediatric stay Child life consult during first nonpediatric stay

[a]As part of a larger quality improvement initiative at our institution, a multidisciplinary team developed an ideal-state inpatient transition experience for children with chronic conditions within a children's hospital. To facilitate description, these were categorized using labels from the Six Core Elements Framework.

tals. The instrument was refined and finalized after pilot testing with 5 pediatricians not involved in the study, at 3 institutions. Refinements centered on questionnaire formatting, ie, clarifying instructions, definitions, and question stems to minimize ambiguity and improve efficiency when completing the survey.

Institutional Context and Factors Influencing Inpatient Transitions

The following hospital characteristics were assessed: administrative structure (free-standing, hospital-within-hospital, or "free-leaning," ie, separate physical structure but same administrative structure as a general hospital), urban versus rural, academic versus nonacademic, presence of an inpatient adolescent unit, presence of subspecialty admitting services, and providers with med–peds or family medicine training. The following provider group characteristics were assessed: number of full-time equivalents (FTEs), scope of practice (inpatient only, combination inpatient/outpatient), proportion of providers at a "senior" level (ie, at least 7 years posttraining or at an associate professor rank), estimated number of discharges per week, and proportion of patients cared for without resident physicians.

Inpatient Transition Initiative

Each institution was categorized as having or not having an inpatient transition initiative by whether they indicated having either (1) an institutional leader of the transition from pediatric to adult-oriented inpatient settings or (2) an inpatient transition process, for which "process" was defined as "a standard, organized, and predictable set of transition activities that may or may not be documented, but the steps are generally agreed upon."

Specific Inpatient Transition Activities

Respondents indicated whether 22 activities occurred consistently, defined as at least 50% of the time. To facilitate description, activities were grouped into categories using the labels from the Six Core Elements framework[3] (Table 1): Policy, Tracking and Monitoring, Readiness, Planning, Transfer of Care, and Transfer Completion. Respondents were also asked whether outpatient pediatric-adult transition activities existed at their institution and whether they were linked to inpatient transition activities.

Data Collection

After verifying contact information, respondents received an advanced priming phone call followed by a mailed request to participate with a printed uniform resource locator (URL) to the web survey. Two email reminders containing the URL were sent to nonresponders at 5 and 10 days after the initial mailing. Remaining nonresponders then received a reminder phone call, followed by a mailed paper copy of the survey questionnaire to be completed by hand approximately 2 weeks after the last emailed request. The survey was administered using the Qualtrics web survey platform (www.qualtrics.com). Data collection occurred between January 2016 and July 2016. Participants received a $20 incentive.

TABLE 2. **Respondent and Institutional Characteristics of General Pediatrics Services at US Children's Hospitals**

			Inpatient Transition Initiative				
	Overall		Yes (n = 37)		No (n = 59)		
Respondent and Institutional Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	***P***
Respondent role							
Division director	36	41	13	39	23	43	.47
Medical director	22	25	7	21	15	28	
Department chair	6	7	3	9	3	6	
Delegate	15	17	5	15	10	19	
Other	8	9	5	15	3	6	
Children's hospital administrative structure							
Free-standing	31		16	49	15		.14
Free-leaning	19	36	5	15	14	28	
Hospital-within-hospital	37	22	12	36	25	26	
		43				46	
Academic medical center							
Yes	68	78	28	85	40	74	.29
Urban versus rural							
Urban	76	88	30	91	46	87	.74
Inpatient provider FTE							
<5	18	21	6	18	12	22	.55
6 to 10	31	36	10	30	21	39	
11 or more	38	44	17	52	21	39	
Estimated weekly discharges							
<25	20	23	7	22	13	24	.51
25 to 50	38	44	12	38	26	48	
51 or more	28	33	13	41	15	28	
Provider experience (proportion senior)							
0%-19%	17	20	4	12	13	24	.63
20%-39%	27	31	10	30	17	32	
40%-59%	24	28	11	33	13	24	
60%-79%	11	13	4	12	7	13	
80%-100%	8	9	4	12	4	7	
Inpatient provider scope							
Inpatient only	61	71	23	70	38	72	.37
Mixed (inpatient/outpatient) only	3	4	0	0	3	6	
Combination inpatient/mixed	22	26	10	30	12	23	
Inpatient service scope							
All admitted to a generalist	25	29	11	33	14	26	.47
Some admitted to subspecialist	62	71	22	67	40	74	
Providers with adult-oriented training							
Med–peds	35	40	18	55	17	32	.04
Family medicine	3	4	2	6	1	2	.55
Specific adult-oriented hospital for transition							
Yes	36	42	16	50	20	38	.41
Inpatient adolescent unit							
Yes	11	13	7	21	4	7	.09
Patients cared for without residents							
0%-19%	60	69	23	70	37	69	.37
20%-59%	14	16	7	21	7	13	
60%-100%	13	15	3	9	10	19	
Outpatient transition process							
Yes	41	45	24	71	17	29	.001

NOTE: Abbreviations: FTE, full-time equivalent; med–peds, dual-trained internal medicine–pediatrics.

Statistical Analysis

Descriptive statistics summarized the current state of inpatient transition at general pediatrics services across US children's hospitals. Exploratory factor analysis assessed whether individual activities were sufficiently correlated to allow grouping items and constructing scales. Differences in institutional or respondent characteristics between hospitals that did and did not report having an inpatient initiative were compared using t tests for continuous data. Fisher's exact test was used for categorical data because some cell sizes were ≤5. Bivariate logistic regression quantified associations between presence versus absence of specific transition activities and presence versus absence of an inpatient transition initiative. Analyses were completed in STATA (SE version 14.0; StataCorp, College Station, Texas). The institutional review board at our institution approved this study.

RESULTS

Responses were received from 96 of 195 children's hospitals (49.2% response rate). Responding institution characteristics are summarized in Table 2. Free-standing children's hospitals made up just over one-third of the sample (36%), while the remaining were free-leaning (22%) or hospital-within-hospital (43%). Most children's hospitals (58%) did not have a specific adult-oriented hospital identified to receive transitioning patients. Slightly more than 10% had an inpatient adolescent unit. The majority of institutions were academic medical centers (78%) in urban locations (88%). Respondents represented small (<5 FTE, 21%), medium (6-10 FTE, 36%), and large provider groups (11+ FTE, 44%). Although 70% of respondents described their groups as "hospitalist only," meaning providers only practiced inpatient general pediatrics, nearly 30% had providers practicing inpatient and outpatient general pediatrics. Just over 40% of respondents reported having med–peds providers. Pediatric-adult transition processes for outpatient care were present at 45% of institutions.

Transition Activities

Thirty-eight percent of children's hospitals had an inpatient transition initiative using our study definition—31% by having a set of generally agreed upon activities, 19% by having a leader, and 11% having both. Inpatient transition leaders included pediatric hospitalists (43%), pediatric subspecialists and primary care providers (14% each), med–peds providers (11%), or case managers (7%). Respondent and institutional characteristics were similar at institutions that did and did not have an inpatient transition initiative (Table 2); however, children's hospitals with inpatient transition initiatives more often had med–peds providers (P = .04). Institutions with pediatric-adult outpatient care transition processes more often had an inpatient initiative (71% and 29%, respectively; P = .001).

Exploratory factor analysis identified 2 groups of well-correlated items, which we grouped into "preparation" and "transfer initiation" scales (supplementary Appendix). The preparation scale was composed of the following 5 items (Cronbach α = 0.84): proactive identification of patients anticipated to need transition, proactive identification of patients overdue for transition, readiness formally assessed, timing discussed with family, and patient and/or family informed that the next stay would be at the adult facility. The transfer initiation scale comprised the following 6 items (Cronbach α = 0.72): transition education provided to families, primary care–subspecialist agreement on timing, subspecialist–subspecialist agreement on timing, patient decision-making ability established, adult facility tour, and standardized handoff communication between healthcare providers. While these items were analyzed only in this scale, other activities were analyzed as independent variables. In this analysis, 40.9% of institutions had a preparation scale score of 0 (no items performed), while 13% had all 5 items performed. Transfer initiation scale scores ranged from 0 (47%) to 6 (2%).

Specific activities varied widely across institutions, and none of the activities occurred at a majority of children's hospitals (Table 3). Only 11% of children's hospital transition policies referenced transitions of inpatient care. The activity most commonly reported across children's hospitals was addressing potential insurance problems (41%). The least common inpatient transition activities were having child life consult during the first adult hospital stay (6%) or having a system to track and monitor youth in the inpatient transition process (2%). Transition processes and policies were relatively new among institutions that had them—average years an inpatient transition process had been in place was 1.2 (SD 0.4), and average years with a transition policy, including inpatient care, was 1.3 (SD 0.4).

Transition Activities at Hospitals With and Without an Inpatient Transition Initiative

Most activities assessed in this study (both scales plus 5 of 11 individual activities) were significantly more common in children's hospitals with an inpatient transition initiative (Table 3). The most common activity was addressing potential insurance problems (46%), and the least common activity was having a system to track and monitor youth in the inpatient transition process (3%). The majority of institutions without an inpatient transition initiative (53%) performed 0 transfer initiation scale items. Large effect sizes between hospitals with and without a transition initiative were observed for use of a checklist to complete tasks (odds ratio [OR] 9.6, P = .04) and creation of a transition care plan (OR 9.0, P = .008). Of the 6 activities performed at similarly low frequencies at institutions with and without an initiative, half involved transition planning, the essential step after readiness but before actual transfer of care.

DISCUSSION

We conducted the first national survey describing the policies and procedures of the transition of general inpatient care from children's to adult-oriented hospitals for youth and young adults with chronic conditions. Our main findings demonstrate that a relatively small number of general inpatient services at children's hospitals have leaders or dedicated processes to shepherd this transition, and a minority have a specific adult hospital identified to receive their patients. Even among institutions with inpatient transition initiatives, there is wide variabil-

TABLE 3. **Current Inpatient Transition Activities within General Pediatrics Services at US Children's Hospitals**

	Inpatient Transition Initiative					
	Yes (n = 37)		No (n = 59)			
Inpatient Transition Activities	n	%	n	%	**OR**	**95% CI**
Policy						
Formal policy includes inpatient transitions	8	24	2	4	8.3	1.6-41.9
Tracking and monitoring						
System to track and monitor youth in inpatient transition process	1	3	1	2	1.6	0.1-27.0
Readiness						
Family educated about communication differences in internal medicine	8	24	5	9	3.1	0.9-10.6
Preparation Scale[a]						
0 items	10	31	26	46	Ref	
1	4	13	11	20	0.9	0.2-3.7
2	2	6	4	7	1.3	0.2-8.2
3	3	9	8	14	1.0	0.2-4.4
4	6	19	3	5	5.2	1.1-24.9
5	7	22	4	7	4.6	1.1-19.0
Planning						
Transition care conference between pediatric and adult providers	4	12	2	4	3.7	0.6-21.6
Insurance problems addressed	15	46	21	38	1.4	0.6-3.3
Transition care plan with patient needs and long-term therapeutic goals created	8	25	2	4	9.0	1.8-45.6
Summary of the transition care plan provided to the patient/family	6	19	5	9	2.4	0.7-8.4
Transfer of care						
Transfer Initiation Scale[b]						
0 items	12	36	29	53	Ref	
1	4	12	12	22	0.8	0.2-3.0
2	5	15	7	13	1.7	0.5-6.5
3	7	21	3	6	5.6	1.2-25.5
4	2	6	4	7	1.2	0.2-7.5
5	1	3	0	0	n/a	n/a
6	2	6	0	0	n/a	n/a
Patient/family meet inpatient adult care team	9	27	3	6	6.4	1.6-25.7
Transition checklist used to complete tasks	5	15	1	2	9.6	1.1-86.6
Transfer completion						
Pediatric provider and patient/family interaction during first nonpediatric stay	6	18	2	4	5.9	1.1-31.2
Child life consulted during the first nonpediatric stay	1	3	4	7	0.4	0.0-3.7

[a]Preparation Scale: proactive identification of patients anticipated to need transition, proactive identification of patients overdue for transition, readiness formally assessed, timing discussed with family, and patient/family informed the next stay would be at the adult facility.

[b]Transfer Initiation Scale: transition education provided to families, primary care–subspecialist agreement on timing, subspecialist–subspecialist agreement on timing, patient decision-making ability established, adult facility tour, and standardized handoff communication between healthcare providers.

NOTE: Abbreviations: CI, confidence interval; n/a, not applicable; OR, odds ratio; Ref, reference.

ity in the performance of activities to facilitate transitioning out of US children's hospitals. In these institutions, performance seems to be more lacking in later links of the transition chain. Results from this work can serve as a baseline and identify organizational needs and opportunities for future work.

Children's hospital general services with and without an inpatient pediatric-adult transition initiative had largely similar characteristics; however, the limited sample size may lack power to detect some differences. Perhaps not surprisingly, having med–peds providers and outpatient transition processes were the characteristics most associated with having an inpatient pediatric-adult transition initiative. The observation that over 70% of hospitals with an outpatient process had an inpatient transition leader or dedicated process makes us optimistic that as general transition efforts expand, more robust inpatient transition activities may be achievable.

We appreciate that the most appropriate location to care for hospitalized young adults with childhood-onset chronic conditions is neither known nor answered with this study. Both options face challenges—adult-oriented hospitals may not be equipped to care for adult manifestations of childhood-onset conditions,[14,15] while children's hospitals may lack the resources and expertise to provide comprehensive care to adults.[7] Although hospital charges and lengths of stay may be greater when adults with childhood-onset chronic conditions are admitted to children's compared with adult hospitals,[12,13,16] important confounders such as severity of illness could explain why adult-aged patients may both remain in children's hospitals at older ages and simultaneously have worse outcomes than peers. Regardless, at some point, transitioning care into an adult-oriented hospital may be in patients' best interests. If so, families and providers need guidance on (1) the important aspects of this transition and (2) how to effectively implement the transition.

Because the most important inpatient transition care activities are not empirically known, we designed our survey to assess a broad set of desirable activities emerging from our multidisciplinary quality improvement work. We mapped these activities to the categories used by the Six Core Elements framework.[3] Addressing insurance issues was one of the most commonly reported activities, although still fewer than 50% of hospitals reported addressing these problems. It was notable that the majority of institutions without a transition initiative performed none of the transfer initiation scale items. In addition, 2 features of transition efforts highlighted by advocates nationally—use of a checklist and creation of a transition care plan— were 9 times more likely when sites had transition initiatives. Such findings may be motivating for institutions that are considering establishing a transition initiative. Overall, we were not surprised with hospitals' relatively low performance across most transition activities because only about 40% of US families of children with special healthcare needs report receiving the general services they need to transition to adult healthcare.[17]

We suspect that a number of the studied inpatient transition activities may be uncommon for structural reasons. For example, having child life consultation during an initial adult stay was rare. In fact, we observed post hoc that it occurred only in hospital-within-hospital systems, an expected finding because adult-only facilities are unlikely to have child life personnel. Other barriers, however, are less obviously structural. Almost no respondents indicated providing a tour of an adult facility, which was true whether the children's hospital was free-standing or hospital-within-hospital. Given that hospitals with med–peds providers more often had inpatient transition initiatives, it would be interesting to examine whether institutions with med–peds training programs are able to overcome more of these barriers because of the bridges inherently created between departments even when at physically separated sites.

Having a system to track and/or monitor youth going through the transition process was also uncommon. This presumably valuable activity is one of the Six Core Elements[3] and is reminiscent of population management strategies increasingly common in primary care.[18] Pediatric hospitalists might benefit from adopting a similar philosophy for certain patient populations. Determining whether this activity would be most appropriately managed by inpatient providers versus being integrated into a comprehensive tracking and/or monitoring strategy (ie, inpatient care plus primary care, subspecialty care, school, employment, insurance, etc.) is worth continued consideration.

Although the activities we studied spanned many important dimensions, the most important transition activities in any given context may differ based on institutional resources and those of nearby adult healthcare providers.[16] For example, an activity may be absent at a children's hospital because it is already readily handled in primary care within that health system. Understanding how local resources and patient needs influence the relationship between transition activities and outcomes is an important next step in this line of work. Such research could inform how institutions adapt effective transition activities (eg, developing care plans) to most efficiently meet the needs of their patients and families.

Our findings align with and advance the limited work published on this aspect of transition. A systematic literature review of general healthcare transition interventions found that meeting adult providers prior to transitioning out of the pediatric system was associated with less concern about admission to the adult hospital floor.[9] Formally recognizing inpatient care as a part of a comprehensive approach to transition may help adults with childhood-onset chronic conditions progress into adult-oriented hospitals. Inpatient and outpatient providers can educate one another on critical aspects of transition that span across settings. The Cystic Fibrosis (CF) Foundation has established a set of processes to facilitate the transition to adult care and specifically articulates the transfer to adult inpatient settings.[19,20] Perhaps as a result, CF is also one of few conditions with fewer adult patients being admitted to children's hospitals[7] despite the increasing number of adults living with the condition.[19] Adapting the CF Foundation approach to other chronic conditions may be an effective approach.

Our study has important limitations. Most pertinently, the list of transition activities was developed at a single institution. Although drawing on accepted national guidelines and a diverse local quality improvement group, our listed activities could not be exhaustive. Care plan development and posttransition follow-up activities may benefit from ongoing development in subsequent work. Continuing to identify and integrate approaches taken at other children's hospitals will also be informative. For example, some children's hospitals have introduced adult medicine consultative services to focus on transition, attending children's hospital safety rounds, and sharing standard care protocols for adult patients still cared for in pediatric settings (eg, stroke and myocardial infarction).[16]

In addition, our findings are limited to generalist teams at children's hospitals and may not be applicable to inpatient subspecialty services. We could not compare differences in respondents versus nonrespondents to determine whether

important selection bias exists. Respondent answers could not be verified. Despite our attempt to identify the most informed respondent at each hospital, responses may have differed with other hospital respondents. We used a novel instrument with unknown psychometric properties. Our data provide only the children's hospital perspective, and perspectives of others (eg, families, primary care pediatricians or internists, subspecialists, etc.) will be valuable to explore in subsequent research. Subsequent research should investigate the relative importance and feasibility of specific inpatient transition activities, ideal timing, as well as the expected outcomes of high-quality inpatient transition. An important question for future work is to identify which patients are most likely to benefit by having inpatient care as part of their transition plan.

CONCLUSIONS

Nevertheless, the clinical and health services implications of this facet of transition appear to be substantial.[16] To meet the Maternal and Child Health Bureau (MCHB) core outcome for children with special healthcare needs to receive "the services necessary to make transitions to adult healthcare,"[21] development, validation, and implementation of effective inpatient-specific transition activities and a set of measurable processes and outcomes are needed. A key direction for the healthcare transitions field, with respect to inpatient care, is to determine the activities most effective at improving relevant patient and family outcomes. Ultimately, we advocate that the transition of inpatient care be integrated into comprehensive approaches to transitional care.

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Clinical Decision-Making: Observing the Smartphone User, an Observational Study in Predicting Acute Surgical Patients' Suitability for Discharge

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INTRODUCTION: An accurate and rapid assessment of an acutely unwell patient's clinical status is paramount for the physician. There is an increasing trend to rely on investigations and results to inform a clinician of a patient's clinical status, with the subtleties of clinical observation often ignored. The aim of this study was to determine if a patient's use of a smartphone during the initial clinical assessment by a surgical consultant could be used as a surrogate marker for patient well-being, represented as their suitability for same-day discharge.

METHODS: This was a prospective observational study performed over 2 periods at a tertiary hospital in South Australia. All patients admitted by junior surgical doctors from the emergency department to the acute surgical unit were eligible for inclusion. Upon consultant review, their status as a smartphone user was recorded in addition to their duration of hospital stay and basic demographic data. All patients and all but 1 of the consultants were blinded to the trial.

RESULTS: Two hundred and twenty-one patients were eligible for inclusion. Of these patients, 11.3% were observed to be using a smartphone and 23.5% of patients were discharged home on day 1. Those who were observed to be using a smartphone were 5.29 times more likely to be discharged home on day 1 and were less likely to be subsequently readmitted.

CONCLUSIONS: The addition of the smartphone sign to a surgeon's clinical acumen can provide yet another tool in aiding the decision for suitability for discharge. *Journal of Hospital Medicine* 2018;13:21-25. Published online first August 23, 2017. © 2018 Society of Hospital Medicine

The value placed on bedside clinical observation in the decision-making process of a patient's illness has been diminished by today's armamentarium of sophisticated technology. Increasing reliance is now placed on the result of nonspecific tests in preference to bedside clinical judgement in the diagnostic and management process. While diagnostic investigations have undoubtedly provided great advancements in medical care, they come at time and financial costs. Physicians should therefore continue to be encouraged to make clinical decisions based on their bedside assessment.

With hospital overcrowding a significant problem within the healthcare system and the expectation that it will worsen with an ageing population, identifying factors that predict patient suitability for discharge has become an important focus for clinicians.[1,2] There exists a paucity of literature predicting discharge suitability of general surgical patients admitted through the emergency department (ED). Furthermore, despite the extensive research into the effectiveness of discharge planning,[3] little research has been conducted to describe positive predictive indicators for discharge. Observations made during surgical rounds have led the authors to consider that individuals who are using a smartphone during their bedside assessment may be clinically well enough for discharge.

The aim of this study was to assess whether the clinical assessment of an acute surgical patient could be usefully augmented by the observation of the active use of smartphones (the smartphone sign) and whether this could be used as a surrogate marker to indicate a patient's well-being and suitability for same-day discharge from the hospital in acute surgical patients.

METHODS

Design and Setting

This was a prospective observational study performed over 2 periods at a tertiary hospital in South Australia, Australia. At our institution, acute surgical patients are admitted to the acute surgical unit (ASU) from the ED by junior surgical doctors. Patients are then reviewed by the on-call surgical consultant, who implements management plans or advises discharge on 2 occasions per day.

Participants

All patients admitted under the ASU were considered eligible for the study. Exclusion criteria included patients that (i) required immediate surgical intervention (defined as time of review to theatre of less than 4 hours) and (ii) had immediate admission to the intensive care unit.

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Consultant surgeons are employed within a general surgical subspecialty, including upper gastrointestinal, hepatobiliary, breast and endocrine, and colorectal. All surgeons from each team partake in the general surgery on-call roster. Each surgeon was included at least once within the observation periods. Experience of consultant surgeons ranged from 5 years of postfellowship experience to surgeons with more than 30 years of experience, with the majority having more than 10 years of postfellowship experience.

Patients were stratified into 2 distinct cohorts upon consultant review: smartphone positive (spP) was defined as a patient who was using a smartphone or who had their phone on their bed; a patient was classified as smartphone negative (spN) if they did not fulfil these criteria. The presence or absence of a smartphone was recorded by the authors, who were present on consultant ward rounds but not involved in the decision-making process of patient care. In order to minimize bias, only 1 surgeon (PGD) was aware that the study was being conducted and all patients were blinded to the study. Additional information that was collected included patient demographics, requirement for surgery, and length of stay (LOS). A patient who was discharged on the same day as the consultant review was considered to be discharged on day 1, all other patients were considered to have LOS greater than 1 day. Requirement for surgery was defined as a patient who underwent a surgical procedure in an operating suite. Thirty-day unplanned readmission rates for all patients were examined. Readmission to another public hospital within the state was also included within the readmission data.

Observation Periods

An initial 4-week pilot study was conducted to assess for a possible association between spP and same-day discharge. A second 8-week study period was undertaken 1 year later accounting for the employment of the authors at the study's institution. Unless stated, the results described are the accumulation of both study periods.

Statistical Analysis

As this is the first study of its kind, no prior estimates of numbers were known. After 2 weeks of data collection, data were analyzed in order to provide an estimate of the total number of patients required to provide a statistically valid result ($\alpha = 0.05$; power = 0.80). Sample size was calculated to be 40 subjects. It was agreed that in order to make the study as robust as possible, data should be collected for the 2 observation periods.

Demographic data are presented as means with standard deviations (SDs) or frequencies with percentages. A 2-sample Student t test was used to compare the age of spP and spN patients. A χ^2 test and logistic regressions were used to assess the association between smartphone status and patient demographics, LOS, and requirement for surgery. Results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). A P value of $<.05$ was considered significant. All data were analyzed by using R 3.2.3 (R Foundation for Statistical Computing, Vienna, Austria).

TABLE 1. **Demographic Data**

Characteristic	Period 1	Period 2
Patients	67	154
Male (%)	39 (58.2%)	90 (58.4%)
Mean age	44.9	52.6
spP (%)	13 (19.4%)	12 (7.8%)
Discharge day 1	21 (31.35%)	31 (20.1%)
Surgery	3 (4.5%)	57 (37.0%)

NOTE: Abbreviation: spP, smartphone positive.

RESULTS

During the 2 observation periods, a total of 227 eligible surgical admissions were observed with complete data for 221 patients. Six patients were excluded as their smartphone status was not recorded. The study sample represents our population of interest within an ASU, and we had complete data for 97.4% of participants with a 100% follow-up. There was no significant effect of study between the 2 observation periods ($\chi^2 = 140.19$; $P = .10$). The mean age of patients was 50.24 years. Further demographic data are presented in Table 1. Twenty-five (11.3%) patients were spP and 196 (88.7%) were spN. Fifty-two (23.5%) patients were discharged home on day 1, and 169 (76.5%) had admissions longer than 1 day (see Figure). Sixty (27%) patients underwent surgery during their admission. Twenty-two patients had unplanned readmissions; only 1 of these patients had been observed to be spP.

There was a statistically significant difference in ages between the spP and spN groups ($t = 8.40$; $P < .0005$), with the average age of spP patients being 31.84 years compared with 52.58 years for spN patients. There was no statistical difference between gender and smartphone status ($\chi^2 = 1.78$; $P = .18$; Table 2).

For those patients discharged home on day 1, there was a statistically significant association with being spP ($\chi^2 = 14.55$, $P = .0001$). Patients who were spP were 5.29 times more likely to be discharged on day 1 (95% CI, 2.24-12.84). Of the variables analyzed, only gender failed to demonstrate an effect on discharge home on day 1 (Table 3). Overall, the presence of a smartphone was found to have a sensitivity of 56.0% (95% CI, 34.93-75.60) and a specificity of 80.6% (95% CI, 74.37-85.90) in regard to same-day discharge. However, it was found to have a negative predictive value of 93.49% (95% CI, 88.65-96.71).

When examining readmission rates, only 4% of spP patients were readmitted versus 10.7% of spN patients. Accounting for variables, spP patients were 4 times less likely to be readmitted, though this was not statistically significant (OR 4.02; 95% CI, 0.43-37.2; $P = .22$). Furthermore, when examining only those patients discharged on day 1, smartphone status was not a predictor of readmission (OR 0.94; 95% CI, 0.06-15.2; $P = .97$).

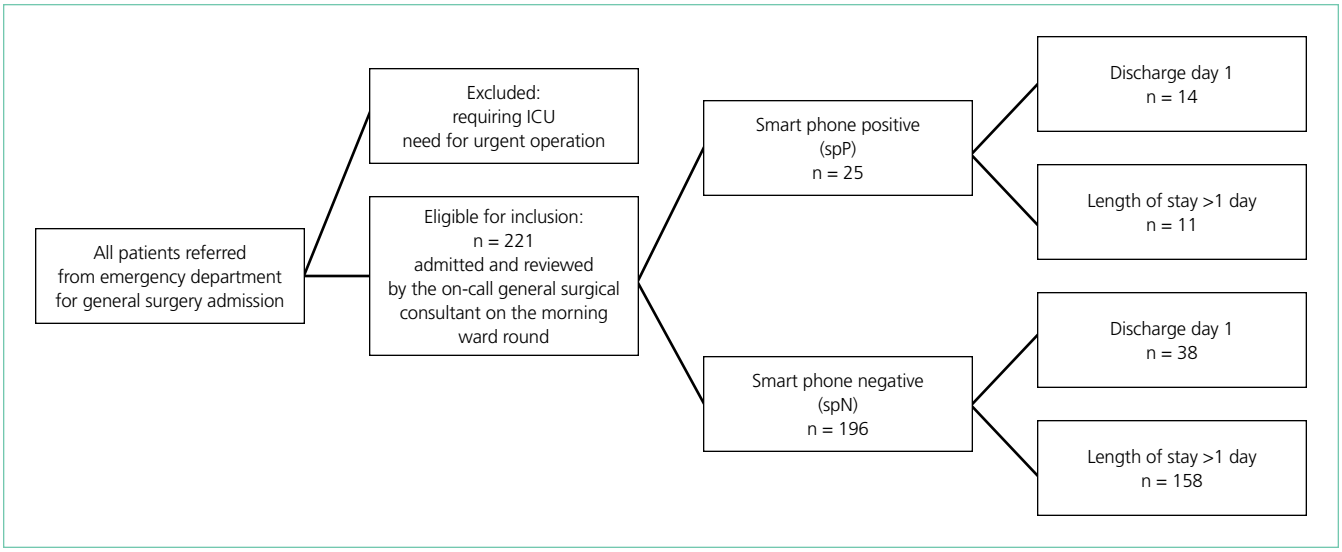

FIG. Patient pathway flow diagram.

NOTE: Abbreviations: ICU, intensive care unit; spP, smartphone positive; spN, smartphone negative.

TABLE 2. **Smartphone Positive and Negative According to Gender and Age**

Characteristics	spP	spN	P value
Male (%)	11 (44%)	118 (60.2%)	$\chi 2 = 1.78$; P = .18
Age	31.84	52.58	t = 8.40; P < .0005

NOTE: Abbreviations: spP, smartphone positive; spN, smartphone negative.

TABLE 3. **Statistical Analysis of those Discharged on Day 1**

Characteristics	Odds Ratio	95% CI
Sex	1.53	0.77-3.18
Age	0.98	0.96-1.00
Operation	1.64	0.046-0.46
spP	4.03	1.54-10.94

NOTE: Abbreviations: CI, confidence interval; spP, smartphone positive.

To mitigate the effect of age, analysis was conducted excluding those aged over 55 years (the previous retirement age in Australia), leaving 131 patients for analysis. The average age of spP patients was 31.8 years (SD 10.0) compared with 36.7 years (SD 10.9) for spN patients, representing a significant difference (t = 2.14; *P* = .04); 51.1% of patients were male, 19.1% of patients were spP, 26.0% of patients proceeded to an operation, the oldest spP was 51 years, and 29.0% of patients were discharged home on day 1. There was no difference in gender and smartphone status ($\chi^2 = 0.33$; *P* = .6). When analyzing those discharged on day 1, again spP patients were more likely to be discharged home ($\chi^2 = 9.4$; *P* = .002), and spP patients were 3.6 times more likely to be discharged home on day 1.

There were 4 spP patients who underwent an operation. Two patients had an incision and drainage of a perianal abscess, 1 patient underwent a laparotomy for an internal hernia after recently undergoing a Roux-en-Y gastric bypass at another hospital, and the final patient underwent a laparoscopic appendicectomy. One of these patients was still discharged home on day 1.

DISCUSSION

As J. A. Lindsay[4] said, "For one mistake made for not knowing, ten mistakes are made for not looking." At medical school, we are taught the finer techniques of the physical examination in order to support our diagnosis made from the history. It is not until we are experienced clinicians do we develop the clinical acumen and ability to tell an unwell patient from a well patient at a glance—colloquially known as the "end of the bed" assessment. In the pretechnology era, a well patient could frequently be seen reading their book, eg, the "novel-sign." With the advent of the smartphone and electronic devices upon which novels can be read, statuses updated, and locations "checked into" (ie, the modern "vital signs"), the book sign may be a thing of the past. However, the ability for the clinician to assess a patient's wellness is still crucial, and the value of any additional "physical signs" need to be estimated.

We observed a cohort of patients through a busy ASU in a tertiary hospital in South Australia, Australia. Acute surgical patients admitted to the hospital who were observed to be on their phones upon consultant review were more than 5 times likely to be discharged that same day. To the best of our knowledge, this is the first study to prospectively collect data to assess a frequently used but unevaluated clinical observation.

The use of a smartphone can tell us a lot about an individual's physiology. We can assume the individual's airway and breathing are adequate, allowing enough oxygen to reach the lungs and subsequently circulate. The individual is usually sit-

ting up in bed and thus has an adequate blood pressure and blood oxygenation that can maintain cerebral perfusion. They have the cognitive and cerebral processing in place to function the device, and we can examine their cerebellar function by looking for fine-motor movements.

Mobile phone ownership is pervasive within Australia,[5] with a conservative estimated 85.7% of the population (20.57 million people of a total population of approximately 24 million) owning a mobile phone and an estimated 50% to 79% of mobile phone ownership being of a smartphone.[6,7] This ownership is not just limited to the young, with 74% of Australians over 65 owning or using a mobile phone.[8] Despite this high phone ownership among those over 65, it is still significantly less than their younger counterparts and may be one reason for the absence of spP in those older than 51 years. A key point in the study is that overall phone ownership was not known, and, thus, it is not possible to determine the proportion of spN patients who were negative because they did not own a phone. However, based on general population data, the incidence of spP patients was well below that seen in the community (11.3%)[5] and even when excluding those over 55, the percentage of spP patients only rose to 19.1%. Unsurprisingly, increasing age was associated with a decreased likelihood of being spP ($P < .0005$), as younger people are more likely to own a phone.[8] There was no association with gender ($P = .18$). There are a number of explanations that may explain the lower than expected percentage of spP patients, including the inability for the patient to gather their possessions during a medical emergency, patients storing their phones prior to doctor review (72%-85% of Australians report talking on phones in public places to be rude or intrusive[5]), but more importantly, that our hypothesis that patients were too unwell to use their device appears to hold true.

There are potential alternate reasons other than smartphone status that may account for patients being discharged home on day 1. While there was no association seen with gender, the need for an operation prolonged a patient's stay (OR 1.64; 95% CI, 0.046-0.46), and there was a trend seen with increasing age (OR 0.98; 95% CI, 0.96-1.00). Neither of these 2 demographics are unsurprising: increasing age is associated with increasing medical comorbidities and thus complexity; even the simplest of operations require a postprocedure observation period, automatically increasing their LOS. Additionally, measured demographics are limited and there may be further unmeasured reasons that account for earlier discharge.

The other key component to this study is the value of the physical examination, albeit only assessing 1 component: the general inspection. In their review of the value of the physical examination of the cardiovascular system, Elder et al. highlight an important point: in traditional teaching, the value of a physical sign is compared with a diagnostic reference, typically imaging or an invasive test.[9] They argue that this definition undervalues the physical examination and list other values aside from accuracy including accessibility, contribution to clinical care beyond diagnoses, cost effectiveness, patients' safety, patients' perceptions, and pedagogic value; and they argue that the physical examination should always be considered in regard to the clinical context—in this case, the newly admitted general surgical patient.

The assessment of the presence or absence of a smartphone is readily performed upon general inspection and is easily visible; general inspection of the patient and failure to observe the clinical sign when present are 2 of the greatest errors associated with physical examination.[10] Furthermore, given its unique status as a physical sign, the authors' opinion and experience is that it is readily teachable. McGee states, "…a fundamental lesson [in regards to teaching] is that the diagnosis of many clinical problems, despite modern testing, still depends primarily on what the clinician sees, hears, and feels."[11] In their article, Paley et al. found that more than 80% of patients admitted from the ED under internal medicine could be accurately diagnosed based largely on history and examination alone and concluded that basic clinical skills are sufficient for achieving an accurate diagnosis in most cases.[12] Although Paley et al. were assisted with basic tests (such as electrocardiogram and basic haematological and biochemistry results), the point of clinical skills is not lost. Furthermore, this assessment was made in a group of patients generally considered to be complex in contrast to the "standard" appendicitis or cholecystitis patient that makes up a significant proportion of general surgical patients.

There are a number of limitations to this study, however, including smartphones that may have been missed during the observational period. Potential confounding variables such as socioeconomic status and the overall smartphone ownership of our subjects were not known. We did not ask all admitted patients whether they owned a phone or whether they had a phone in their possession. Knowledge of those who owned phones but were not in possession of them could strengthen our argument that spN patients were not using their phone because they were unwell, rather than just not having access to it.

However, this study has a number of strengths, including a large sample size and data that were prospectively collected by a method and in a setting that was the same for all participants. Clear and appropriate definitions were used, which minimizes misclassification bias. Participants and decision makers were blinded to the study, and potentially confounding variables such as age and sex were accounted for.

Assessing the suitability for discharge from the hospital is a decision encountered by hospital-based clinicians every day. These skills are not taught, but are rather learned as a junior doctor acquires experience. It is unlikely that protocols will be developed to aid identification of potential discharges from an acute surgical ward; acute surgical conditions are too varied and dynamic to be able to pool all data. We continue to rely on our own and fellow colleagues' (doctors, nurses, and other staff) input and assessment. However, our study has shown that it is possible to identify and quantify clinical findings that are already regularly used, albeit potentially subconsciously, to assess suitability for discharge. We have shown in this large, prospectively collected observational study that if a surgical patient is seen using their electronic device, they are more like-

ly to be safe to go home. Thus, surgeons can reliably use this observation as a trigger to consider discharging the patient following a more thorough assessment.

CONCLUSION

While these observations might appear to be rather a simplistic way of trying to quantify whether or not a patient is fit for discharge, any clues that hint towards a patient's well-being should be taken into account when making an overall assessment. The active use of a smartphone is one such measure.

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Perception of Resources Spent on Defensive Medicine and History of Being Sued Among Hospitalists: Results from a National Survey

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The United States spends substantially more per capita for healthcare than any other nation. Defensive medicine is 1 source of such spending, but its extent is unclear. Using a national survey of approximately 1500 US hospitalists, we report the estimates the US hospitalists provided of the percent of resources spent on defensive medicine and correlates of their estimates. We also ascertained how many reported being sued. Sixty-eight percent of eligible recipients responded. Overall, respondents estimated that 37.5% of healthcare costs are due to defensive medicine. Just over 25% of our respondents, including 55% of those in practice for 20 years or more, reported being sued for medical malpractice. Veterans Affairs (VA) hospital affiliation, more years practicing as a physician, being male, and being a non-Hispanic white individual were all independently associated with decreased estimates of resources spent for defensive medicine. *Journal of Hospital Medicine* 2018;13:26-29. Published online first August 23, 2017.

Annual healthcare costs in the United States are over $3 trillion and are garnering significant national attention.[1] The United States spends approximately 2.5 times more per capita on healthcare when compared to other developed nations.[2] One source of unnecessary cost in healthcare is defensive medicine. Defensive medicine has been defined by Congress as occurring "when doctors order tests, procedures, or visits, or avoid certain high-risk patients or procedures, primarily (but not necessarily) because of concern about malpractice liability."[3]

Though difficult to assess, in 1 study, defensive medicine was estimated to cost $45 billion annually.[4] While general agreement exists that physicians practice defensive medicine, the extent of defensive practices and the subsequent impact on healthcare costs remain unclear. This is especially true for a group of clinicians that is rapidly increasing in number: hospitalists. Currently, there are more than 50,000 hospitalists in the United States,[5] yet the prevalence of defensive medicine in this relatively new specialty is unknown. Inpatient care is complex and time constraints can impede establishing an optimal therapeutic relationship with the patient, potentially raising liability fears. We therefore sought to quantify hospitalist physician estimates of the cost of defensive medicine and assess correlates of their estimates. As being sued might spur defensive behaviors, we also assessed how many hospitalists reported being sued and whether this was associated with their estimates of defensive medicine.

METHODS

Survey Questionnaire

In a previously published survey-based analysis, we reported on physician practice and overuse for 2 common scenarios in hospital medicine: preoperative evaluation and management of uncomplicated syncope.[6] After responding to the vignettes, each physician was asked to provide demographic and employment information and malpractice history. In addition, they were asked the following: In your best estimation, what percentage of healthcare-related resources (eg, hospital admissions, diagnostic testing, treatment) are spent purely because of defensive medicine concerns? _____% resources

Survey Sample & Administration

The survey was sent to a sample of 1753 hospitalists, randomly identified through the Society of Hospital Medicine's (SHM) database of members and annual meeting attendees. It is estimated that almost 30% of practicing hospitalists in the United States are members of the SHM.[5] A full description of the sampling methodology was previously published.[6] Selected hospitalists were mailed surveys, a $20 financial incentive, and subsequent reminders between June and October 2011.

The study was exempted from institutional review board review by the University of Michigan and the VA Ann Arbor Healthcare System.

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TABLE. **Multivariable Regression Results: Variables Associated with Estimated Spending on Defensive Medicine**

Variable	Adjusted Mean Estimated Resources Spent on Defensive Medicine	Mean Difference in Estimated Resources Spent on Defensive Medicine[a]	*P* Value
VA affiliated non-VA affiliated	32.2% 37.7%	−5.5%	.025
Mean years practicing (+10 years)	---	−2.9%	.003
Employed by private group Paid by self or hospital	38.8% 36.7%	2.2%	.235
Insurance paid by employer group Paid by self or hospital	35.7% 38.3%	−2.6%	.141
Personally been sued for medical malpractice Never been sued for medical malpractice	37.8% 37.2%	−0.6%	.670
Male Female	36.4% 39.4%	−3.0%	.023
Non-Hispanic white All others	32.5% 44.7%	−12.2%	<.001

[a]Parameter estimates from linear regression.

Variables

The primary outcome of interest was the response to the "% resources" estimated to be spent on defensive medicine. This was analyzed as a continuous variable. Independent variables included the following: VA employment, malpractice insurance payer, employer, history of malpractice lawsuit, sex, race, and years practicing as a physician.

Statistical Analysis

Analyses were conducted using SAS, version 9.4 (SAS Institute). Descriptive statistics were first calculated for all variables. Next, bivariable comparisons between the outcome variables and other variables of interest were performed. Multivariable comparisons were made using linear regression for the outcome of estimated resources spent on defensive medicine. A *P* value of <.05 was considered statistically significant.

RESULTS

Of the 1753 surveys mailed, 253 were excluded due to incorrect addresses or because the recipients were not practicing hospitalists. A total of 1020 were completed and returned, yielding a 68% response rate (1020 out of 1500 eligible). The hospitalist respondents were in practice for an average of 11 years (range 1-40 years). Respondents represented all 50 states and had a diverse background of experience and demographic characteristics, which has been previously described.[6]

Resources Estimated Spent on Defensive Medicine

Hospitalists reported, on average, that they believed defensive medicine accounted for 37.5% (standard deviation, 20.2%) of all healthcare spending. Results from the multivariable regression are presented in the Table. Hospitalists affiliated with a VA hospital reported 5.5% less in resources spent on defensive medicine than those not affiliated with a VA hospital (32.2% VA vs 37.7% non-VA, $P = .025$). For every 10 years in practice, the estimate of resources spent on defensive medicine decreased by 3% ($P = .003$). Those who were male (36.4% male vs 39.4% female, $P = .023$) and non-Hispanic white (32.5% non-Hispanic white vs 44.7% other, $P \leq .001$) also estimated less resources spent on defensive medicine. We did not find an association between a hospitalist reporting being sued and their perception of resources spent on defensive medicine.

Risk of Being Sued

Over a quarter of our sample (25.6%) reported having been sued at least once for medical malpractice. The proportion of hospitalists that reported a history of being sued generally increased with more years of practice (Figure). For those who had been in practice for at least 20 years, more than half (55%) had been sued at least once during their career.

DISCUSSION

In a national survey, hospitalists estimated that almost 40% of all healthcare-related resources are spent purely because of defensive medicine concerns. This estimate was affected by personal demographic and employment factors. Our second major finding is that over one-quarter of a large random sample of hospitalist physicians reported being sued for malpractice.

Hospitalist perceptions of defensive medicine varied significantly based on employment at a VA hospital, with VA-affiliated hospitalists reporting less estimated spending on defensive medicine. This effect may reflect a less litigious environment within the VA, even though physicians practicing within the VA can be reported to the National Practitioner Data Bank.[7] The different environment may be due to the VA's patient mix (VA

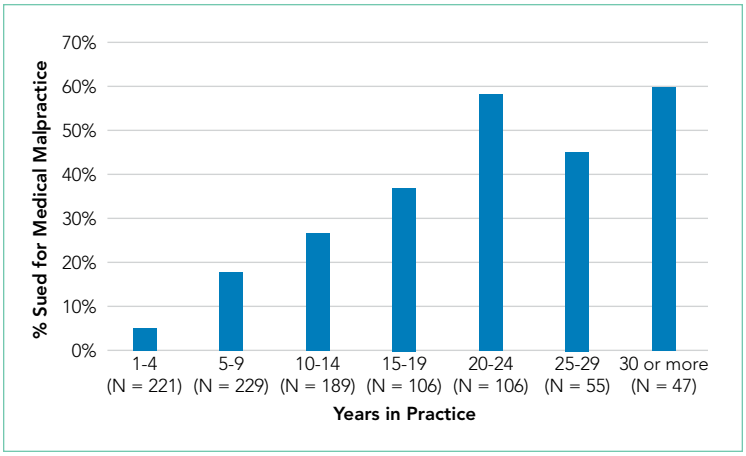

FIG. Proportion of hospitalists that have personally been sued by years in practice.

patients tend to be poorer, older, sicker, and have more mental illness)[8]; however, it could also be due to its de facto practice of a form of enterprise liability, in which, by law, the VA assumes responsibility for negligence, sheltering its physicians from direct liability.

We also found that the higher the number of years a hospitalist reported practicing, the lower the perception of resources being spent on defensive medicine. The reason for this finding is unclear. There has been a recent focus on high-value care and overspending, and perhaps younger hospitalists are more aware of these initiatives and thus have higher estimates. Additionally, non-Hispanic white male respondents estimated a lower amount spent on defensive medicine compared with other respondents. This is consistent with previous studies of risk perception which have noted a "white male effect" in which white males generally perceive a wide range of risks to be lower than female and non-white individuals, likely due to sociopolitical factors.[9] Here, the white male effect is particularly interesting, considering that male physicians are almost 2.5 times as likely as female physicians to report being sued.[10]

Similar to prior studies,[11] there was no association with personal liability claim experience and perceived resources spent on defensive medicine. It is unclear why personal experience of being sued does not appear to be associated with perceptions of defensive medicine practice. It is possible that the fear of being sued is worse than the actual experience or that physicians believe that lawsuits are either random events or inevitable and, as a result, do not change their practice patterns.

The lifetime risk of being named in a malpractice suit is substantial for hospitalists: in our study, over half of hospitalists in practice for 20 years or more reported they had been sued. This corresponds with the projection made by Jena and colleagues,[12] which estimated that 55% of internal medicine physicians will be sued by the age of 45, a number just slightly higher than the average for all physicians.

Our study has important limitations. Our sample was of hospitalists and therefore may not be reflective of other medical specialties. Second, due to the nature of the study design, the responses to spending on defensive medicine may not represent actual practice. Third, we did not confirm details such as place of employment or history of lawsuit, and this may be subject to recall bias. However, physicians are unlikely to forget having been sued. Finally, this survey is observational and cross-sectional. Our data imply association rather than causation. Without longitudinal data, it is impossible to know if years of practice correlate with perceived defensive medicine spending due to a generational effect or a longitudinal effect (such as more confidence in diagnostic skills with more years of practice).

Despite these limitations, our survey has important policy implications. First, we found that defensive medicine is perceived by hospitalists to be costly. Although physicians likely overestimated the cost (37.5%, or an estimated $1 trillion is far higher than previous estimates of approximately 2% of all healthcare spending),[4] it also demonstrates the extent to which physicians feel as though the medical care that is provided may be unnecessary. Second, at least a quarter of hospitalist physicians have been sued, and the risk of being named as a defendant in a lawsuit increases the longer they have been in clinical practice.

Given these findings, policies aimed to reduce the practice of defensive medicine may help the rising costs of healthcare. Reducing defensive medicine requires decreasing physician fears of liability and related reporting. Traditional tort reforms (with the exception of damage caps) have not been proven to do this. And damage caps can be inequitable, hard to pass, and even found to be unconstitutional in some states.[13] However, other reform options hold promise in reducing liability fears, including enterprise liability, safe harbor legislation, and health courts.[13] Finally, shared decision-making models may also provide a method to reduce defensive fears as well.[6]

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Vascular Ultrasonography: A Novel Method to Reduce Paracentesis Related Major Bleeding

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Paracentesis is a core competency for hospitalists. Using ultrasound for fluid localization is standard practice and involves a low-frequency probe. Experts recommend a "2-probe technique," which incorporates a high-frequency ultrasound probe in addition to the low-frequency probe to identify blood vessels within the intended needle path. Evidence is currently lacking to support this 2-probe technique, so we performed a pre- to postintervention study to evaluate its effect on paracentesis-related bleeding complications. From February 2010 to August 2011, procedures were performed using only low-frequency probes (preintervention group), while the 2-probe technique was used from September 2011 to February 2016 (postintervention group). A total of 5777 procedures were performed. Paracentesis-related minor bleeding was similar between groups. Major bleeding was lower in the postintervention group (3 [0.3%], n = 1000 vs 4 [0.08%], n = 4777; *P* = .07). This clinically meaningful trend suggests that using the 2-probe technique might prevent paracentesis-related major bleeding. *Journal of Hospital Medicine* 2018;13:30-33. Published online first October 18, 2017.

Ascites is the most common complication of cirrhosis and often leads to hospitalization.[1] Paracentesis is recommended for all patients admitted with ascites and cirrhosis.[1] Additionally, the Society of Hospital Medicine considers the ability to perform paracenteses a core competency for hospitalists.[2] Although considered a safe procedure, major bleeding complications occur in 0.2% to 1.7% of paracenteses.[3-7] Patients with cirrhosis form new abdominal wall vessels because of portal hypertension, and hemoperitoneum from the laceration of these vessels during paracentesis carries a high morbidity and mortality.[6,8] Ultrasound guidance using a low-frequency ultrasound probe is currently standard practice for paracentesis and has been shown to reduce bleeding complications.[9-11] However, the use of vascular ultrasound (high-frequency probe) is also recommended to identify blood vessels within the intended needle pathway to reduce bleeding, but no studies have been performed to demonstrate a benefit.[3,11] This study aimed to evaluate whether this "2-probe technique" reduces paracentesis-related bleeding complications.

METHODS

The procedure service at Cedars Sinai Medical Center (CSMC) in Los Angeles performs paracentesis regularly with ultrasound guidance. CSMC is a tertiary care, academic medical center with 861 licensed beds. We performed a pre- to postintervention study of consecutive patients (admitted and ambulatory) who underwent paracentesis done by 1 proceduralist (MJA) from the procedure service at CSMC from February 2010 through February 2016. From February 1, 2010, through August 2011, paracenteses were performed using only low-frequency, phased array ultrasound probes (preintervention group). From September 1, 2011, through February 2016, a 2-probe technique was used, whereby ultrasound interrogation of the abdomen using a low-frequency, phased array probe (to identify ascites) was supplemented with a second scan using a high-frequency, linear probe to identify vasculature within the planned needle path (postintervention group). As a standard part of quality assurance, CSMC documented all paracentesis-related complications from procedures performed by their center. Northwestern University investigators (JHB, EC, JF) independently evaluated these data to look at bleeding complications before and after the implementation of the 2-probe technique. The CSMC and Northwestern University institutional review boards approved this study.

Procedure Protocol

Each patient's primary team or outpatient physician requested a consultation for paracentesis from the CSMC procedure service. All patient evaluations began with an abdominal ultrasound using the low-frequency probe to determine the presence of ascites and a potential window of access to the fluid. After September 1, 2011, the CSMC procedure service implemented the 2-probe technique to also evaluate the abdominal wall for the presence of vessels. Color flow Doppler

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TABLE. **Patient Clinical and Demographic Characteristics of Paracentesis Procedures and Bleeding Outcomes**

	Preintervention Procedures (n = 1000)	Missing[a]	Postintervention Procedures (n = 4777)	Missing[a]	*P* value
Age (years), mean (SD)	58.81 (11.51)	—	60.28 (12.75)	—	< .001
Male, No. (%)	606 (60.6%)	—	2619 (54.8%)	—	.003
Body mass index (kg/m2), mean (SD)	26.17 (17.21)	281 (28%)	25.30 (5.54)	917 (19%)	.012
Inpatient, No. (%)	486 (48.6%)	—	2771 (58%)	—	< .001
International normalized ratio, mean (SD)	1.61 (0.72)	31 (3.1%)	1.63 (0.70)	139 (2.9%)	.65
Partial thromboplastin time (seconds), mean (SD)	42.57 (20.58)	32 (3.2%)	40.21 (16.20)	320 (6.7%)	< .001
Platelet count (10^3/uL), median (IQR)	106.00 (72.50, 185.00)	7 (0.7%)	110.00 (65.00, 198.00)	49 (1.0%)	.31
Hematocrit (%), mean (SD)	31.09 (5.61)	15 (1.5%)	29.99 (5.40)	82 (1.7%)	< .001
Serum creatinine (mg/dl), median (IQR)	1.30 (0.80, 2.00)	8 (0.8%)	1.20 (0.80, 2.20)	43 (.9%)	.028
Serum sodium (meq/l), mean (SD)	135.40 (5.14)	488 (48.8%)	135.13 (5.61)	2941 (61.5%)	.32
Serum bilirubin (mg/dl), mean (SD)	4.85 (8.11)	252 (25.2%)	5.21 (9.19)	1136 (23.8%)	.32
Fluid volume (ml), mean (SD)	4809.75 (2990.83)	—	4436.81 (2858.82)	—	< .001
Number of needle passes, mean (SD)	1.01 (0.10)	—	1.01 (0.10)	—	.68
Minor bleeding, No. (%)	5 (0.5%)	—	30 (0.6%)	—	.64
Major bleeding, No. (%)	3 (0.3%)	—	4 (0.1%)	—	.07
Major bleeding minus 1 postintervention, No. (%)	3 (0.3%)	—	3 (0.1%)	—	.03

[a]Missing data are mostly from outpatients who did not routinely obtain labs before paracentesis. NOTE: Abbreviations: IQR, interquartile range; SD, standard deviation.

ultrasound further helped to differentiate blood vessels as necessary. The optimal window was then marked on the abdominal wall, and the paracentesis was performed. Per the routine of the CSMC procedure service, antiplatelet or anticoagulant medications were not held for paracenteses.

Measurement

All data were collected prospectively at the time of the procedure, including the volume of fluid removed, the number of needle passes required, and whether the patient was on antiplatelet or anticoagulant medications (including warfarin, direct oral anticoagulants, thrombin inhibitors, heparin, or low molecular weight heparins). Patients were followed for complications for up to 24 hours after the procedure or until a clinical question of a complication was reconciled. Minor bleeding was defined as new serosanguinous fluid on repeat paracentesis not associated with hemodynamic changes, local bruising or bleeding at the site, or abdominal wall hematoma. Major bleeding was defined by the development of hemodynamic instability or by reaccumulation of fluid on ultrasound within 24 hours postparacentesis and one of the following: an associated hemoglobin drop of greater than 2 g/dl, blood seen on repeat paracentesis, blood density fluid on a computed tomography scan, or the lack of an alternative explanation. All data were recorded in a handheld database (HanDbase; DDH Software, Wellington, FL).

A query of the electronic medical record was performed to obtain patient demographics and relevant clinical information, including age, sex, body mass index, International Normalized Ratio (INR), partial thromboplastin time (PTT), platelet counts (10^3/uL, hematocrit (%) and creatinine (mg/dl). Our query for laboratory data retrieved the closest laboratory entry up to 48 hours before the procedure.

Statistical Analysis

We used a χ^2 test, Student t test, or Kruskal-Wallis test to compare demographic and clinical characteristics of procedure patients between the 2 study groups (pre- and postintervention). Major and minor bleeding were compared between the 2 groups using the χ^2 test.[12] We used the χ^2 test instead of the Fisher's exact test for several reasons. The usual rule is that the Fisher's exact test is necessary when 1 or more expected outcome values are less than 5. However, McDonald argues that the χ^2 test should be used with large sample sizes (more than 1000) in lieu of the outcome-value-of-5 rule.[12] The Fisher's exact test also assumes that the row and column totals are fixed. However, the outcomes in our study were not fixed because any patient could have a bleeding complication during each procedure. When row and column totals are not fixed, only 5% of the time will a *P* value be less than.05, and the Fisher's exact test is too conservative.[12] We performed all statistical analyses using IBM SPSS Statistics Version 22 (IBM Corp, Armonk, NY).

RESULTS

Patient demographic and clinical information can be found in the Table. The proceduralist (MJA) performed a total of 5777 paracenteses (1000 preintervention, 4777 postintervention) on 1639 patients. Four hundred eighty-nine (10.2%) vascular anomalies were identified within the intended needle path in the postintervention group (Figure). More patients in the preintervention group were on aspirin (93 [9.3%] vs 230 [4.8%]; $P < .001$) and therapeutic intravenous anticoagulants (33 [3.3%] vs 89 [1.9%]; $P = .004$), while more patients in the postintervention group were on both an antiplatelet and oral anticoagulant (1 [0.1%] vs 38 [0.8%]; $P = .015$) and subcutaneous prophylactic anticoagulants (184 [18.4%] vs 1120 [23.4%]; $P = .001$) at the time of the procedure. There were no other differences between groups with antiplatelet or anticoagulant drugs. We found no difference in minor bleeding between pre- and postintervention groups. Major bleeding was lower after the 2-probe technique was implemented (3 [0.3%] vs 4 [0.08%]; $P = .07$). There were no between-group differences in INR, PTT, or platelet counts among major bleeders. One patient in the postintervention group had hemodynamic instability and dropped his hemoglobin by 3.8 g/dl at 7 hours after the procedure. This was unexplained, as the patient had no abdominal symptoms or findings on examination. The patient received several liters of fluid before ultimately dying, and the primary team considered sepsis as a possible cause, but no postmortem examination was performed. This was the only death attributed to a major bleeding complication. We included this patient in our analysis because the cause of his demise was not completely clear. However, excluding this patient would change the results from a trend to a statistically significant difference between groups (3 [0.3%] vs 3 [0.06%]; $P = .03$).

DISCUSSION

To our knowledge, we report the largest series of paracentesis prospectively evaluated for bleeding complications, and this is the first study to evaluate whether adding a vascular ultrasound (high-frequency probe) avoids major bleeding. In our series, up to 10% of patients had abnormal vessels seen with a vascular ultrasound that were within the original intended trajectory path of the needle. These vessels were also likely present yet invisible when ultrasound-guided paracentesis using only the standard, low-frequency probe was being performed. It is unknown whether these vessels are routinely traversed with the needle, nicked, or narrowly avoided during paracenteses performed using only a low-frequency probe.

Procedure-related bleeding may not be completely avoidable, despite using the vascular probe. Some authors have suggested that the mechanism of bleeding is more related to the rapid reduction in intraperitoneal pressure, which increases the gradient across vessel walls, resulting in rupture and bleeding.[6] However, in our series, using vascular ultrasound also reduced major bleeding to numbers lower than those historically reported in the literature (0.2%).[3-4] Our preintervention number needed to harm was 333 procedures to cause 1 major bleed, compared to 1250 (or 1666 using the 3-patient bleeding analysis) in the postintervention group. In 2008, 150,000 Medicare beneficiaries underwent paracentesis.[13] Using our study analysis, if vascular ultrasound was used on these patients, up to 360 major bleeds may have been prevented, along with a corresponding reduction in unnecessary morbidity and mortality.

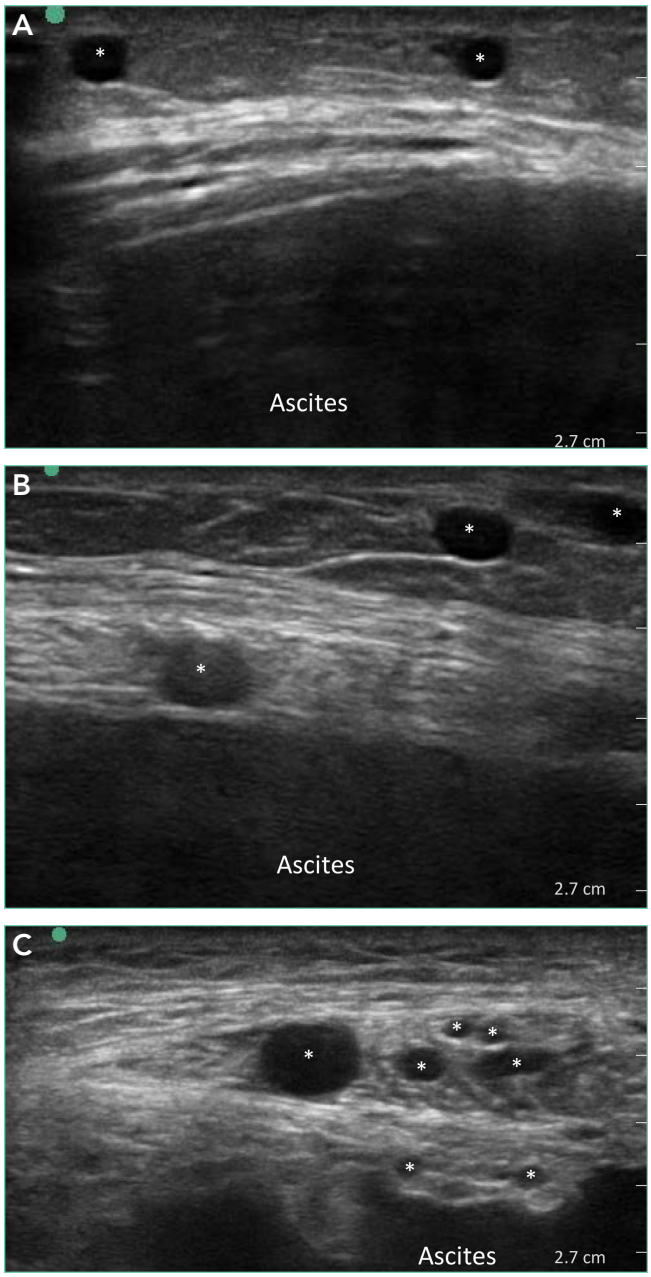

FIG. Ultrasound images obtained with the vascular probe showing dilated blood vessels in the abdominal wall of 3 patients (A, B, C), allowing for the intended needle path to be altered during paracentesis. These vessels could not be seen with the phased array probe. (* = blood vessel)

Our study has several limitations. First, it was limited to 1 center with 1 very experienced proceduralist. Although it is possible that the reduction in major bleeding may have been due to the increasing experience of the proceduralist over time, we do not think that this is likely because he had already performed thousands of paracenteses over 9 years before the start of our study. Second, major bleeding was rare and there-

fore precluded a multivariate analysis to control for temporal trends that might have occurred in our pre- to poststudy design. Statistically significant demographic and clinical variable differences between groups were likely not clinically meaningful. Although more patients were on intravenous anticoagulants in the preintervention group, coagulopathy or low platelets do not increase the bleeding risk during paracenteses,[1,8] and there was no clinical difference in INR, PTT, or platelets between groups (Table). Third, it is possible that unmeasured characteristics contributed to more patient complications in the preintervention group. Finally, we were unable to evaluate length of stay and mortality differences between groups that might have been attributable to the procedure because of the low number of major bleeding complications and the inability to perform a multivariate analysis.

CONCLUSION

Our results suggest that using the 2-probe technique to predetermine the needle path before performing paracentesis might prevent major bleeding. Based on our findings, we believe that the addition of a vascular ultrasound during paracentesis should be considered by all hospitalists.

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The Diagnostic Yield of Noninvasive Microbiologic Sputum Sampling in a Cohort of Patients with Clinically Diagnosed Hospital-Acquired Pneumonia

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The clinical predictors of positive sputum culture have not been previously reported in hospital-acquired pneumonia (HAP), and data on yield of sputum culture in this setting are scant. Current Infectious Disease Society of America guidelines for HAP recommend noninvasive sputum sampling, though the data for this practice are limited. We assessed the yield of sputum culture in HAP cases at an academic medical center from January 2007 to July 2013. HAP cases were identified by International Classification of Diseases, Ninth Revision-Clinical Modification codes for bacterial pneumonia and all cases were validated by chart review. Our cohort had 1172 hospitalizations with a HAP diagnosis. At least 1 sputum specimen was collected noninvasively and sent for bacterial culture after hospital day 2 and within 7 days of HAP diagnosis in 344 of these hospitalizations (29.4%), with a total of 478 sputum specimens, yielding 63 (13.2%) positive, 109 (22.8%) negative, and 306 (64.0%) contaminated cultures (>10 epithelial cells per high power field). Significant predictors of a positive sputum culture were chronic lung disease (relative risk [RR] = 2.0; 95% confidence interval [CI], 1.2-3.4) and steroid use (RR = 1.8; 95% CI, 1.1-3.2). The most commonly identified organisms were Gram-negative rods not further speciated (25.9%), *Staphylococcus aureus* (21.0%), and *Pseudomonas aeruginosa* (14.8%). Because of the ease of obtaining a sputum sample combined with the prevalence of commonly drug-resistant organisms, we suggest that sputum culture in HAP is a potentially useful noninvasive diagnostic technique. *Journal of Hospital Medicine* 2018;13:34-37. Published online first October 18, 2017. © 2018 Society of Hospital Medicine

Pneumonia is a major cause of hospitalization, mortality, and healthcare cost.[1,2] The diagnosis involves clinical features plus radiographic evidence of infection. Hospital-acquired pneumonia (HAP) is defined by the Infectious Disease Society of America (IDSA) as a pneumonia that occurs ≥48 hours after admission and is not associated with mechanical ventilation.[3]

IDSA recommendations suggest that patients with suspected HAP be treated based on results of noninvasively obtained sputum cultures rather than being treated empirically.[3] This recommendation is graded as weak with low-quality evidence based on a lack of both evidence showing that respiratory cultures improve clinical outcomes and studies examining the yield of noninvasive collection methods.[4,5] However, resistant pathogens lead to a risk of inadequate empiric therapy, which is associated with increased mortality.[6] Culture data may provide an opportunity for escalation or de-escalation of antibiotic coverage. IDSA recommendations for microbiologic sampling are thus aimed at increasing appropriate coverage and minimizing unnecessary antibiotic exposure.

While the yield and clinical utility of sputum culture in community-acquired pneumonia has been studied extensively, data examining the yield of sputum culture in HAP (non–ventilator-associated pneumonia [non-VAP]) are sparse. In 1 small single-center study, researchers demonstrated positive sputum cultures in 17/35 (48.6%) patients with radiographically confirmed cases of HAP,[7] while in another study, researchers demonstrated positive sputum cultures in 57/63 (90.5%).[8] We aimed to identify the frequency with which sputum cultures positively identify an organism, identify predictors of positive sputum cultures, and characterize the microbiology of sputum cultures in a large cohort of HAP cases.

METHODS

We conducted a retrospective cohort study of patients admitted to a large academic medical center in Boston, Massachusetts, from January 2007 to July 2013. All patients ≥18 years of age were eligible for inclusion. We excluded outside hospital transfers, those with a length of hospitalization <48 hours, and psychiatric admissions.

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The study was approved by the institutional review board at the Beth Israel Deaconess Medical Center and granted a waiver of informed consent. Data were collected from electronic databases and supplemented by chart review.

Hospital-Acquired Pneumonia

We defined HAP as pneumonia occurring at least 48 hours after admission, consistent with American Thoracic Society and IDSA criteria.[3] To identify cases, we reviewed the charts of all admissions identified as having a discharge *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) code for bacterial pneumonia (481, 482, 483, 485, 486, 507), indicated as not "present-on-admission." We validated that the treating clinician had clinically diagnosed pneumonia and initiated antibiotics for this purpose by performing chart review. We reviewed the radiologist interpretation of radiographs surrounding the date of the clinical diagnosis of pneumonia to confirm the presence of a new opacity. Uncertain cases (with respect to either the presence of pneumonia or the timing of the diagnosis) were reviewed by a second member of the study team and, in the case of disagreement, adjudicated by a third member of the study team. Only the first clinically validated HAP per hospitalization was included in the analysis. To focus on HAP rather than VAP, we excluded hospitalizations in which the date of a procedure code for mechanical ventilation preceded the date of pneumonia diagnosis.

Microbiology

In our analysis, we used sputum samples obtained from expectorated or induced samples to evaluate the yield of noninvasive sputum sampling, as recommended by the IDSA. We included sputum samples collected ≥48 hours after admission and within 7 days of the clinical diagnosis of HAP. Sputum samples with >10 epithelial cells per high-power field (hpf) were considered to be contaminated. Among noncontaminated samples, positive sputum cultures were defined as those with a microbiologic diagnosis other than "oral flora," while those with no growth or growth of oral flora or only yeast were considered to be negative. The hospital's microbiology laboratory does not routinely provide species identification for Gram-negative rods (GNRs) growing on culture in the presence of growth of ≥3 other colony types. We considered such GNRs (not further speciated) to represent a positive culture result in our analysis given that colonization versus pathogenicity is a clinical distinction and, as such, these results may impact antibiotic choice.

Statistical Analysis

Data were analyzed by using SAS software, version 9.3. We used a 2-sided *P* value of <.05 to indicate statistical significance for all comparisons. We used the χ^2 test and the nonparametric median test for unadjusted comparisons.

To identify predictors of a positive (versus negative or contaminated) sputum culture among patients with HAP, we used a generalized estimating equation model with a Poisson distribution error term, log link, and first-order autoregressive correlation structure to account for multiple sputum specimens per patient. We combined culture negative and contaminated samples to highlight the clinical utility of sputum culture in a real-world setting. Potential predictors chosen based on clinical grounds included all variables listed in Table 1. We defined comorbidities specified in Table 1 via ICD-9-CM secondary diagnosis codes and diagnosis related groups (DRGs) using Healthcare Cost and Utilization Project Comorbidity Software, version 3.7, based on the work of Elixhauser et al.[9,10]; dialysis use was defined by an ICD-9-CM procedure code of 39.95; inpatient steroid use was defined by a hospital pharmacy charge for a systemic steroid in the 7 days preceding the sputum sample.

RESULTS

There were 230,635 hospitalizations of patients ≥18 years of age from January 2007 to July 2013. After excluding outside hospital transfers (n = 14,422), hospitalizations <48 hours in duration (n = 59,774), and psychiatric hospitalizations (n = 9887), there were 146,552 hospitalizations in the cohort.

Pneumonia occurred ≥48 hours after admission in 1688 hospitalizations. Excluding hospitalizations where pneumonia occurred after mechanical ventilation (n = 516) resulted in 1172 hospitalizations with (non-VAP) HAP. At least 1 sputum specimen was collected noninvasively and sent for bacterial culture after hospital day 2 and within 7 days of HAP diagnosis in 344 of these hospitalizations (29.4%), with a total of 478 sputum specimens (398 expectorated, 80 induced). Hospitalizations of patients with noninvasive sputum sampling were more likely to be male (63.1% vs 50.9%; *P* = .001) and to have chronic lung disease (24.4% vs 17.5%, *P* = .01) but were otherwise similar to hospitalizations without noninvasive sampling (Supplemental Table 1).

Of these 478 specimens, there were 63 (13.2%) positive cultures and 109 (22.8%) negative cultures, while 306 (64.0%) were considered contaminated. Table 1 displays the cohort characteristics overall and stratified by sputum culture result. For positive cultures, the median number of days between specimen collection and culture finalization was 3 (25th-75th percentile 2-4). On review of the gram stains accompanying these cultures, there were >25 polymorphonuclear cells per hpf in 77.8% of positive cultures and 59.4% of negative cultures (*P* = .02).

The top 3 bacterial organisms cultured from sputum samples were GNRs not further speciated (25.9%), *Staphylococcus aureus* (21.0%), and *Pseudomonas aeruginosa* (14.8%). The frequencies of isolated microorganisms are presented in Table 2.

In an adjusted analysis (Table 1), the significant predictors of a positive sputum culture were chronic lung disease (relative risk [RR] = 2.0; 95% confidence interval [CI], 1.2-3.4) and steroid use (RR = 1.8; 95% CI, 1.1-3.2).

DISCUSSION

To our knowledge, our study is the first to assess the predictors of positive sputum culture among patients with HAP (non-VAP) who had sputum samples obtained noninvasively, and this study is larger than prior studies in which research-

TABLE 1. **Cohort Characteristics, Overall and Stratified By Sputum Culture Result, and Adjusted Association Between Each Characteristic And Sputum Culture Positivity**

Characteristic	Overall n = 478	Positive Culture n = 63	Negative or Contaminated Culture n = 415	Adjusted Relative Risk[a] [95% CI] n = 478
Age in years – median (25th-75th percentile)	68.0 (56-75)	68.0 (60.0-75.0)	68.0 (55.0-75.0)	1.0 [1.0-1.0]
Gender				
Female	166 (34.7%)	26 (41.3)	140 (33.7)	Reference
Male	312 (65.3%)	37 (58.7)	275 (66.3)	0.9 [0.5-1.5]
Hospital day on which the sample was obtained—median (25th-75th percentile)	7.0 (5-12)	8.0 (5.0-14.0)	7.0 (5.0-12.0)	1.0 [1.0-1.0]
Collection method				
Expectorated	398 (83.3%)	56 (88.9)	342 (82.4)	Reference
Induced	80 (16.7%)	7 (11.1)	73 (17.6)	0.7 [0.3-1.5]
Patient Location				
Ward	375 (78.5%)	46 (73.0)	329 (79.3)	Reference
Intensive Care Unit	103 (21.6%)	17 (27.0)	86 (20.7)	1.3 [0.8-2.3]
Service				
Surgical	149 (31.2%)	23 (36.5)	126 (30.4)	Reference
Medical	329 (68.8%)	40 (63.5)	289 (69.6)	0.6 [0.4-1.2]
Comorbidities				
Congestive Heart Failure	92 (19.3%)	14 (22.2)	78 (18.8)	1.2 [0.6-2.3]
Chronic Lung Disease	113 (23.6%)	26 (41.3)	87 (21.0)	2.0 [1.2-3.4][b]
Diabetes Mellitus	124 (25.9%)	17 (27.0)	107 (25.8)	0.9 [0.5-1.7]
Chronic Liver Disease	37 (7.7%)	6 (9.5)	31 (7.5)	1.5 [0.7-3.2]
Dialysis	39 (8.2%)	8 (12.7)	31 (7.5)	1.6 [0.8-3.2]
Steroid Use	117 (24.5%)	22 (34.9)	95 (22.9)	1.8 [1.1-3.2][b]

[a]Adjusted relative risk determined using a generalized estimating equation model with a Poisson distribution error term, log link, and first-order autoregressive correlation structure controlling for all characteristics simultaneously as independent variables.

[b]Numbers represent statistically significant associations between comorbidities and sputum culture positivity.

Note: Abbreviations: ICU, intensive care unit.

ers reported on sputum culture yield in HAP. Sputum samples were obtained in 29.4% cases of clinically diagnosed HAP. Although 87% of specimens obtained were culture-negative or contaminated, 13% yielded a bacterial organism. Although we do not report the antibiotic sensitivity patterns of the isolated organisms, the organisms identified frequently demonstrate antibiotic resistance, highlighting the potential for both antibiotic escalation and de-escalation based on sputum culture. In a multivariable model, presence of chronic lung disease and steroid use in the preceding week were both significantly associated with culture positivity.

The retrospective nature of the study raises the possibility of selection bias from systematic differences between the 29.4% of patients with HAP who had sputum collected and those who did not. Patients with sputum cultures were similar to patients without cultures in most measured characteristics, but we are unable to know what the yield of noninvasive sputum culture would have been had all patients with HAP been sampled. As such, our findings reflect the yield of sputum culture among patients with HAP for whom cultures were successfully obtained. It is not clear why only 29.4% of HAP patients received IDSA guideline-concordant care, but similar rates of culture use are reported elsewhere.[7] While physician decision-making could have contributed to this finding, it is also possible that many sick, hospitalized patients are simply unable to produce sputum for analysis. In future studies, researchers should examine barriers to guideline-concordant care.

We considered a culture result of GNRs (not further speciated) as positive in our analysis because this result indicates growth of mixed bacterial types, the pathogenicity of which is a clinical determination. Physicians may request speciation and antibiotic sensitivities and, as such, these results have the potential to impact antibiotic choice. Had we considered such cultures to be negative or contaminated, the rate of culture positivity would have been only slightly reduced from 63/478 (13.2%) to 50/478 (10.5%).

The strengths of our study include the chart-based validation of administratively identified cases of pneumonia and a large cohort. There are also limitations. The single-center nature of the study has implications for pretest probability and generalizability. Additionally, in our study, we did not examine outcomes among patients treated empirically versus those treated based on sputum culture results. Finally, our reliance on administrative codes to identify cases of HAP for subsequent validation could

TABLE 2. **Microbiology of Positive Sputum Cultures.**

Organism	n[a]	% of Isolated Organisms
Gram-negative rods (not further speciated)[b]	21	25.9
Staphylococcus aureus	17	21.0
Pseudomonas aeruginosa	12	14.8
Haemophilus influenzae	5	6.2
Klebsiella pneumoniae	5	6.2
Escherichia coli	3	3.7
Streptococcus pneumoniae	3	3.7
Moraxella catarrhalis	3	3.7
Beta streptococci (not group A)	3	3.7
Enterobacter cloacae	3	3.7
Serratia marcescens	2	2.5
Klebsiella oxytoca	1	1.2
Enterobacter aerogenes	1	1.2
Stenotrophomonas maltophilia	1	1.2
Mycobacterium avium complex	1	1.2

[a]Number of speciated organisms (n = 81) adds up to more than total number of positive cultures (n = 63) because some cultures grew multiple organisms.[b]Not further speciated because of the presence of ≥3 other bacterial types growing on culture, based on our microbiology laboratory protocol.

have resulted in incomplete capture of HAP cases.

In conclusion, in our study, we provide an estimate of the diagnostic yield of sputum culture in a large cohort with chart-validated HAP, a description of HAP microbiology, and predictors of positive sputum culture. Thirteen percent of patients who had sputum culture testing received a microbiologic diagnosis. Because of the relative ease of obtaining a sputum sample and the microbiologic distribution in our study (representing a mix of commonly drug-resistant pathogens and more typical community-acquired pathogens), we suggest that sputum culture in HAP is a useful diagnostic tool with the potential to inform antibiotic escalation or de-escalation.

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Bedside Assessment of the Necessity of Daily Lab Testing for Patients Nearing Discharge

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As part of the Choosing Wisely® campaign, the Society of Hospital Medicine recommends against performing "repetitive complete blood count chemistry testing in the face of clinical and lab stability." With this recommendation as a framework, we targeted 2 hospitalist-run inpatient medicine units that employed bedside, scripted, interdisciplinary rounds. Our multifaceted intervention included prompting the hospitalist to identify clinically stable patients for next-day discharge and to discontinue labs when appropriate. It was coupled with the education of the clinicians and a regular data review for the hospitalists and unit staff. Among 2877 discharges included in a 1-year period, there was a significantly decreasing trend after the intervention in the percentage of patients getting labs in the 24, 48, and 72 hours before discharge (−1.87%, −1.47%, and −0.74% decrease per month, respectively; $P < .05$). Our structured, multifaceted approach effectively reduced daily lab testing in the 24 to 48 hours prior to discharge. *Journal of Hospital Medicine* 2018;13:38-40. Published online first October 18, 2017. © 2018 Society of Hospital Medicine

As part of the Choosing Wisely® campaign, the Society of Hospital Medicine recommends against performing "repetitive complete blood count [CBC] and chemistry testing in the face of clinical and lab stability."[1] This recommendation stems from a body of research that shows that frequent or excessive phlebotomy can have negative consequences, including iatrogenic anemia (termed hospital-acquired anemia), which may necessitate blood transfusion.[2] The downstream effects of potentially unnecessary testing, including the evaluation of false-positive results, must also be considered. Additional important effects include patient discomfort and disruption of sleep and unproductive work by hospital staff, including nurses, phlebotomists, and laboratory technicians.

Though interventions to reduce unnecessary daily labs have been previously evaluated, there are no studies that focus on decreasing lab testing on patients deemed clinically stable and close to discharge. This is in part due to the absence of clear criteria or guidelines to define clinical stability in the context of lab utilization.

We therefore aimed to implement a multifaceted, patient-centered initiative—the Necessity of Labs Assessed Bedside (NO LABS)—that focused on reducing lab testing in patients at 24 to 48 hours before discharge. We targeted the 24 to 48-hour period before the anticipated date of discharge, as this may be a period of greater stability and provide an opportunity to identify and decrease unnecessary testing.

METHODS

The study took place at Mount Sinai Hospital, which is an 1174-bed tertiary care teaching hospital in New York City. We targeted 2 inpatient medicine units where virtually all patients are assigned to a hospitalist rotating for a 2- to 4-week period, for the period of July 1, 2015, to July 31, 2016. These units employed bedside interdisciplinary rounds (IDR) attended by the hospitalist, social worker, case manager, nurse, nurse manager, and medical director. Bedside IDR focuses on the daily plan and patient safety by utilizing a scripted format.[3] Our multifaceted intervention included prompting the hospitalist physician during bedside IDR, education of the clinicians, and regular data review for the hospitalists and unit staff.

As described by Dunn et al.,[3] the IDR script included the following: a review of the plan of care by the hospitalist, identifying a patient's personal goals for the day, a brief update of discharge planning (as appropriate), and a safety assessment performed by the nurse (identifying Foley catheters, falls risk, etc). We incorporated an inquiry into the daily IDR script identifying clinically stable patients for discharge in the next 24 to 48 hours (based on physician judgment), followed by a prompt to the hospitalist to discontinue labs when appropriate. The unit medical director and nurse manager were both tasked with prompting the hospitalist at the bedside. Our hospital utilizes computerized physician order entry. Lab orders were then discontinued by the clinician during rounds using a computer on wheels (or after rounds when one was not available). The hospitalist, unit medical director, and nurse manager were reminded about the project through weekly e-mails and in-person communication.

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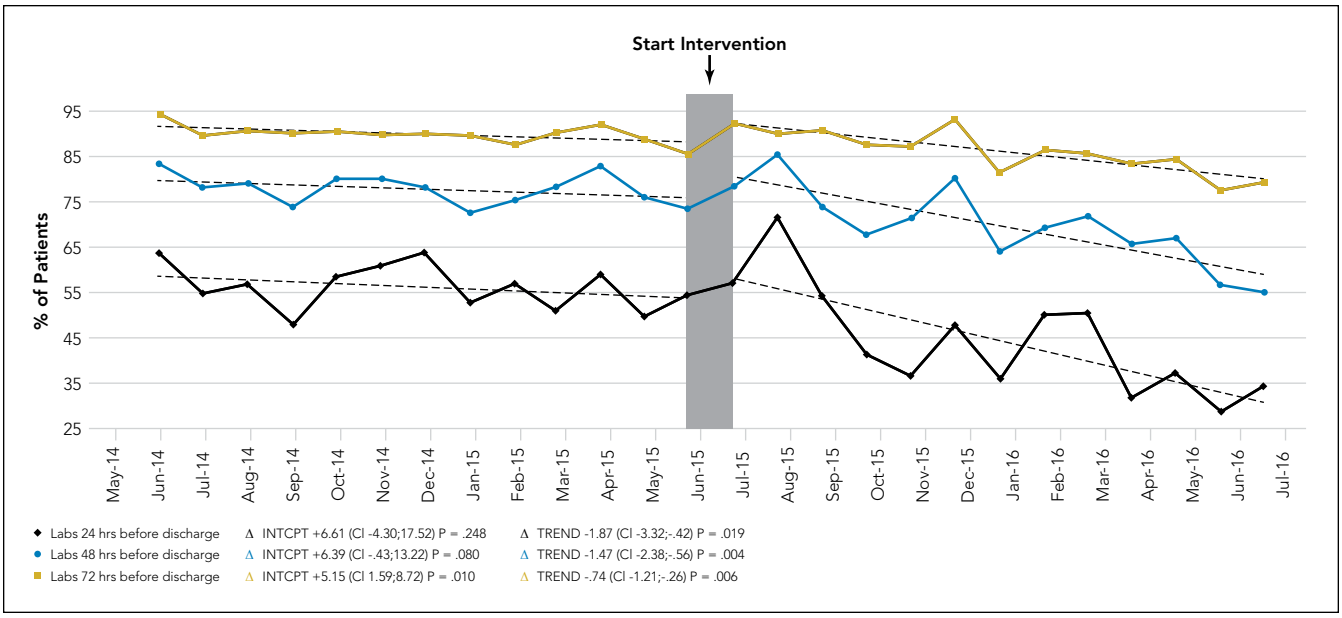

FIG. Monthly percentage of patients with labs ordered in days prior to discharge.

NOTE: Interrupted time-series analysis results showing monthly percentage of patients with labs ordered in the 24/48/72 hours preceding discharge. ΔINTCPT and ΔTREND depict the change in intercept and slope, respectively, between the pre and postintervention periods. The gray bar identifies the start of the intervention period.

To assess whether the prompt was being incorporated consistently, an observer was added to rounds beginning in the second month of the project. The observer was present at least 3 times a week for the subsequent 3 months of the project. Our intervention also included education geared towards hospitalists, including a brief presentation on reducing unnecessary lab testing during a monthly hospitalist faculty meeting (the first and sixth month of the intervention). The group's data on laboratory testing within the 24 to 48 hours prior to discharge were also presented at these monthly meetings (beginning 2 months into the intervention and monthly thereafter). Lastly, we provided the unit staff with unit-level metrics, biweekly for the first 3 months and every 2 to 3 months thereafter.

We extracted electronic medical record (EMR) data on lab utilization for patients on the 2 hospitalist units for the intervention period. Baseline data were obtained from July 1, 2014, to June 30, 2015. Patients with a length of stay (LOS) ≤7 days (75th percentile) were included; on these units, longer stays were considered more likely to have complex social issues delaying discharge and thus less likely to require laboratory testing. We tracked ordering for 4 common lab tests: basic metabolic panel, CBC, CBC with differential, and the comprehensive metabolic panel. The primary outcome was the monthly percentage of patients for whom testing was ordered in the 24 and 48 hours preceding discharge. A secondary outcome was testing at 72 hours preceding discharge to identify any potential compensatory (increased) testing the evening prior. We applied a quasi-experimental interrupted time series design with a segmented regression analysis to estimate changes before and after our intervention, expressed in acute changes (change in intercept) and over time (changes in trend) while adjusting for preintervention trends. All analyses were performed with SAS v9.4 statistical software (SAS Institute, Cary, NC). Our project was deemed a quality improvement project, and thus an IRB submission was not required.

RESULTS

There were 1579 discharges in the preintervention period and 1308 discharges in the postintervention period. The average age of the patient population was similar in the baseline and postintervention groups (61.5 vs 59.3 years; $P = .400$), and there was no difference in the mean LOS before and after implementation (3.67 vs 3.68 days; $P = .817$).

There was a significant decrease in the average percentage of patients with any lab order at 24 hours prior to discharge, from a preintervention average of 50.1% to a postintervention average of 34.5% ($P = .004$). Similarly, labs ordered at 48 hours prior to discharge also decreased (from 77.6% down to 55.1%; $P = .005$). This corresponded to a significantly decreasing trend (relative to the preintervention period) in the percentage of patients getting labs after the intervention in the 24, 48, and 72 hours before discharge (−1.87% [$P = .019$], −1.47% [$P = .004$], and −0.74% [$P = .006$] decrease per month, respectively; Figure). There was an initial period of increased lab testing at 72 hours before discharge (+5.15%; $P = .010$); however, by the fifth month of the project, testing reached preintervention levels and was followed by a sustained decrease in testing. When assessing the entire hospitalization, we saw a decrease in the mean number of labs ordered per patient day, from 1.96 down to 1.83 post intervention ($P = .0101$).

DISCUSSION

Our structured, multifaceted approach effectively reduced daily lab testing in the 24 to 48 hours prior to discharge. Bedside IDR provided a unique opportunity to effectively communicate to the patient about necessary (or unnecessary) testing. More-

over, given the complexity of identifying clinical stability, our strategy focused on the onset of discharge planning, a more easily discernible and less obtrusive focal point to promote the discontinuation of lab testing.

Though the nature of bundled interventions can make it difficult to identify which intervention is most effective, we believe that all interventions were effective in different capacities during various phases in the intervention period. We believe that the decrease in lab testing in the 24 to 48 hours preceding discharge was primarily driven by the new rounding structure. This is evident in the significant decrease seen in the first few months of the intervention period. Six months into the intervention, we begin to see a decrease at 72 hours prior to discharge. Additionally, we see a decrease in the mean number of labs per patient day over the entire hospitalization period. We attribute these results to a gradual shift in the culture in our division as a direct consequence of educational sessions and individual feedback provided during this time.

To our knowledge, this is the first study to use anticipated discharge as a correlate for clinical stability and therefore as an opportunity to prompt discontinuation of laboratory testing. Other studies evaluated interventions targeting the EMR and the ease with which providers can order recurring labs. These include restricting recurring orders in the EMR,[4] a robust education and awareness campaign targeting house staff,[5] and other multifaceted approaches to decreasing lab utilization,[6] all of which have shown promising results. While these approaches show varying degrees of success, ours is unique in its focus on the period prior to discharge. In addition, the intervention can be readily implemented in settings that utilize scripted IDR. It also brings high-value decision-making to the bedside by informing the patient that in the setting of presumed clinical stability, no additional tests are warranted.

Our study has several limitations. First, while interdisciplinary discharge rounds are widely implemented,[7,8] our rounds occur at the bedside and employ a script, potentially limiting generalizability. The structured prompting may be feasible during structured IDR in a standard conference room setting, though we did not assess this model. Second, bedside rounds only included patients who were able to participate. Rounding on patients unable to participate, such as patients with delirium with agitation, was done outside the patient room rather than at the bedside. A modified script was used in these instances (absent questions addressed to the patient), allowing for the prompt to be incorporated. These patients were included in the analysis. Lastly, as previously stated, we cannot clearly identify which intervention (the prompt, education, or feedback) most effectively led to a sustained decrease in lab ordering.

Our structured, multifaceted intervention reduced laboratory testing during the last 48 hours of admission. Hospitals that aim to decrease potentially unnecessary lab testing should consider implementing a bundle, including a prompt at a uniform and structured point during the hospitalization of patients who are expected to be discharged within 24 to 48 hours, clinician education, an audit, and feedback.

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Penalizing Physicians for Low-Value Care in Hospital Medicine: A Randomized Survey

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Low-value services—those for which there is little to no benefit, little benefit relative to cost, or outsized potential harm compared with benefit—persist widely despite professional consensus, guidelines, and national campaigns to reduce them. As policy makers consider financially penalizing physicians to deter low-value services, physician support for such penalties remains unknown. We conducted a randomized survey experiment among physicians to evaluate how the framing of harms from low-value care—in terms of those to patients, healthcare institutions, or society—influenced physician support of financial penalties for low-value care services. Policy support rate was 39.6% overall and highest when the harms of low-value care were framed as costs to society (48.4%). Compared with respondents receiving the "patient harm" version, those receiving the "societal harm" version (adjusted odds ratio [OR] 2.83; 95% confidence interval [CI], 1.20-6.69), but not the "institutional harm" framing (adjusted OR 1.53; 95% CI, 0.66-3.53), were more likely to report policy support. Our results suggest that emphasizing the impact of these harms may increase acceptability of financial penalties among physicians and contribute to the larger effort to decrease low-value care in hospital settings. *Journal of Hospital Medicine* 2018;13:41-44. Published online first November 22, 2017.

Reducing low-value care—services for which there is little to no benefit, little benefit relative to cost, or outsized potential harm compared with benefit—is an essential step toward maintaining or improving quality while lowering cost. Unfortunately, low-value services persist widely despite professional consensus, guidelines, and national campaigns aimed to reduce them.[1-3] In turn, policy makers are beginning to consider financially penalizing physicians in order to deter low-value services.[4,5] Physician support for such penalties remains unknown. In this study, we used a randomized survey experiment to evaluate how the framing of harms from low-value care—in terms of those to patients, healthcare institutions, or society—influenced physician support of financial penalties for low-value care services.

METHODS

Study Sample

By using a stratified random sample maintained by the American College of Physicians, we conducted a web-based survey among 484 physicians who were either internal medicine residents or internists practicing hospital medicine.

Instrument Design and Administration

Our study focused on 3 low-value services relevant to inpatient medicine: (1) placing, and leaving in, urinary catheters for urine output monitoring in noncritically ill patients; (2) ordering continuous telemetry monitoring for nonintensive care unit (non-ICU) patients without a protocol governing continuation; and (3) prescribing stress ulcer prophylaxis for medical patients not at a high risk for gastrointestinal (GI) complications. Although the nature and trade-offs between costs, harms, and benefits vary by individual service, all 3 are promulgated through the Choosing Wisely® guidelines as low value based on existing data and professional consensus from the Society of Hospital Medicine.[6]

To evaluate intended behavior related to these 3 low-value services, respondents were first presented with 3 clinical vignettes focused on the care of patients hospitalized for pneumonia, congestive heart failure, and alcohol withdrawal, which were selected to reflect common inpatient medicine scenarios. Respondents were asked to use a 4-point scale (very likely to very unlikely) to estimate how likely they were to recommend various tests or treatments, including the low-value services noted above. Respondents who were "somewhat unlikely" and "very unlikely" to recommend low-value services were considered concordant with low-value care guidelines.

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TABLE. **Physician Characteristics (by Survey Version)**

Physician Characteristic	Overall (n = 187)	Version			*P* Value
		Patient (n = 60)	Societal (n = 62)	Institutional (n = 65)	
Age (median, IQR)	39 (33-47)	39 (35-44)	42 (33-48)	39 (33-47)	.85
Male (%)	57.8	58.3	53.2	61.5	.85
Professional position (%)					.99
Practicing physician	87.2	86.7	87.1	87.7	
Resident physician	12.8	13.3	12.9	12.3	
Practice incentives (%)[a]					.71
Cost incentives	20.9	25.0	22.6	15.4	
Non-cost incentives[b]	68.4	63.3	67.7	73.8	
No incentives	10.7	11.7	9.7	10.8	
Attitudinal items (% support)					
Providing financial incentives to individual physicians is an effective way to improve the value of healthcare.	73.3	76.7	75.8	67.7	.45
If a test or treatment has any chance of helping the patient, it is the clinician's duty to offer it regardless of cost.	70.1	78.3	69.4	63.1	.18
Clinicians should consider the costs of a test or treatment to society when making clinical decisions.	79.1	71.7	85.5	80.0	.17
Clinicians should consider the costs of a test or treatment to healthcare providers (practices, hospitals, and insurance companies) when making clinical decisions for their patients.	66.3	61.7	74.2	63.1	.27
It is inappropriate for anyone other than the treating clinician and patient to decide if a test or treatment is "worth the cost."	63.6	75.0	54.8	61.5	.06
Concordance between intended behavior and low-value care guidelines (%)					
Telemetric monitoring	11.8	8.3	9.7	16.9	.60
Stress ulcer prophylaxis	57.8	63.3	51.6	58.5	.33
Urinary catheterization	78.6	76.7	82.3	76.9	.25

[a]Refers to the % of respondents reporting that they are measured on these incentives in their inpatient practice.
[b]Includes quality, productivity, and patient satisfaction incentives.
NOTE: Abbreviation: IQR, interquartile range.

Following the vignettes, respondents then used a 5-point scale (strongly agree to strongly disagree) to indicate their agreement with a policy that financially penalizes physicians for prescribing each service. Support was defined as "somewhat or strongly" agreeing with the policy. Respondents were randomized to receive 1 of 3 versions of this question (supplementary Appendix).

All versions stated that, "According to research and expert opinion, certain aspects of inpatient care provide little benefit to patients" and listed the 3 low-value services noted above. The "patient harm" version also described the harm of low-value care as costs to patients and risk for clinical harms and complications. The "societal harm" version described the harms as costs to society and utilization of limited healthcare resources. The "institutional harm" version described harms as costs to hospitals and insurers.

Other survey items were adapted from existing literature[7-9] and evaluated respondent beliefs about the effectiveness of physician incentives in improving the value of care, as well as the appropriateness of including cost considerations in clinical decision-making.

The instrument was pilot tested among study team members and several independent internists affiliated with the University of Pennsylvania. After incorporating feedback into the final instrument, the web-based survey was distributed to eligible physicians via e-mail. Responses were anonymous and respondents received a $15 gift card for participation. The protocol was reviewed and deemed exempt by the University of Pennsylvania Institutional Review Board.

Statistical Analysis

Respondent characteristics (sociodemographic, intended clinical behavior, and cost control attitudes) were described by using percentages for categorical variables and medians and interquartile ranges for continuous variables. Balance in respondent characteristics across survey versions was evaluated using χ^2 and

Kruskal-Wallis tests. Multivariable logistic regression, adjusted for characteristics in the Table, was used to evaluate the association between survey version and policy support. All tests of significance were 2-tailed with significance level alpha = 0.05. Analyses were performed using STATA version 14.1 (StataCorp LLC, College Station, TX, http://www.stata.com).

RESULTS

Of 484 eligible respondents, 187 (39%) completed the survey. Compared with nonrespondents, respondents were more likely to be female (30% vs 26%, $P = .001$), older (mean age 41 vs 36 years, $P < .001$), and practicing clinicians rather than internal medicine residents (87% vs 69%, $P < .001$). Physician characteristics were similar across the 3 survey versions (Table). Most respondents agreed that financial incentives for individual physicians is an effective way to improve the value of healthcare (73.3%) and that physicians should consider the costs of a test or treatment to society when making clinical decisions for patients (79.1%). The majority also felt that clinicians have a duty to offer a test or treatment to a patient if it has any chance of helping them (70.1%) and that it is inappropriate for anyone beyond the clinician and patient to decide if a test or treatment is "worth the cost" (63.6%).

Concordance between intended behavior and low-value care guidelines ranged considerably (Figure). Only 11.8% reported behavior that was concordant with low-value care guidelines related to telemetric monitoring, whereas 57.8% and 78.6% reported concordant behavior for GI ulcer prophylaxis and urinary catheter placement, respectively.

Overall, policy support rate was 39.6% and was the highest for the "societal harm" version (48.4%), followed by the "institutional harm" (36.9%) and "patient harm" (33.3%) versions. Compared with respondents receiving the "patient harm" version, those receiving the "societal harm" version (adjusted odds ratio [OR] 2.83; 95% confidence interval [CI], 1.20-6.69), but not the "institutional harm" framing (adjusted OR 1.53; 95% CI, 0.66-3.53), were more likely to report policy support. Policy support was also higher among those who agreed that providing financial incentives to individual physicians is an effective way to improve the value of healthcare (adjusted OR 4.61; 95% CI, 1.80-11.80).

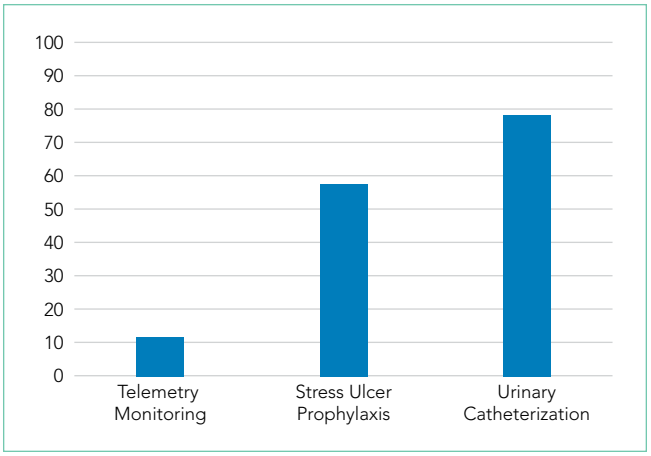

FIG. Percent Concordance between Intended Behavior and Low Value Care Guidelines.

DISCUSSION

To our knowledge, this study is the first to prospectively evaluate physician support of financial penalties for low-value services relevant to hospital medicine. It has 2 main findings.

First, although overall policy support was relatively low (39.6%), it varied significantly on the basis of how the harms of low-value care were framed. Support was highest in the "societal harm" version, suggesting that emphasizing these harms may increase acceptability of financial penalties among physicians and contribute to the larger effort to decrease low-value care in hospital settings. The comparatively low support for the "patient harm" version is somewhat surprising but may reflect variation in the nature of harm, benefit, and cost trade-offs for individual low-value services, as noted above, and physician belief that some low-value services do not in fact produce significant clinical harms.

For example, whereas evidence demonstrates that stress ulcer prophylaxis in non-ICU patients can harm patients through nosocomial infections and adverse drug effects,[10,11] the clinical harms of telemetry are less obvious. Telemetry's low value derives more from its high cost relative to benefit, rather than its potential for clinical harm.[6] The many paths to "low value" underscore the need to examine attitudes and uptake toward these services separately and may explain the wide range in concordance between intended clinical behavior and low-value care guidelines (11.8% to 78.6%).

Reinforcing policies could more effectively deter low-value care. For example, multiple forces, including Medicare payment reform and national accreditation policies,[12,13] have converged to discourage low-value use of urinary catheters in hospitalized patients. In contrast, there has been little reinforcement beyond consensus guidelines to reduce low-value use of telemetric monitoring. Given questions about whether consensus methods alone can deter low-value care beyond obvious "low hanging fruit,"[14] policy makers could coordinate policies to accelerate progress within other priority areas.

Broad policies should also be paired with local initiatives to influence physician behavior. For example, health systems have begun successfully leveraging the electronic medical record and utilizing behavioral economics principles to design interventions to reduce inappropriate overuse of antibiotics for upper respiratory infections in primary care clinics.[15] Organizations are also redesigning care processes in response to resource utilization imperatives under ongoing value-based care payment reform. Care redesign and behavioral interventions embedded at the point of care can both help deter low-value services in inpatient settings.

Study limitations include a relatively low response rate, which limits generalizability. However, all 3 randomized groups were similar on measured characteristics, and experimental randomization reduces the nonresponse bias concerns accompanying descriptive surveys. Additionally, although we evaluat-

ed intended clinical behavior in a national sample, our results may not reflect actual behavior among all physicians practicing hospital medicine. Future work could include assessments of actual or self-reported practices or examine additional factors, including site, years of practice, knowledge about guidelines, and other possible determinants of guideline-concordant behaviors.

Despite these limitations, our study provides important early evidence about physician support of financial penalties for low-value care relevant to hospital medicine. As policy makers design and organizational leaders implement financial incentive policies, this information can help increase their acceptability among physicians and more effectively reduce low-value care within hospitals.

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When Reducing Low-Value Care in Hospital Medicine Saves Money, Who Benefits?

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One emerging policy solution for deterring low-value care is to financially penalize physicians who prescribe it. However, physicians' willingness to support such policies may depend on whether they perceive that benefits accrue to patients or to insurers and hospitals. We surveyed physicians practicing hospital medicine to evaluate the association between policy support and physician beliefs about who benefits from the money saved through reducing low-value services in hospital medicine. Overall, physicians believed that more of any money saved would go to profits and leadership salaries for insurance companies and hospitals and/or health systems rather than to patients. These beliefs were associated with policy support: 66% of those supporting physician penalties were more likely to believe that benefits accrue to patients or physicians, compared to 39% of those not supporting policies ($P < 0.001$). Our findings are consistent with a sense of healthcare justice, in which physicians are less likely to support penalties imposed on themselves if the resulting benefits accrue to corporate or organizational interests. Effective physician penalties will likely need to address the belief that insurers and provider organizations stand to gain more than patients when low-value care services are reduced. *Journal of Hospital Medicine* 2018;13:45-48. Published online first November 22, 2017 © 2018 Society of Hospital Medicine

Physicians face growing pressure to reduce their use of "low value" care—services that provide either little to no benefit, little benefit relative to cost, or outsized potential harm compared to benefit. One emerging policy solution for deterring such services is to financially penalize physicians who prescribe them.[1,2]

Physicians' willingness to support such policies may depend on who they believe benefits from reductions in low-value care. In previous studies of cancer screening, the more that primary care physicians felt that the money saved from cost-containment efforts went to insurance company profits rather than to patients, the less willing they were to use less expensive cancer screening approaches.[3]

Similarly, physicians may be more likely to support financial penalty policies if they perceive that the benefits from reducing low-value care accrue to patients (eg, lower out-of-pocket costs) rather than insurers or hospitals (eg, profits and salaries of their leaders). If present, such perceptions could inform incentive design. We explored the hypothesis that support of financial penalties for low-value care would be associated with where physicians thought the money goes.

METHODS

Study Sample

By using a panel of internists maintained by the American College of Physicians, we conducted a randomized, web-based survey among 484 physicians who were either internal medicine residents or internal medicine physicians practicing hospital medicine.

Survey Instrument

Respondents used a 5-point scale ("strongly disagree" to "strongly agree") to indicate their agreement with a policy that financially penalizes physicians for prescribing services that provide few benefits to patients. Respondents were asked to simultaneously consider the following hospital medicine services, deemed to be low value based on medical evidence and consensus guidelines[4]: (1) placing, and leaving in, urinary catheters for urine output monitoring in noncritically ill patients, (2) ordering continuous telemetry monitoring for nonintensive care unit patients without a protocol governing continuation, and (3) prescribing stress ulcer prophylaxis for medical patients not at a high risk for gastrointestinal complications. Policy support was defined as "somewhat" or "strongly" agreeing with the policy. As part of another study of this physician cohort,

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FIG. Physician Beliefs about where Money Saved from Reducing Low-Value Services Goes.

this question varied in how the harm of low-value services was framed: either as harm to patients, to society, or to hospitals and insurers as institutions. Respondent characteristics were balanced across survey versions, and for the current analysis, we pooled responses across all versions.

All other questions in the survey, described in detail elsewhere,[5] were identical for all respondents. For this analysis, we focused on a question that asked physicians to assume that reducing these services saves money without harming the quality of care and to rate on a 4-point scale ("none" to "a lot") how much of the money saved would ultimately go to the following 6 nonmutually exclusive areas: (a) other healthcare services for patients, (b) reduced charges to patients' employers or insurers, (c) reduced out-of-pocket costs for patients, (d) salaries and bonuses for physicians, (e) salaries and profits for insurance companies and their leaders, and (f) salaries and profits for hospitals and/or health systems and their leaders.

Based on the positive correlation identified between the first 4 items (a to d) and negative correlation with the other 2 items (e and f), we reverse-coded the latter 2 and summed all 6 into a single-outcome scale, effectively representing the degree to which the money saved from reducing low-value services

TABLE. **Odds Ratios for Physician Beliefs about Who Benefits from Reductions in Low-Value Care**

	Odds Ratios (95% CI)	
Variable	**Unadjusted**	**Adjusted**
Policy Support		
No	1.00	1.00
Yes	3.1 (1.7-5.7)	2.8 (1.5-5.3)
Age		0.99 (0.96-1.0)
Gender		
Male		1.00
Female		0.55 (0.27-1.1)
Professional Status		
Practicing internist		1.00
Resident		1.1 (0.39-2.9)
Incentives		
Cost		1.00
Noncost		1.2 (0.57-2.6)
None		0.63 (0.30-1.3)
Survey Version		
Patient harm		1.00
Societal harm		1.2 (0.57-2.6)
Institutional harm		0.63 (0.30-1.3)

NOTE: Abbreviation: CI, confidence interval.

accrues generally to patients or physicians instead of to hospitals, insurance companies, and their leaders. The Cronbach alpha for the scale was 0.74, indicating acceptable reliability. Based on scale responses, we dichotomized respondents at the median into those who believe that the money saved from reducing low-value services would accrue as benefits to patients or physicians and those who believe benefits accrue to insurance companies or hospitals and/or health systems and their leaders. The protocol was exempted by the University of Pennsylvania Institutional Review Board.

Statistical Analysis

We used a χ^2 test and multivariable logistic regression analysis to evaluate the association between policy support and physician beliefs about who benefits from reductions in low-value care. A χ^2 test and a Kruskal-Wallis test were also used to evaluate the association between other respondent characteristics and beliefs about who benefits from reductions in low-value care. Analyses were performed by using Stata version 14.1 (StataCorp, College Station, TX). Tests of significance were 2-tailed at an alpha of .05.

RESULTS

Compared with nonrespondents, the 187 physicians who responded (39% response rate) were more likely to be female (30% vs 26%, $P = 0.001$), older (mean age 41 vs 36 years old, $P < 0.001$), and practicing clinicians rather than internal medicine residents (87% vs 69%, $P < 0.001$). Twenty-one percent reported that their personal compensation was tied to cost incentives.

Overall, respondents believed that more of any money saved from reducing low-value services would go to profits and leadership salaries for insurance companies and hospitals and/or health systems rather than to patients (panel A of Figure). Few respondents felt that the money saved would ultimately go toward physician compensation.

Physician beliefs about where the majority of any money saved goes were associated with policy support (panel B of Figure). Among those who did not support penalties, 52% believed that the majority of any money saved would go to salaries and profits for insurance companies and their leaders, and 39% believed it would go to salaries and profits for hospitals and/or health systems and their leaders, compared to 35% ($P = 0.02$) and 32% ($P = 0.37$), respectively, among physicians who supported penalties.

Sixty-six percent of physicians who supported penalties believed that benefits from reducing low-value care accrue to patients or physicians, compared to 39% among those not supporting penalties ($P < 0.001$). In multivariable analyses, policy support was associated with the belief that the money saved from reducing low-value services would accrue as benefits to patients or physicians rather than as salaries and profits for insurance companies or hospitals and/or health systems and their leaders (Table). There were no statistically significant associations between respondent age, gender, or professional status and beliefs about who benefits from reductions in low-value care.

DISCUSSION

Despite ongoing efforts to highlight how reducing low-value care benefits patients, physicians in our sample did not believe that much of the money saved would benefit patients.

This result may reflect that while some care patterns are considered low value because they provide little benefit at a high cost, others yield potential harm, regardless of cost. For example, limiting stress ulcer prophylaxis largely aims to avoid clinical harm (eg, adverse drug effects and nosocomial infections). Limiting telemetric monitoring largely aims to reduce costly care that provides only limited benefit. Therefore, the nature of potential benefit to patients is very different—improved clinical outcomes in the former and potential cost savings in the latter. Future studies could separately assess physician attitudes about these 2 different definitions of low-value services.

Our study also demonstrates that the more physicians believe that much of any money saved goes to the profits and salaries of insurance companies, hospitals and/or health systems, and their leaders rather than to patients, the less likely they are to support policies financially penalizing physicians for prescribing low-value services.

Our study does not address why physicians have the beliefs that they have, but a likely explanation, at least in part, is that financial flows in healthcare are complex and tangled. Indeed,

a clear understanding of who actually benefits is so hard to determine that these stated beliefs may really derive from views of power or justice rather than from some understanding of funds flow. Whether or not ideological attitudes underlie these expressed beliefs, policymakers and healthcare institutions might be advised to increase transparency about how cost savings are realized and whom they benefit.

Our analysis has limitations. Although it provides insight into where physicians believe relative amounts of money saved go with respect to 6 common options, the study did not include an exhaustive list of possibilities. The response rate also limits the representativeness of our results. Additionally, the study design prevents conclusions about causality; we cannot determine whether the belief that savings go to insurance companies and their executives is what reduces physicians' enthusiasm for penalties, whether the causal association is in the opposite direction, or whether the 2 factors are linked in another way.

Nonetheless, our findings are consistent with a sense of healthcare justice in which physicians support penalties imposed on themselves only if the resulting benefits accrue to patients rather than to corporate or organizational interests. Effective physician penalties will likely need to address the belief that insurers and provider organizations stand to gain more than patients when low-value care services are reduced.

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Things We Do For No Reason: Electrolyte Testing in Pediatric Acute Gastroenteritis

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The "Things We Do for No Reason" (TWDFNR) 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.

Acute gastroenteritis (AGE) remains a substantial cause of childhood illness and is 1 of the top 10 reasons for pediatric hospitalization nationwide. In the United States, AGE is responsible for 10% of hospital admissions and approximately 300 deaths annually.[1] The American Academy of Pediatrics (AAP) and other organizations have emphasized supportive care in the management of AGE. Routine diagnostic testing has been discouraged in national guidelines except in cases of severe dehydration or an otherwise complicated course. Despite AGE guidelines, diagnostic laboratory tests are still widely used even though they have been shown to be poor predictors of dehydration. Studies have shown that high test utilization in various pediatric disease processes often influences the decision for hospitalization without improvement in patient outcome. In children with AGE, the initial and follow-up laboratory tests may not only be something that we do for no reason, but something that is associated with more risk than benefit.

An 18-month-old healthy male is brought to the emergency department (ED) with a chief complaint of 2 days of nonbloody, nonbilious emesis and watery diarrhea. He has decreased energy but smiles and plays for a few minutes. He has had decreased wet diapers. His exam is notable for mild tachycardia, mildly dry lips, and capillary refill of 3 seconds. A serum electrolyte panel is normal except for a sodium of 134 mEq/L, a bicarbonate of 16 mEq/L, and an anion gap of 18, which are flagged as abnormal by the electronic medical record. These results prompt intravenous (IV) access, a normal saline bolus, and admission on maintenance fluids overnight. The next morning, his electrolyte panel is repeated, and his sodium is 140 mEq/L and bicarbonate is 15 mEq/L. He is now drinking well with no further episodes of emesis, so he is discharged home.

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WHY PHYSICIANS MIGHT THINK ELECTROLYTE TESTING IS HELPFUL

Many physicians across the United States continue to order electrolytes in AGE as a way to avoid missing severe dehydration, severe electrolyte abnormalities, or rare diagnoses, such as adrenal insufficiency or new-onset diabetes, in a child. Previous studies have revealed that bicarbonate and blood urea nitrogen (BUN) may be helpful predictors of severe dehydration. A retrospective study of 168 patients by Yilmaz et al.[2] showed that BUN and bicarbonate strongly correlated with dehydration severity ($P < .00001$ and $P = .01$, respectively). A 97-patient prospective study by Vega and Avner[3] showed that bicarbonate <17 can help in predicting percent body weight loss (PBWL) (sensitivity of 77% for PBWL 6-10 and 94% for PBWL >10).

In AGE, obtaining laboratory data is often considered to be the more conservative approach. Some attribute this to the medical education and legal system rewarding the uncovering of rare diagnoses,[4] while others believe physicians obtain laboratory data to avoid missing severe electrolyte disorders. One author notes, "physicians who are anxious about a patient's problem may be tempted to do something—anything—decisive in order to diminish their own anxiety."[5] Severe electrolyte derangements are common in developing countries[6] but less so in the United States. A prospective pediatric dehydration study over 1 year in the United States demonstrated rates of 6% and 3% of hypo- and hypernatremia, respectively (n = 182). Only 1 patient had a sodium level >160, and this patient had an underlying genetic syndrome, and none had hyponatremia <130. Hypoglycemia was the most common electrolyte abnormality, which was present in 9.8% of patients. Electrolyte results changed management in 10.4% of patients.[7]

WHY ELECTROLYTE TESTING IS GENERALLY NOT HELPFUL

In AGE with or without dehydration, guidelines from the AAP and other international organizations emphasize supportive care in the management of AGE and discourage routine diagnostic testing.[8-10] Yet, there continues to be wide variation in AGE management.[11-13] Most AGE cases presenting to an outpatient setting or ED are uncomplicated: age >6 months, nontoxic appearance, no comorbidities, no hematochezia, diarrhea <7 days, and mild-to-moderate dehydration.

Steiner et al.[14] performed a systematic meta-analysis of the precision and accuracy of symptoms, signs, and laboratory tests for evaluating dehydration in children. They concluded that a standardized clinical assessment based on physical exam (PE)

TABLE. **Clinical Dehydration Scale for Children (Total Score From 0-8)**[26]

Characteristics	0	1	2
General appearance	Normal	Thirsty, restless, or lethargic, but irritable when touched	Drowsy, limp, cold, or sweaty, and/or comatose
Eyes	Normal	Slightly sunken	Very sunken
Mucous membranes	Moist	Sticky	Dry
Tears	Tears	Decreased tears	Absent

NOTE: A score of 0 represents no dehydration; a score of 1-4, some dehydration; and a score of 5-8, moderate or severe dehydration.

findings more accurately classifies the degree of dehydration than laboratory testing. Steiner et al[14] specifically analyzed the works by Yilmaz et al.[2] and Vega and Avner,[3] and determined that the positive likelihood ratios for >5% dehydration resulting from a BUN >45 or bicarbonate <17 were too small or had confidence intervals that were too wide to be clinically helpful alone. Therefore, Steiner et al.[14] recommended that laboratory testing should not be considered definitive for dehydration.

Vega and Avner[3] found that electrolyte testing is less helpful in distinguishing between <5% (mild) and 5% to 10% (moderate) dehydration compared to PBWL. Because both mild and moderate dehydration respond equally well to oral rehydration therapy (ORT),[8] electrolyte testing is not helpful in managing these categories. Many studies have excluded children with hypernatremia, but generally, severe hypernatremia is uncommon in healthy patients with AGE. In most cases of mild hypernatremia, ORT is the preferred resuscitation method and is possibly safer than IV rehydration because ORT may induce less rapid shifts in intracellular water.[15]

Tieder et al.[16] demonstrated that better hospital adherence to national recommendations to avoid diagnostic testing in children with AGE resulted in lower charges and equivalent outcomes. In this large, multicenter study among 27 children's hospitals in the Pediatric Hospital Information System (PHIS) database, only 70% of the 188,000 patients received guideline-adherent care. Nonrecommended laboratory testing was common, especially in the admitted population. Electrolytes were measured in 22.1% of the ED and observation patients compared with 85% of admitted patients. Hospitals that were most guideline adherent in the ED demonstrated 50% lower charges. The authors estimate that standardizing AGE care and eliminating nonrecommended laboratory testing would decrease admissions by 45% and save more than $1 billion per year in direct medical costs.[16] In a similar PHIS study, laboratory testing was strongly correlated with the percentage of children hospitalized for AGE at each hospital ($r = 0.73$, $P < .001$). Results were unchanged when excluding children <1 year of age ($r = 0.75$, $P < .001$). In contrast, the mean testing count was not correlated with return visits within 3 days for children discharged from the ED ($r = 0.21$, $P = .235$), nor was it correlated with hospital length of stay ($r = -0.04$, $P = .804$) or return visits within 7 days ($r = 0.03$, $P = .862$) for hospitalized children.[12] In addition, Freedman et al.[17] revealed that the clinical dehydration score is independently associated with successful ED discharge without revisits, and laboratory testing does not prevent missed cases of severe dehydration.

Nonrecommended and often unnecessary laboratory testing in AGE results in IV procedures that are sometimes repeated because of abnormal values. "Shotgun testing," or ordering a panel of labs, can result in abnormal laboratory values in healthy patients. Deyo et al.[18] cite that for a panel of 12 laboratory values, there is a 46% chance of having at least 1 abnormal lab, even in healthy patients. These false-positive results can then drive further testing. In AGE, an abnormal bicarbonate may drive repeat testing to confirm normalization, but the bicarbonate may actually decrease once IV fluid therapy is initiated due to excessive chloride in isotonic fluids. Coon et al.[19] have shown that seemingly innocuous testing or screening can lead to overdiagnosis, which can cause physical and psychological harm to the patient and has financial implications for the family and healthcare system. While this has not been directly investigated in pediatric AGE, it has been studied in common pediatric illnesses, including pneumonia and urinary tract infections.[20,21] For children, venipuncture and IV placements are often the most distressful components of a hospital visit and can affect future healthcare encounters, making children anxious and distrustful of the healthcare system.[22,23]

WHY ELECTROLYTE TESTING MIGHT BE HELPFUL

Electrolyte panels may be useful in assessing children with severe dehydration (scores of 5-8 on the Clinical Dehydration Scale (CDS) or more than 10% weight loss) or in complicated cases of AGE (those that do not meet the criteria of age >6 months, nontoxic appearance, no comorbidities, no hematochezia, and diarrhea <7 days) to guide IV fluid management and correct markedly abnormal electrolytes.[14]

Electrolyte panels may also rarely uncover disease processes, such as new-onset diabetes, hemolytic uremic syndrome, adrenal insufficiency, or inborn errors of metabolism, allowing for early diagnosis and preventing adverse outcomes. Suspicion to investigate such entities should arise during a thorough history and PE instead of routinely screening all children with symptoms of AGE. One should also have a higher level of concern for other disease processes when clinical recovery does not occur within the expected amount of time; symptoms usually resolve within 2 to 3 days but sometimes will last up to a week.

WHAT WE SHOULD DO INSTEAD

A thorough history and PE can mitigate the need for electrolyte testing in patients with uncomplicated AGE.[14] ORT with repeated clinical assessments, including PE, can assist in monitoring clinical improvement and, in rare cases, identify alternative causes of vomiting and diarrhea.[24] We have included 1 validated and simple-to-use CDS (sensitivity of 0.85 [95% confidence interval, 0.73-0.97] for an abnormal score; Table).[25,26] A

standardized use of a CDS, obtained with vital signs, from patient presentation through discharge can help determine initial dehydration status and clinical progression. If typical clinical improvement does not take place, it may be time to evaluate for rarer causes of vomiting and diarrhea. Once a patient is clinically rehydrated or if a patient is tolerating oral fluids so that rehydration is expected, the patient should be ready for discharge, and no further laboratory testing should be necessary.

RECOMMENDATIONS

- Perform a thorough history and PE to diagnose AGE.[8]
- Clinical assessment of dehydration should be performed upon initial presentation and repeatedly with vital signs throughout the stay using a validated CDS to classify the patient's initial dehydration severity and monitor improvement. Obtain a current patient weight and compare with previously recorded weights, if available.[25,26]
- Laboratory testing in patients with AGE should not be performed unless a patient is classified as severely dehydrated, is toxic appearing, has a comorbidity that increases the likelihood of complications, or is not improving as expected.
- Rehydration via ORT is preferred to an IV in mild and moderate dehydration.[15]
- If initial testing is performed and indicates an expected value indicative of dehydration, do not repeat testing to demonstrate normalization as long as the child is clinically improving as expected.

CONCLUSION

Children presenting with mild-to-moderate dehydration should be treated with supportive measures in accordance with current guidelines. Electrolyte panels very rarely provide clinical information that cannot be garnered through a thorough history and PE. As in our clinical scenario, the laboratory values obtained may have led to potential harm, including overdiagnosis, painful procedures, and psychological distress. Without testing, the patient likely could have been appropriately treated with ORT and discharged from the ED.

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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Interventions to Reduce the Overuse of Imaging for Pulmonary Embolism: A Systematic Review

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BACKGROUND: Imaging use in the diagnostic workup of pulmonary embolism (PE) has increased markedly in the last 2 decades. Low PE prevalence and diagnostic yields suggest a significant problem of overuse.

PURPOSE: The purpose of this systematic review is to summarize the evidence associated with the interventions aimed at reducing the overuse of imaging in the diagnostic workup of PE in the emergency department and hospital wards.

DATA SOURCES: PubMed, MEDLINE, Embase, and EBM Reviews from 1998 to March 28, 2017.

STUDY SELECTION: Experimental and observational studies were included. The types of interventions, their efficacy and safety, the impact on healthcare costs, the facilitators, and barriers to their implementation were assessed.

DATA SYNTHESIS: Seventeen studies were included assessing clinical decision support (CDS), educational interventions, performance and feedback reports (PFRs), and institutional policy. CDS impact was most comprehensively documented. It was associated with a reduction in imaging use, ranging from 8.3% to 25.4%, and an increase in diagnostic yield, ranging from 3.4% to 4.4%. The combined implementation of a CDS and PFR resulted in a modest but significant increase in the adherence to guidelines. Few studies appraised the safety of interventions. There was a lack of evidence concerning economic aspects, facilitators, and barriers.

CONCLUSIONS: A combined implementation of an electronic CDS and PFRs is more effective than purely educational or policy interventions, although evidence is limited. Future studies of high-methodological quality would strengthen the evidence concerning their efficacy, safety, facilitators, and barriers. *Journal of Hospital Medicine* 2018;13:52-61. © 2018 Society of Hospital Medicine

The last 2 decades have seen a dramatic rise in the use of medical imaging in general,[1,2] as well as in the diagnostic workup of pulmonary embolism (PE) more specifically, since the introduction of multidetector row computed tomography pulmonary angiography (CTPA) in 1998.[3] From 1999 to 2010, the proportions of emergency department (ED) visits associated with a diagnosis of PE and admissions for PE have increased markedly in the United States, where the situation has been well documented.[4,5] A 14-fold increase in the use of CTPA was observed in health maintenance organizations from 2001 to 2008.[3] A significant increase in the probability of having a diagnosis of PE in the ED was reported, likely because of increased access to CTPA, from 2001 to 2010.[4] With a prevalence of 2% or less in the ED, diagnostic yields as low as 5% suggest a significant problem of overuse.[6,7]

Strategies have been proposed to improve the appropriateness of imaging in the detection of PE, and these rely on the use of a validated clinical decision rule (CDR) to assess the pretest probability of the diagnosis. The purpose of this systematic review is to summarize the evidence associated with interventions aimed at reducing the overuse of imaging in the diagnostic workup of PE in the ED and hospital wards. Specifically, the types of interventions, their clinical effectiveness, as well as possible harms will be assessed. A secondary objective is to appraise the impact of these interventions on healthcare costs as well as the facilitators and barriers to their implementation.

METHODS

Inclusion Criteria

Targeted settings were EDs and inpatient services of adult tertiary and quaternary care hospitals. The search addressed interventions aimed at reducing the overuse of imaging in the diagnostic workup for PE. The comparators were usual care or another type of related intervention. The main outcomes considered were the use of imaging, diagnostic yield, radiation dose, adherence to guidelines to a quality measure, safety, and costs; both experimental and observational studies were included.

Literature Search

A systematic literature search in the following electronic databases was performed: PubMed, MEDLINE, Embase, and EBM

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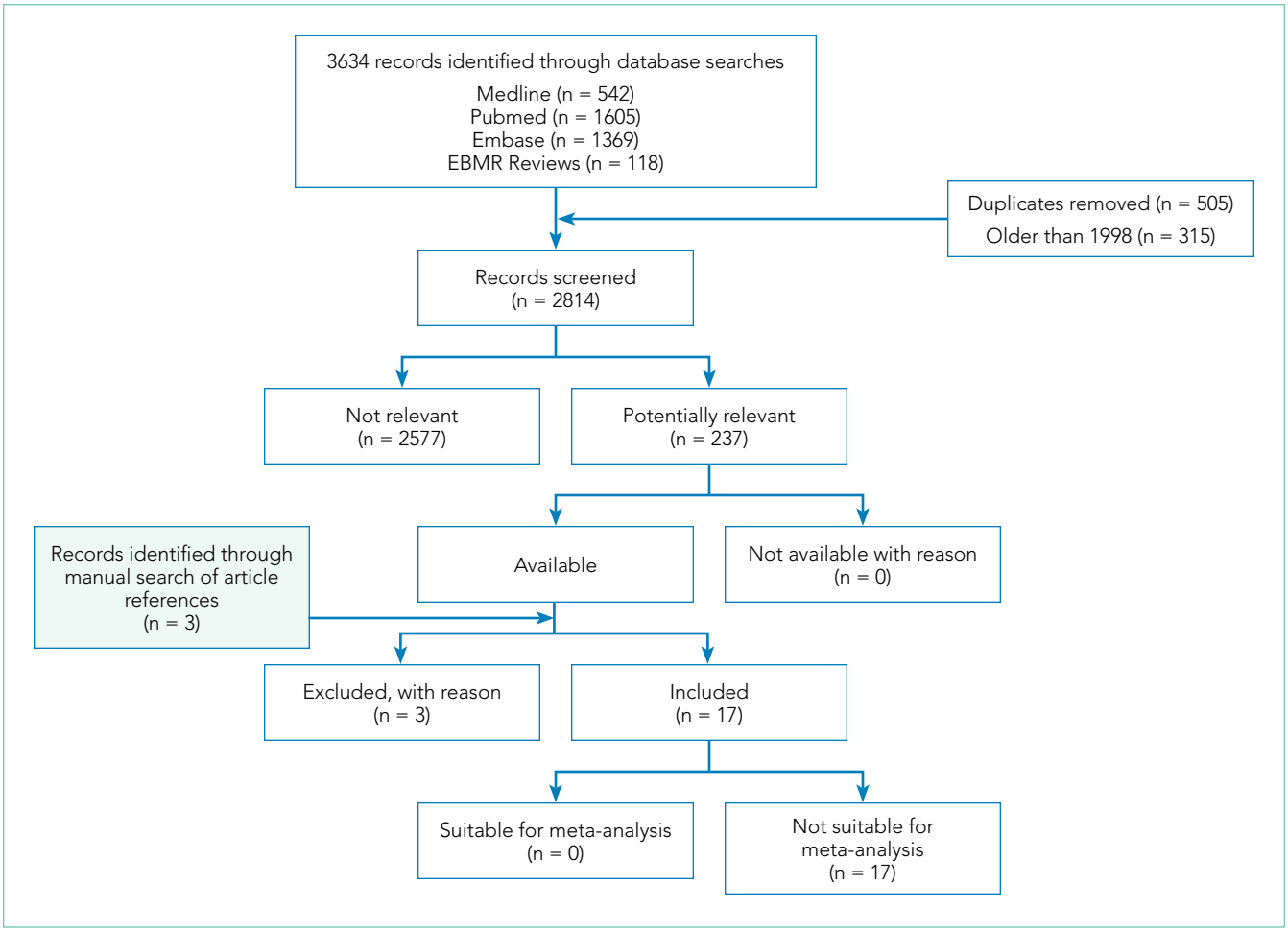

FIG. Literature selection process.

Reviews (Cochrane, ACP Journal Club, Database of Abstracts of Reviews of Effects, Cochrane Central Register of Controlled Trials, Cochrane Methodology Register, Cochrane Health Technology Assessment, and the NHS Economic Evaluation Database). The reference period was from 1998 to March 28, 2017, and publications in English and French were searched. The detailed search strategy, adapted to each of the databases, appears in supplemental Appendix 1.

Study Selection and Data Extraction

One author (SD) reviewed the titles of the selected articles and excluded those that obviously did not satisfy the inclusion criteria. Then, 2 authors (SD and LL) independently reviewed the titles and abstracts of the remaining articles. They reviewed the full manuscript of potentially relevant articles for inclusion. Disagreements that could not be resolved by discussion would have been arbitrated by a third author (CCL); however, no such disagreement occurred.

Quality and Risk of Bias Assessment

For experimental or quasiexperimental studies that involved an intervention group and a control group, the criteria proposed by the Cochrane collaborative for the evaluation of bias were used.[8] For studies using a before and after design, the following main biases associated with such designs were assessed: history effect, maturation bias, testing bias, regression to the mean, and conditioning bias.[9]

Data Extraction and Synthesis

Data pertaining to efficacy, safety, costs, and facilitators and barriers to the implementation of interventions were extracted from the studies. The research process adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2009 checklist.[10] In view of the heterogeneity of the studies, a narrative synthesis was produced in accordance with the methodology proposed by Popay et al.[11] The review protocol was registered in PROSPERO (this registry can be consulted at the following URL address: http://www.crd.york.ac.uk/PROSPERO/).

RESULTS

The search screened 2814 records after the removal of duplicates and studies published before 1998. The figure illustrates the literature selection process.[12] Seventeen studies were included in the review following appraisal. Most of the studies (15/17) evaluated interventions in the ED,[7,13-26] while the

TABLE 1. **Characteristics of Included Studies**

Study	Postintervention Period	CDR	Setting	Expected Results
Randomized Controlled Trials (RCT)				
Kline et al. (2014)[13]	10 months	PERC and D-dimer	3 academic ED and 1 community hospital in the United States	Estimated cumulative radiation dose (mSv) Hospital costs LOS Patient satisfaction
Raja et al. (2015)[14]	12 months	3 levels Wells criteria and D-dimer	ED of a quaternary-care academic hospital in the United States	CTPA use (n of CTPA, n of patients seen/physician) Yield of CTPA (n of positive exams/n of exams ordered for PE) Adherence to evidence-based guidelines Adherence to the Wells criteria D-dimer level
Non-Randomized Control Study				
Goldstein et al.[27]	5 months	D-dimer	Inpatient medical wards of an academic hospital in the United States	Number of imaging exams ordered Mortality, duration of hospitalization, and 3-month incidence of recurrent VTE or bleeding complications
"Before and After" Prospective Studies				
Kline et al. (2004)[23]	12 months	Charlotte rule[37] and D-dimer	Large urban ED of a university hospital in the United States	Presence of an adverse outcome incident within 90 days n of pulmonary vascular imaging studies Rate of pulmonary vascular imaging (number of patients imaged/ED census) and median LOS Physician satisfaction
Raja et al. (2014)[24]	12 months	3 levels Wells criteria and D-dimer	ED of a quaternary-care academic hospital in the United States	Documented adherence to the National Quality Measure (NQM) Utilization rate of CTPA (n of CTPA per registered number of ED patient visits) Yield of CTPA (proportion of all CTPA performed positive for PE)
Stein et al.[25]	12 months	Clinical algorithm based on PIOPED II [38]	ED, radiology, and nuclear medicine services of a large urban academic medical center in the United States	n and results of CTPA and V/Q scan performed quarterly Mean effective dose for imaging performed to evaluate suspected PE each year for each patient
"Before and After" Retrospective Studies				
Agarwal et al.[15]	3 months	3 levels Wells criteria and D-dimer	ED of a hospital in Australia	Application of the Wells criteria (yes/no) Chest x-ray results Wells score D-dimer testing (yes/no) D-dimer level CTPA or V/Q scan result
Booker and Johnson[26]	2 months and 24 days	Dichotomous Wells criteria, 3 levels Wells criteria, PERC, and D-dimer	ED of a community teaching hospital in the United States	Age, gender, vitals on presentation D-dimer level Signs and symptoms of DVT, immobilization or surgery within past month, history of malignancy, exogenous estrogen use, hemoptysis Percentage of CTPA ordered with low Wells score, patients without D-dimer percentage of CTPA ordered on negative D-dimer percentage of CTPA positive for PE

Continued on page 55

remaining studies (2/17) were conducted in clinical wards of acute care hospitals.[27,28] Thirteen studies were conducted in the United States, 3 in Australia, and 1 in Europe. Four types of interventions were identified in the selected studies: electronic clinical decision support (CDS) (8/17), educational interventions (7/17), performance feedback reports (PFRs) (1/17), and an institutional clinical pretest policy (1/17). In 10 of the studies, the proposed intervention was mandatory.

TABLE 1. **Characteristics of Included Studies (continued)**

Study	Postintervention Period	CDR	Setting	Expected Results
Char and Yoon[7]	12 months	Clinical pretest (Wells criteria or other) D-dimer	ED of an HMO (Hawai) in the United States	Prevalence of PE (n r of positive CTPA/n of CTPA ordered for PE) × 100 Wells score D-dimer level Proportion of patients with D-dimer testing CTPA result
Drescher et al.[16]	4 months	Dichotomous Wells criteria and D-dimer	ED of an academic hospital in the United States	CTPA positivity rate ([n of positive CTPA/n of CTPA ordered for PE] × 100) Order rate ([total number of CTPA/total ED visits] × 100) Patient returns within 6 months
Dunne et al.[28]	32 months	3 levels Wells criteria and D-dimer	Radiology department and inpatient units of a quaternary care academic hospital in the United States	Monthly use of CTPA/1000 admissions CTPA yield (percentage of positive CTPA for PE). Monthly CTPA yield before and after intervention, by clinical specialty of the ordering providers.
Geeting et al.[17]	12 months	Dichotomous Wells criteria and D-dimer	ED of a tertiary care academic hospital in the United States	CTPA use (n of CTPA exams and rate of study utilization [ED visits with CTPA]) Appropriate CTPA use CTPA overuse/underuse Diagnostic yield ([n of positive CTPA studies/n of CTPA studies performed] × 100)
Goergen et al.[18]	9 months	Charlotte rule and D-dimer	ED of a tertiary referral academic hospital in Australia	n of patients with low risk and negative D-dimer diagnosed with PE or DVT during follow up Proportion of patients with documented risk assessment Proportion of imaged patients with low risk and negative D-dimer Comparison of the proportion of patients in the study and control groups who underwent imaging of any type or D-dimer assay
Jiménez et al.[19]	12 months	3 levels Wells criteria and D-dimer	ED of an acute care hospital in Spain	Use (n of CTPA per 1000 ED visits) Yield (percentage of CTPA positive for PE) Fatal and nonfatal VTE that occurred during the 3-month follow-up period
Kanaan et al.[20]	26 days	Dichotomous Wells criteria or another clinical pretest[38-40] D-dimer	ED of a tertiary care center in the United States	Sex, pregnancy status (females) Result of CDR (Wells or other) D-dimer result Percentage with D-dimer performed before CTPA, percentage with negative D-dimer Percentage with alternative explanation for chest pain Imaging result (V/Q scan, CTPA or other) Percentage of patients <40 years with CTV performed, prevalence rates for VTE by CTPA, any changes to the patient's treatment
Prevedello et al.[21]	18 months	3 levels Wells criteria and D-dimer	ED of a quaternary-care academic hospital in the United States	Patient age and gender History of malignancy, surgery or thrombosis, and evidence of D-dimer elevation Presence of PE Imaging requests entered by attending physicians
Raja et al. (2012)[22]	18 months	3 levels Wells criteria and D-dimer	ED of a quaternary-care academic hospital in the United States	Age, sex, date of study, history of neoplasm, VTE or recent surgery, and D-dimer level Presence of PE Diagnostic yield ([positive CTPA/total number of CTPA] × 100) Use rate ([n of CTPA performed/1000 visits to the ED] × 100)

NOTE: Abbreviations: CDS, clinical decision support; CDR, clinical decision rule; CTPA, computed tomodensitometry pulmonary angiography; CTV, computed tomographic venography; DVT, deep vein thrombosis; ED, emergency department; HMO, health maintenance organization; LOS, length of stay; mSv, millisievert; PE, pulmonary embolism; PERC, pulmonary embolism rule-out criteria, V/Q, ventilation/perfusion; VTE, venous thromboembolism.

One systematic review and meta-analysis pertaining to the impact of CDRs on CTPA use and yield was identified.[29] Five of the studies it included were also included in the present review.[13,16,21-23] However, its focus is different than the present one, which aims at assessing the evidence associated with the interventions being implemented to promote the use of the CDRs.[29]

The list of included studies appears in supplemental Appendix 2. The list of potentially relevant studies that were finally excluded is provided in supplemental Appendix 3.

TABLE 2. **Results Pertaining to Efficacy By Type of Intervention**

Study	Number of Participants			Use of Imaging		Diagnostic Yield		Radiation Dose		Adherence to Guidelines or a QM	
	Physicians	Patients with Suspected PE	Patients Tested by CTPA or V/Q scan		*P* or 95% CI	%	*P* and/or 95% CI	mSv	*P* and/or 95% CI		*P*
Clinical Decision Support (CDS)											
Voluntary Participation											
Drescher et al.[16]			Before: 205 After: 229	Before: 14 CTPA per 1000 After: 12.8 per 1000	N/A	Before: 8.3 After: 12.7	4.9- 12.9 8.6- 17.7				
Dunne et al.[28]			Before: 3037 After: 2825	Before: 26 CTPA per 1000 After: 22.8 CTPA per 1000	.008	Before: 10.4 After: 12.1	.65				
Kline et al. (2014)[13]	270 emergency physicians	Intervention: 264 Control : 277						Proportion of patients exposed to >5 mSv Intervention: 25% Control: 33%	Difference: 8%; CI 95%; *P*= .038		
Prevedello et al.[21]			Before: 1542 After: 1349	Before: 26.5 per 1000 After: 24.3 per 1000	<.02	Before: 9.2 After: 12.6	<.01				
Raja et al. (2012)[22]			Before: 3855 After: 2983	Before: 14.5 to 26.4 per 1000 (quarterly use) After: 26.4 to 21.1 per 1000 (quarterly use)	<.0001 .0379	Before: 5.8 After: 9.8	.0323				
Mandatory Participation											
Geeting et al.[17]			Before: 1413 After: 1417	Before: 3.02% (ED visits with CTPA) After: 2.85% (ED visits with CTPA)	.13	Before: 6.89 After: 7.53	.406			Increased from 58% (1st month) to 76% (last month)	N/A
Jiménez et al.[19]		Before: 652 After: 711		Before: 2.6-3.16 per 1000 (quarterly use) Proportion of patients with CTPA: 55% After: 3.19-2.38 per 1000 (quarterly use) Proportion of patients with CTPA: 49%	.17 .09 .02	Before: 31 Quarterly yield: 37.7-27.1 After: 33 Quarterly yield: 26.0-46.5	.26 <.01				
Raja et al. (2014)[24]			Before: 1209 After: 1212			Before: 10.4 After: 10.1	.88			Before: 56.9% After: 75.6%	<.01

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Most studies (14/17) presented a before-after design, with data collection corresponding to periods preceding and following a specific intervention. Most of them are retrospective and assessed the efficacy and safety results. They were deemed of generally poor quality and were subject to many of the biases mentioned above as well as to an interaction between the intervention and its implementation context. The remaining 3 studies were experimental in design with a comparative control group.[13,14,27] In 2 of these studies, a comparison was made with traditional clinical practice (no intervention).[13,27] In the third, the intervention was compared with CDS only.[14] The control group studies were of intermediate to very

TABLE 2. **Results Pertaining to Efficacy By Type of Intervention (continued)**

Study	Number of Participants: Physicians	Number of Participants: Patients with Suspected PE	Number of Participants: Patients Tested by CTPA or V/Q scan	Use of Imaging	Use of Imaging: *P* or 95% CI	Diagnostic Yield: %	Diagnostic Yield: *P* and/or 95% CI	Radiation Dose: mSv	Radiation Dose: *P* and/or 95% CI	Adherence to Guidelines or a QM	Adherence to Guidelines or a QM: *P*
Educational Interventions											
Voluntary Participation											
Booker and Johnson[26]			Before: 206 After: 206	Before: 2.9 CTPA ordered/day After: 2.5 CTPA ordered/day	N/A	Before: 8.7% After: 9.2%	.243			CTPA ordered with PERC score of 0 Before: 23 After: 19 Percentage of CTPA on patient with no DD and low dichotomous Wells score Before: 22.9% After: 16.6% Percentage of CTPA on patients with negative DD Before: 7.4% After: 3.3%	.15 .04
Goldstein et al.[27]			Intervention: 304 Control: 166	Intervention: 11.3% Control: 6.2 %	<.01					Intervention: DD in 7.1% of cases Control: DD in 2.0% of cases	<.01
Kanaan et al.[20]			Before: 100 After: 100							Before: 7% CTPA studies ordered appropriately After: 6% CTPA studies ordered appropriately	.77
Stein et al.[25]			Before: 1979 After: 2136	Before: 1.7 (ratio of CTPA:V/Q scanning) After: 0.8 (ratio of CTPA:V/Q scanning	<.0001			Mean effective dose: Before: 8 mSv After: 6.4 mSv	<.0001		
Mandatory Participation											
Agarwal et al.[15]		Before: 187 After: 109								Before: 65% adherence to CPG After: 78% adherence to CPG	.017
Goergen et al.[18]		Before: 191 After: 791		Before: 77% After: 56%	OR=0.39 (0.27-0.56) < .001	Before: 12.04 After: 9.48	N/A			After: 62% of ED visits with documented risk assessment 87% of low-risk and negative DD with no other imaging	N/A
Kline et al. (2004)[23]			Before: 453 After: 1460	Before: 7.4 per 1000 After: 6.4 per 1000)	Difference: -1 (-1.8 to 0.0)	Before: 8.2% After: 11.3%	Difference: 3.0% (-0.1% to 6.5%)				

Continued on page 58

TABLE 2. **Results Pertaining to Efficacy By Type of Intervention (continued)**

Study	Number of Participants: Physicians	Number of Participants: Patients with Suspected PE	Number of Participants: Patients Tested by CTPA or V/Q scan	Use of Imaging	Use of Imaging: *P* or 95% CI	Diagnostic Yield: %	Diagnostic Yield: *P* and/or 95% CI	Radiation Dose: mSv	Radiation Dose: *P* and/or 95% CI	Adherence to Guidelines or a QM	Adherence to Guidelines or a QM: *P*
Performance and Feedback Reports (PFR) (Voluntary Participation)											
Raja et al. (2015)[14]	Intervention: 22			Intervention: Before: 20.2 per 1000 After: 18.1 per 1000	.0789	Intervention: Before: 11.2 After: 13.1	.3625			Intervention: Before: 78.3 After: 85.2	.0043
	Control: 21			Control: Before: 20.4 per 1000 After: 20.1 per 1000	.8033	Control: Before: 11.6 After: 11.2	.8326			Control: Before: 78.8 After: 77.2	.5235
Policy (Voluntary Participation)											
Char and Yoon[7]		Before: 510 After: 547		Before: 15.64 per 1000 After: 12.54 per 1000	.01	Before: 4.7% After: 11.7%	<.001			After: 4% of patients had clinical probability assessment recorded	N/A

NOTE: Definitions: diagnostic yield: the percentage of examinations positive for PE; use of imaging: the percentage of patients imaged or number of examinations for PE per 1000 admissions or ED patients. Abbreviations: CDR, clinical decision rule; CI: confidence interval; CPG, clinical practice guidelines; CTPA, computed tomodensitometry pulmonary angiography; DD, D-dimer; mSv, millisievert; N/A, not available; OR, odds ratio; QM, quality measure; SD, standard deviation; V/Q, ventilation-perfusion.

good quality and were subject to biases of performance, detection, selection, and attrition.

Table 1 summarizes the study characteristics of the included studies. The detailed methodological quality appraisal of the control group studies appears in supplemental Appendix 4.

There is much heterogeneity in the studies, with a variety of indicators used and limited overlap in the presentation of the results. Table 2 summarizes the results pertaining to efficacy by intervention category. The baseline volume of imaging per 1000 ED admissions varied from 2.6 to 26.5.[19,21] The diagnostic yield, measured before intervention to diminish overuse, varied from 4.7% to 31%.[7,19] If the European study is removed, however, the range for the baseline volume of imaging is 7.4 to 26.5, and the diagnostic yield range is 4.7% to 12%.[7,18,21,23]

Efficacy

CDS and PFRs

Eight of the studies appraised CDS interventions.[13,16,17,19,21,22,24,28] They consisted of computer-based applications imbedded into the computerized physician order entry of the setting (ED or clinical ward of an acute care hospital), which are prompted when a physician orders an imaging exam or D-dimer test.

The implementation of electronic CDS was associated with the use of imaging, diminishing between 8.3% and 25.4% following intervention.[19,21] In studies evaluating the effect of electronic CDS, a rise in diagnostic yield ranging from 3.4% to 4.4%[16,21] and a rise in appropriate ordering ranging from 18% to 19% are also seen.[17,24] One study observed a significant impact on unnecessary radiation exposure.[13]

In 1 study, both electronic CDS and PFRs were used together, and an increase of 8.8% was seen in appropriate ordering ($P < 5$).[14]

Educational Interventions and Policy

Seven of the interventions assessed in the included studies were educational in their essence, involving training sessions aimed at strengthening physician use of CDRs for the diagnosis of PE.[15,18,20,23,25-27] Three studies observed a statistically significant impact on the compliance to clinical guidelines postintervention.[15,26,27] Two studies observed a statistically significant decrease in imaging use.[18,23] One study noticed an increase in diagnostic yield postintervention.[23] One study observed a significant impact on radiation exposure.[25]

The impact of a policy fostering the use of a CDR and D-dimer was appraised in 1 study.[7] This intervention translated into a significant reduction of CTPA use and a significant increase of CTPA diagnostic yield. However, only 4% of patient charts reported a clinical probability of PE, and in most cases, the type of CDR used was not mentioned.[7]

Safety

A minority of studies evaluated the safety of the interventions.[13,18,19,23,25,27] Only 2 of these studies involved comparison with a control group.[13,27] Although the studies differed in study designs and evaluated different interventions in different contexts, limiting the ability to arrive at general conclusions, there was no increase in mortality and complications associated with the interventions.

The 2 studies involving a control group did not find significant differences between the intervention and the control groups with respect to mortality, complications because of thromboembolic and bleeding events, or any other adverse event during the 3-months' follow-up.[13,27]

Jiménez et al.[19] reported less than 1% mortality following the implementation of a CDS (0.7%; 95% CI, 0.2%-1.1%). In

their study assessing the impact of an educational intervention, Kline et al.[23] (2004) observed that none of the patients discharged with a fully negative Charlotte rule died suddenly and unexpectedly at 90-day follow-up. However, another educational intervention aimed at reducing ED patients' radiation exposure observed a significant increase in the 90-day all-cause mortality of patients with negative CTPA, which was associated with a decline in the 90-day mortality of patients with negative ventilation/perfusion (V/Q) scanning.[25]

Jiménez et al.[19] observed an absolute decrease of 2.5% in the incidence of symptomatic VTE events after the intervention (95% CI, 0.9%-4.6%; $P < .01$). The occurrence of VTE events, including PE, reached 1% in Goergen et al.[18] and 3.9% in Kline et al.[23] (2004) during follow-up.

Economic Aspects

Kline et al.[13] (2014) found a significant decrease in charges and estimated costs for medical care within 90 days of initial ED presentation in the patients who were investigated with CTPA in the intervention group. The median costs of medical care within 30 days of the initial ED presentation were US $1274 in the control group and US $934 in the intervention group ($P = .018$).[13] The median charges of medical care within 30 days of the initial ED presentation were US $7595 in the control group and US $6281 in the intervention group ($P = .004$).[13]

Facilitators and Barriers

Only 1 study appraised the reasons given by emergency physicians for not adhering to CDS recommendations.[16] The reason most often given was the time needed to access and use the application, which was perceived as having a negative impact on productivity as well as a preference for intuitive clinical judgment.[16] Though not the result of specific evaluation or data collection, some authors commented on the factors that may facilitate or impede the implementation of interventions to diminish the inappropriate use.[14,20] Kanaan et al.[20] proposed that factors other than the knowledge of current clinical guidelines may explain CTPA use. Booker and Johnson[26] suggested that the demand for rapid turnover in the ED may lead to "so-called 'blanket ordering', which attempts to reach diagnosis as quickly as possible despite cost and patient safety." Raja et al.[14] (2015) suggested that the unambiguous representation of guidelines based on validated, high-quality evidence in the CDS may have improved physician adoption in their study.

DISCUSSION

Efficacy

Baseline values for the use of imaging and diagnostic yield show important variation, especially when compared with the study performed in Europe.[19] In general, only a modest impact is measured with regard to a decrease in the use of imaging, an increase in diagnostic use, and adherence to validated CDRs.

Among the interventions appraised, CDS was evaluated in the largest number of included studies, and its impact has been appraised with the largest number of indicators. Among the 6 studies that assessed the impact of this type of intervention on the use of imaging, 4 observed a significant decrease of CTPA use postintervention.[19,21,22,28] None of these studies involved a control group. The 2 with CDS that had no significant impact on CT use were conducted in US EDs and were based on dichotomous Wells scores.[16,17] Adherence to CDS recommendations was mandatory in 1 and voluntary in the other.[16,17] The variable impact of these interventions was at least partly attributable to contextual factors. However, because of the lack of data pertaining to these factors, it is not possible to draw conclusive remarks on their effect.

The impact of CDS on diagnostic yield was mixed because 3 studies observed an increase in diagnostic yield postintervention,[16,21,22] and 3 others monitored no significant impact.[19,24,28] Adherence to guidelines or a quality measure was assessed in 2 studies, which reported a significant increase in appropriate ordering.[17,24] Raja et al.[24] (2014) observed an 18.7% increase in appropriate ordering after the implementation of a CDS from 56.9% to 75.6% ($P < .01$). Geeting et al.[17] observed a similar increase, with appropriate ordering increasing from 58% to 76% over the duration of the intervention. However, this increase in appropriate use was not associated with a variation in CTPA use or diagnostic yield, which leads the investigators to posit that the physicians gradually inflated the Wells score they keyed into the CDS despite that no threshold Wells score was required to perform a CTPA.[17]

Raja et al.[14] (2015) demonstrated that the implementation of performance feedback reporting, in addition to a CDS, can significantly increase adherence to CDR for the evaluation of PE in the ED. Additional studies would help to better understand the potential impact of such reports on CTPA use in the diagnostic workup of PE. However, it suggests that a combination of interventions, including the implementation of a CDS, performance feedback reporting, and well-designed and specific educational interventions, may have a more significant impact than any of these types of interventions taken separately.

The impact of the educational interventions appraised in this review on the expected results is mixed, though it is difficult to compare the observed results and draw conclusive remarks, as the characteristics of the interventions and study designs are different from each other.

Safety

There is limited evidence on the safety of appraised interventions. Only 6 studies appraised venous thrombolic events or mortality.[13,18,19,23,25,27] However, no adverse events were noted in those studies evaluating possible complications or missed diagnoses. Additional research is needed to confirm the safety of the interventions appraised in this systematic review.

Facilitators and Barriers

There are significant limitations with respect to the analysis of the factors that favor or impede the implementation of the interventions appraised in this review. However, 2 studies that did not meet the inclusion criteria appraised physicians' perceptions and attitudes toward prescribing imaging tests in the diagnostic workup of PE.[31,32] One is Swiss[31] and the other is Canadian.[32] Both were conducted in the ED of academic hospitals. Rohacek et al.[31]

observed that defensive behaviors, such as "fear of missing PE," were frequent and associated with a lower probability of a positive CTPA (OR=0.36; 95% CI, 0.14-0.92). Ahn et al.[32] concluded that, although ED physicians who participated in their survey possessed limited knowledge of radiation doses of CTPA and V/Q scans, they opted for V/Q scans that emit lower radiation doses in younger patients, especially females, which may reflect efforts done in the study setting to reduce patients' radiation exposure.

There is not enough data to conclude on safety and the impact on healthcare costs.

Implications for Future Research

Future controlled studies of high methodological quality would help to better understand the effects associated with the implementation of the interventions aimed at reducing the inappropriate use of imaging in the diagnostic workup of PE. Efficacy results show that the success of the implementation of the various types of interventions is variable. This variation may be at least partly attributable to contextual factors, such as the external environment, the organizational leadership and culture, or the microsystem, such as differences in care patterns.[33-35] The impact of context factors on the effectiveness of the interventions should be assessed further with appropriate tools.[33,34,36]

CONCLUSION

The joint use of CDS and PFRs appears more effective than the other types of intervention in reducing the inappropriate use of CTPA. However, an approach combining these with well-designed educational interventions as well as policies may be even more effective.

Future studies of high methodological quality would strengthen the evidence concerning the relative efficacy and safety of the interventions appraised, especially when various types are combined. Future research should also aim at bringing answers to the knowledge gaps related to the factors of success and barriers associated with the implementation of the interventions.

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Expanding Treatment Opportunities for Hospitalized Patients with Opioid Use Disorders

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The prevalence of opioid use disorders (OUDs) is rising across the United States. Patients with OUDs are often hospitalized for medical conditions other than addiction, such as infection, injury, or pregnancy. These hospital admissions provide an opportunity for healthcare providers to initiate opioid agonist therapy with methadone or buprenorphine. Randomized trials have demonstrated the superior effectiveness of this treatment strategy, but its adoption by hospital providers has been slow. A number of barriers have impeded its implementation, including misperceptions about the regulation of opioid prescribing, limited resources for the transition to community-based treatment, and a lack of familiarity among clinicians about the appropriate initiation and dose adjustment of these opioid agonists for maintenance therapy. We discuss changes in policy and practice to expand opportunities to engage patients with OUDs in opioid agonist treatment during their inpatient hospitalizations. *Journal of Hospital Medicine* 2018;13:62-64. Published online first October 18, 2017.

The United States is facing an epidemic of prescription opioid and heroin use, which has been linked to the escalating prescribing of opioid analgesics. Though opioid prescriptions appear to be reaching a plateau, estimates suggest there are at least 900,000 active heroin users in the United States, and this number continues to grow.[1] One response to this epidemic (through state legislation and medical society guidelines) has been a move to reduce opioid prescribing in order to diminish the potential for diversion and misuse.[2] However, the treatment of pain is not the sole driver of heroin epidemiology, and new strategies are also needed to better engage patients with existing opioid use disorders (OUDs) to begin treatment. These patients are increasingly hospitalized for infectious comorbidities of injection drug use, trauma, or pregnancy, and this may present a unique opportunity to initiate these patients on maintenance opioid agonist therapy, the most effective option for medication-assisted treatment (MAT) for addiction.

MISSED OPPORTUNITIES

Patients with OUDs comprise an estimated 2% to 4% of hospitalized patients, representing a disproportionately large number of inpatients.[3-6] According to a recent analysis of data from the National (Nationwide) Inpatient Sample, the estimated annual number of hospitalizations associated with OUDs in the United States increased from approximately 300,000 to more than 500,000 in the decade from 2002 to 2012.[7] Severe bacterial infections associated with intravenous administration of opioids (including endocarditis, osteomyelitis, septic arthritis, and epidural abscess) increased substantially at an estimated cost of more than $700 million in 2012.[7] Over a similar period, the prevalence of opioid use among women in labor increased from 13.7 to 22.0 per 10,000 live births,[8] and there was a corresponding rise in admissions to neonatal intensive care units for neonatal abstinence syndrome.[9] As the prevalence of prescription drug and heroin dependence continues to rise across the United States, hospitals and clinicians find themselves on the front lines of this epidemic, creating potential opportunities to engage patients in recovery, a "treatable moment" for this vulnerable population.[10]

Currently, a common approach in the hospitalized patient is to attempt medically assisted withdrawal using a rapid taper of long-acting opioids. This process may appeal to healthcare providers who hope to guide their patients in transitioning to opioid abstinence. However, tapering an opioid regimen, even over a period of months, results in unacceptably high rates of relapse (as high as 70% to 90% in some studies), especially when a patient is acutely ill and symptomatic from a concurrent medical issue.[11-13] In the hospital setting, this treatment failure can manifest as pain and undertreated withdrawal symptoms (such as agitation, arthralgias, and gastrointestinal distress), which may hinder some patients from completing their treatment or drive some to leave against medical advice.[14] Further harm may occur when an inpatient rapid taper is accomplished, putting patients at increased risk of a fatal relapse after discharge due to loss of tolerance.[15]

Maintenance opioid agonist therapy with buprenorphine

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or methadone, in which a long-acting opioid is titrated until craving and withdrawal symptoms are well controlled, is the first-line modality for MAT among patients with OUDs in outpatient settings and is associated with reduced risk of fatal overdose and all-cause mortality.[16] Initiation and dose stabilization of agonist therapy with these agents during acute medical hospitalization has been shown to be feasible in a variety of inpatient settings.[17-20] In one trial, patients randomized to buprenorphine induction and linkage to office-based therapy during their inpatient stay were more than 5 times as likely to enter and remain in treatment after discharge when compared with those in whom buprenorphine was tapered.[20] International guidelines support the use of maintenance agonist therapy in this context, but this remains an underutilized strategy in recent efforts to treat OUDs in the United States.[21,22] A few key barriers currently prevent this strategy from being applied broadly within our healthcare system.

TOWARD EVIDENCE-BASED INPATIENT MANAGEMENT

First, there is a common misconception that regulations prohibit the use of methadone and buprenorphine for opioid agonist therapy by inpatient medical providers without special certification. Title 42 of the Code of Federal Regulations (CFR) provides extensive guidance regarding the use of opioid medications by registered outpatient opioid treatment programs. However, it also contains an exemption from these rules for hospitals treating patients with emergent medical needs (21 CFR § 1306.07[c]) allowing hospital-based clinicians "to maintain or detoxify a person as an incidental adjunct to medical or surgical treatment of conditions other than addiction" without restriction. According to guidelines from the Substance Abuse and Mental Health Services Administration, this exemption applies to the use of both methadone and buprenorphine.[23]

Many clinicians and hospital pharmacy departments interpret this law to limit the use of maintenance therapy in patients already enrolled in outpatient programs or to require a rapid taper over the first 3 days of hospitalization. However, these interpretations may in part be rooted in confusion with an adjacent section of the regulations (21 CFR § 1306.07[b]) directed at outpatient physicians providing time-limited, emergency treatment for withdrawal in an office setting. The application of this time limit to hospitalized patients has not been supported by communication from the Drug Enforcement Agency.[24] There is no case law or other regulation requiring an opioid regimen to be time limited for patients during medical hospitalization, and hospital policies need not place undue constraints on the ability of clinicians to stabilize patients on maintenance therapy and transition them to outpatient treatment.

Second, the limited capacity of existing opioid maintenance programs can lead to a gap in treatment upon hospital discharge for patients in whom methadone or buprenorphine is initiated. Health delivery systems can play a role in mitigating the impact of this resource gap. Integrating the model of screening, brief intervention, and referral to treatment into hospital admission processes and engaging social workers, addiction consult services (where available), and other supports early in the course of hospitalization can help facilitate appropriate follow-up care.[25,26] Hospitals may also be eligible for federal funding to strengthen local referral networks for outpatient MAT programs under Section 103 of the Comprehensive Addiction and Recovery Act passed into law in July 2016. Innovative delivery models designed to enhance integration across community stakeholders in healthcare, social services, and criminal justice have recently been developed, such as Vermont's "Hub and Spoke" model,[27] Boston Medical Center's Faster Paths opioid urgent care center,[28] and the police-led Angel Program in Gloucester, Massachusetts.[29] Implementation science studies will be needed to identify the most effective ways to engage inpatient medical teams in such efforts.

Currently, individual providers can already play a central role in providing a bridge for patients in whom a delay in beginning MAT cannot be avoided upon discharge. Interim buprenorphine maintenance treatment has been shown to dramatically decrease the use of illicit opioids among those awaiting initiation of comprehensive MAT programs and substantially increase retention in long-term treatment.[20,30,31] With the recent expansion of the limits on buprenorphine prescriptions to 275 patients per provider (part of the waiver required under the Drug Addiction Treatment Act [DATA] of 2000 to provide outpatient buprenorphine treatment, also known as a DATA waiver), this may be an increasingly promising option for hospital discharge.

Obtaining a waiver to prescribe buprenorphine is not required for the inpatient initiation of buprenorphine therapy. However, doing so is relatively simple (requiring an online, 8-hour training [https://www.samhsa.gov/medication-assisted-treatment/training-resources/buprenorphine-physician-training]) and allows hospital-based providers not only to ensure optimal management of OUDs during hospitalization but also to help their patients with the next steps toward recovery after discharge. The use of buprenorphine may be challenging in some patients with significant pain as a component of their medical condition. For these patients, methadone will likely be better tolerated.

Additional funding is also urgently needed to expand the capacity of existing opioid treatment programs and create specialized discharge-transition clinics that can provide structured interim opioid therapy while patients are on waitlists for traditional MAT programs. Requiring patients who are not ready or able to begin long-term maintenance agonist therapy to rapidly taper an inpatient opioid regimen unnecessarily puts them at risk for overdose after discharge.[15] Regardless of the available resources for long-term treatment within the community, hospital discharge planning should include a naloxone prescription and brief training for patients and their loved ones.[32] The long-acting opioid antagonist, depot naltrexone, is another effective, alternative MAT option and is increasingly used in community settings among patients who are motivated to achieve opioid abstinence.[33,34] It has not yet been studied among hospitalized patients, and further research is needed to determine if it could be a viable option for discharge. However, the requirement that a patient be abstinent from opioids for 7 to 10 days prior to ad-

ministering the first dose of depot naltrexone may serve as a significant barrier to its use for most hospitalized patients.

Finally, healthcare providers must be trained in the appropriate use of opioid agonist therapy. Medical schools, residency programs, and schools of pharmacy and nursing should develop curricula to expand the capacity of nonspecialists to care for patients with OUDs and to focus on judicious analgesic prescribing to prevent chronic opioid use. This curriculum should address the appropriate titration of methadone and buprenorphine for agonist therapy and address the stigma faced by patients with substance use disorders. Other important topics include the management of overdose and withdrawal symptoms, structured approaches to pain management in patients with OUDs, harm-reduction methods, and multidisciplinary care for the psychosocial and psychiatric comorbidities of addiction. Though international guidelines have been developed for the inpatient management of patients with OUDs,[21,22] hospitals and professional societies should take a leadership role in facilitating continuing education to disseminate them among current medical providers.

There is great potential for the leadership and front-line staff of hospital systems, with a few key changes in policy and practice, to become advocates for patients with OUDs to access treatment. As perspectives about opioid prescribing change amid efforts to limit the escalation of the current heroin epidemic, it is vital to identify opportunities to reduce opioid exposure for opioid-naïve patients and enhance the engagement of patients diagnosed with OUDs in treatment.

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Hospitalists in the ICU: Necessary But Not Sufficient

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In the United States, up to 6 million patients are admitted to intensive care units (ICUs) annually at a cost estimated to exceed $80 billion or about 13% of total hospital costs.[1,2] It also appears that as our population ages and illness severity increases, demand for ICU care is increasing.[3] Given its importance, the organization and delivery of critical care has been extensively studied. High-intensity physician staffing by an intensivist (all patients managed or comanaged by an intensivist), while inconsistently shown to be associated with improved outcomes, has been endorsed as a high-quality care model by professional societies and the Leapfrog group. Despite its adoption by many hospitals, widespread implementation has been hampered by a national shortage of intensivists that continues to worsen over time. Hospitals, by necessity, look to alternative models to care for critically ill patients, and one such model is the use of hospitalists.

The Society of Hospital Medicine estimates that there are nearly 50,000 hospitalists practicing in the United States, and several studies show they routinely provide care in the nation's ICUs.[4] While in some ICUs hospitalists work alongside intensivists, in many, they work without intensivist support, and regardless of the model, they often serve as the primary attending physician. There is good reason to think this model of care would be effective. Most hospitalists are internists, graduating from training programs that tend to emphasize care of acutely ill hospitalized patients. Hospitalists are often present in the hospital 24/7, are comfortable working in multidisciplinary teams, and routinely engage in quality improvement, which are all characteristics common in highly functioning ICUs. Yet, a study in this issue of the *Journal of Hospital Medicine* raises some concern.

Sweigart and colleagues[5] surveyed 425 hospitalists to understand the structure and perception of their ICU practices. Consistent with prior studies, 77% provided ICU care with 66% serving as the primary attending. A novel finding is the high level of angst and lack of support hospitalists perceived in caring for these critically ill patients. Among rural hospitalists, 43% reported they were expected to practice beyond their perceived scope of practice, and almost a third reported they never had sufficient intensivist support. Even more concerning is that among hospitalists serving as the primary attending, over two-thirds reported difficulty transferring patients to a higher level of care (Sweigart et al.[5]). While we have concerns over how representative this sample is of hospitalist practice (the survey response rate was only about 10%), it does appear that many hospitalists feel very uncomfortable with the ICU care they are providing and perceive barriers to moving their patients to a potentially safer care setting.

While one might argue more intensivists would solve this problem, calls for more intensivists are shortsighted, as there are compelling reasons to believe that such efforts will do little to address the mismatch between patient need and provider supply. Graduate medical education slots for intensivists cannot be easily and affordably increased, and even if more intensivists could be trained, there are few incentives to encourage them to work where they are needed most. Prioritization of intensivist training also diverts resources from training demands in equally important undersupplied specialties such as primary care.[6] Finally, simply increasing intensivist supply fails to attend to important issues surrounding the multidisciplinary nature of care in an ICU, which relies heavily on multiple providers communicating and collaborating to provide optimal care. As noted in the study by Sweigart and colleagues,[5] even in settings where intensivists were available 24 hours per day or made all major decisions, nearly one-third of hospitalists felt they practiced beyond their scope of expertise, suggesting that more intensivists may do little to improve hospitalists' comfort in caring for patients in the ICU.

In lieu of increasing intensivist numbers, policymakers should consider several strategies that have the potential to improve the quality of care delivered to patients in the ICU without increasing intensivists. Recent data suggest that some ICU patients can be safely managed by physician assistants and nurse practitioners.[7,8] Care models involving such providers may free up overworked intensivists and hospitalists, allowing them to focus their efforts on the sickest patients. ICU telemedicine has also emerged as a promising tool that can bring the expertise of intensivists to hospitals where they are needed. Beyond the additional oversight of routine care practices it provides, telemedicine could allow rapid and real time consultation with intensivists for clinicians at the bedside facing difficult management decisions, potentially saving lives.[9] The rapid growth of clinically integrated networks, which often include large well-staffed medical centers surrounded by many smaller regional hospitals, might facilitate faster implementation of innovative

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telemedicine models. Regionalization of care is a third strategy that may improve the quality of care for the critically ill without increasing intensivist supply. Regionalization seeks to selectively transfer the most ill patients to high-volume centers with the greatest expertise in critical care, a practice associated with reduced mortality.[10] Of course, for regionalization to be successful, front-line providers like hospitalists need to be able to orchestrate the transfer to the referral center, a process that, as noted by Sweigart and others, is neither easy nor universally successful.[11]

A final strategy would be to reduce the demand for intensivists through limiting the number of individuals in an ICU. While policies that explicitly ration ICU beds for individuals who have the greatest ability to benefit are ethically problematic, reductions in ICU beds would force providers to implicitly allocate beds more efficiently. There are a multitude of studies showing that our nation's ICUs are often filled with patients who derive little benefit from intensive care.[12,13] Further research on ethically sound strategies to avoid ICU admission for patients unlikely to benefit is desperately needed. With fewer patients in an ICU, the busy intensivist could focus on the sickest patients and spend more time communicating with hospitalists about patients they are managing together.

Regardless of the care models that develop, hospitalists will increasingly be called upon to staff ICUs. Hospitalists are necessary, but as the study by Sweigart et al.[5] suggests, just throwing them into our current ICU models with little support from their critical care colleagues is not sufficient. In the absence of a major influx of new intensivists, hospital medicine and critical care professional societies need to actively collaborate to develop creative training and educational models that provide hospitalists with the necessary skills to care for the critically ill and to lead the multidisciplinary care teams they will work within. More importantly, these professional societies must advocate together for more substantial reform to our current ICU care models. Novel solutions that prioritize the efficient use of existing ICU beds for those individuals with the greatest ability to benefit, but also capitalize on emerging technologies and regional centers of excellence, have great potential to address the mismatch between supply and demand. Given the increasing demand and substantial cost for ICU care, we can't afford to continue with business as usual.

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Too Much of a Good Thing: Appropriate CTPA Use in the Diagnosis of PE

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There is abundant evidence that the use of computed tomography pulmonary angiography (CTPA) is increasing in emergency departments and more patients are being diagnosed with pulmonary embolism (PE).[1,2] The increasing availability and resolution of CTPA technology since the late 1990s has led some to suggest that PE is now being overdiagnosed, which is supported by decreasing PE case–fatality rates and the detection of small, subsegmental clots that do not result in any meaningful right-ventricular dysfunction.[3,4] Indeed, recent guidelines allow that not all small PEs require anticoagulation therapy.[5] Beyond overdiagnosis, there are potential patient-level harms associated with the liberal use of CTPA imaging, including the consequences of radiation and intravenous contrast exposure.[4,6] At the societal level, excess CTPA use contributes to the growing costs of healthcare.[2,7]

Despite the above concerns, CTPA remains the diagnostic test of choice for PE. There are multiple approaches that are suggested to appropriately use CTPA in the workup of suspected PE, the most common of which is endorsed by best practice publications and combines a clinical score (eg, Well's score) with D-dimer testing, reserving CTPA for those patients with high clinical risk and/or positive D-dimer.[8,9] Despite the professional recommendation, studies have shown that the use of PE diagnostic algorithms in clinical practice is suboptimal, resulting in much practice variation and contributing to the overuse of CTPA.[10,11] In this issue, as a means of clarifying what measures improve adherence with recommended best practices, Deblois and colleagues[12] perform a systematic review of the published interventions that have attempted to reduce CTPA imaging in the diagnosis of PE.

Deblois and colleagues are to be commended for summarizing what is unfortunately a very heterogeneous literature, the limitations of which precluded a formal meta-analysis. The authors report that most of the 17 reviewed studies incorporated either electronic clinical decision support (CDS; usually imbedded into a computerized physician order entry) tools or educational interventions in a retrospective, before-and-after design; only 3 studies were experimental and included a control group. Most of the studies included efficacy, with a few evaluating safety. There was little available evidence regarding cost-effectiveness or barriers to implementation. The most studied approach, CDS, was associated with a decrease in the use of CTPA of between 8.3% and 25.4% along with an increase in PE diagnostic yield of between 3.3% and 4.4%. Likewise, the appropriate use of CTPA (consistent with best practice recommendations) increased with CDS intervention from 18% to 19%. The addition of individual performance feedback seemed to enhance the impact of CDS, although this finding was limited to one investigation. Conversely, educational interventions to improve physician adherence to best practice approaches were less effective than CDS, with only 1 study describing a significant decrease in CTPA use or increase in diagnostic yield. Although safety data were limited, in aggregate, the reported studies did not suggest any increase in mortality with interventions to reduce CTPA use.

As discussed by the authors, CDS was the most studied and most effective intervention to improve appropriate CTPA use, albeit modest in its impact. The lack of contextual details about what factors made CDS effective or not effective makes it difficult to make general recommendations. One cited study did include physician reasons for not embracing CDS, which are not surprising in nature and reflect concerns about impaired efficiency and preference for native clinical judgement over that of electronic tools.

Moving forward, CDS, perhaps coupled with performance feedback, seems to offer the best hope of reducing inappropriate CTPA use. The growing use of electronic medical records, which is accelerated in the United States by the meaningful use provisions of the Health Information Technology for Economic and Clinical Health Act of 2009, implies that CDS tools are going to be implemented across the spectrum of diagnoses, including that of PE.[13] The goals of CDS interventions, namely improved patient safety, quality, and cost-effectiveness, are more likely to be achieved if those studying and designing these electronic tools understand the day-to-day practice of clinical medicine. As summarized by Bates and colleagues[14] in the "Ten Commandments for Effective Clinical Decision Support," CDS interventions will be successful in changing physician behavior and promoting the right test or treatment only if they seamlessly fit into the clinical workflow, have no impact on (or improve upon) physician efficiency, and minimize the need for additional information from the user. As suggested by Deblois et al.,[12] future studies of CDS interventions that aim to align CTPA use with recommended best practices should incorporate more rigorous methodological quality, include safety and cost-effectiveness outcomes, and, perhaps most

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importantly, attempt to understand the environmental and organizational factors that contribute to CDS tool effectiveness.

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The Frontier of Transition Medicine: A Unique Inpatient Model for Transitions of Care

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The transition of care from pediatric to adult providers has drawn increased national attention to the survival of patients with chronic childhood conditions into adulthood.ttps://www.ncbi.nlm.nih.gov/books/NBK11432/ While survival outcomes have improved due to advances in care, many of these patients experience gaps in medical care when they move from pediatric to adult healthcare systems, resulting in age-inappropriate and fragmented care in adulthood.[4] Many youth with chronic childhood conditions are not prepared to move into adult healthcare, and this lack of transition preparation is associated with poorer health outcomes, including elevated glycosylated hemoglobin and loss of transplanted organs.[5-7] National transition efforts have largely focused on the outpatient setting and there remains a paucity of literature on inpatient transitions of care.[8,9] Although transition-age patients represent a small percentage of patients at children's hospitals, they accumulate more hospital days and have higher resource utilization compared to their pediatric cohorts.[10] In this issue, Coller et al.[11] characterize the current state of pediatric to adult inpatient transitions of care among general pediatric services at US children's hospitals. Over 50% of children's hospitals did not have a specific adult-oriented hospital identified to receive transitioning patients. Fewer than half of hospitals (38%) had an explicit inpatient transition policy. Notably only 2% of hospitals could track patient outcomes through transitions; however, 41% had systems in place to address insurance issues. Institutions with combined internal medicine-pediatric (Med-Peds) providers more frequently had inpatient transition initiatives ($P = .04$). It is clear from Coller et al.[11] that the adoption of transition initiatives has been delayed since its introduction at the US Surgeon's conference in 1989, and much work is needed to bridge this gap.[12]

Coller et al.[11] spearhead establishing standardized transition programs using the multidisciplinary Six Core Elements framework and highlight effective techniques from existing inpatient transition processes.[13] While we encourage providers to utilize existing partnerships in the outpatient community to bridge the gap for this at-risk population, shifting to adult care continues to be disorganized in the face of some key barriers including challenges in addressing psychosocial needs, gaps in insurance, and poor care coordination between pediatric and adult healthcare systems.[4]

We propose several inpatient activities to improve transitions. First, we suggest the development of an inpatient transition or Med-Peds consult service across all hospitals. The Med-Peds consult service would implement the Six Core Elements, including transition readiness, transition planning, and providing insurance and referral resources. A Med-Peds consult service has been well received at our institution as it identifies clear leaders with expertise in transition. Coller et al.11 report only 11% of children's hospitals surveyed had transition policies that referenced inpatient transitions of care. For those institutions without Med-Peds providers, we recommend establishing a hospital-wide transition policy, and identifying hospitalists trained in transitions, with multidisciplinary approaches to staff their transition consult service.

Tracking and monitoring youth in the inpatient transition process occurred in only 2% of hospitals surveyed. We urge for automatic consults to the transition service for adult aged patients admitted to children's hospitals. With current electronic health records (EHRs), admission order sets with built-in transition consults for adolescents and young adults would improve the identification and tracking of youths. Assuming care of a pediatric patient with multiple comorbidities can be overwhelming for providers.[14] The transition consult service could alleviate some of this anxiety with clear and concise documentation using standardized, readily available transition templates. These templates would summarize the patient's past medical history and outline current medical problems, necessary subspecialty referrals, insurance status, limitations in activities of daily living, ancillary services (including physical therapy, occupational therapy, speech therapy, transportation services), and current level of readiness and independence.

In summary, the transition of care from pediatric to adult providers is a particularly vulnerable time for young adults with chronic medical conditions, and efforts focused on inpatient transitions of medical care have overall been limited. Crucial barriers include addressing psychosocial needs, gaps in insurance, and poor communication between pediatric and adult providers.[4] Coller et al.[11] have identified several gaps in inpatient transitions of care as well as multiple areas of focus to improve the patient experience. Based on the findings of this study, we urge children's hospitals caring for adult patients to identify transition leaders, partner with an adult hospital to foster effective transitions, and to protocolize inpatient and

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outpatient models of transition. Perhaps the most concerning finding of this study was the widespread inability to track transition outcomes. Our group's experience has led us to believe that coupling an inpatient transition consult team with EHR-based interventions to identify patients and follow outcomes has the most potential to improve inpatient transitions of care from pediatric to adult providers.

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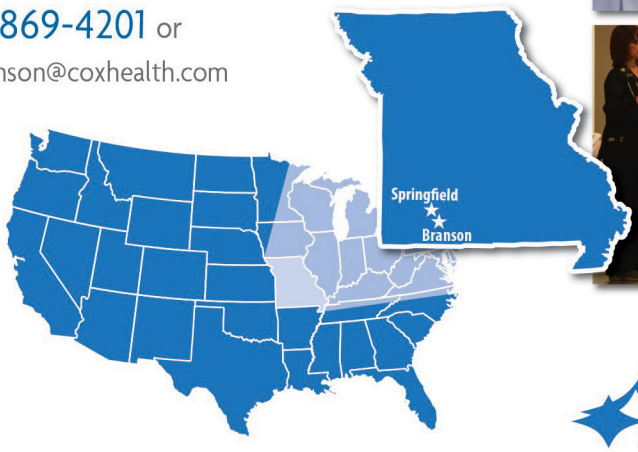

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