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Mental Health Conditions and Unplanned Hospital Readmissions in Children

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OBJECTIVE: Mental health conditions (MHCs) are prevalent among hospitalized children and could influence the success of hospital discharge. We assessed the relationship between MHCs and 30-day readmissions.

METHODS: This retrospective, cross-sectional study of the 2013 Nationwide Readmissions Database included 512,997 hospitalizations of patients ages 3 to 21 years for the 10 medical and 10 procedure conditions with the highest number of 30-day readmissions. MHCs were identified by using the International Classification of Diseases, 9th Revision-Clinical Modification codes. We derived logistic regression models to measure the associations between MHC and 30-day, all-cause, unplanned readmissions, adjusting for demographic, clinical, and hospital characteristics.

RESULTS: An MHC was present in 17.5% of medical and 13.1% of procedure index hospitalizations. Readmission rates were 17.0% and 6.2% for medical and procedure hospitalizations, respectively. In the multivariable analysis, compared with hospitalizations with no MHC, hospitalizations with MHCs had higher odds of readmission for medical admissions (adjusted odds ratio [AOR], 1.23; 95% confidence interval [CI], 1.19-1.26] and procedure admissions (AOR, 1.24; 95% CI, 1.15-1.33). Three types of MHCs were associated with higher odds of readmission for both medical and procedure hospitalizations: depression (medical AOR, 1.57; 95% CI, 1.49-1.66; procedure AOR, 1.39; 95% CI, 1.17-1.65), substance abuse (medical AOR, 1.24; 95% CI, 1.18-1.30; procedure AOR, 1.26; 95% CI, 1.11-1.43), and multiple MHCs (medical AOR, 1.43; 95% CI, 1.37-1.50; procedure AOR, 1.26; 95% CI, 1.11-1.44).

CONCLUSIONS: MHCs are associated with a higher likelihood of hospital readmission in children admitted for medical conditions and procedures. Understanding the influence of MHCs on readmissions could guide strategic planning to reduce unplanned readmissions for children with cooccurring physical and mental health conditions. *Journal of Hospital Medicine* 2018;13:445-452. © 2018 Society of Hospital Medicine

Readmission prevention is a focus of national efforts to improve the quality of hospital care for children.[1-5] Several factors contribute to the risk of readmission for hospitalized children, including age, race or ethnicity, payer, and the type and number of comorbid health conditions.[6-9] Mental health conditions (MHCs) are a prevalent comorbidity in children hospitalized for physical health reasons that could influence their postdischarge health and safety.

MHCs are increasingly common in children hospitalized for physical health indications; a comorbid MHC is currently present in 10% to 25% of hospitalized children ages 3 years and older.[10,11] Hospital length of stay (LOS) and cost are higher in children with an MHC.[12,13] Increased resource use may occur because MHCs can impede hospital treatment effectiveness and the child's recovery from physical illness. MHCs are associated with a lower adherence with medications[14-16] and a lower ability to cope with health events and problems.[17-19] In adults, MHCs are a well-established risk factor for hospital readmission for a variety of physical health conditions.[20-24] Although the influence of MHCs on readmissions in children has not been extensively investigated, higher readmission rates have been reported in adolescents hospitalized for diabetes with an MHC compared with those with no MHC.[25,26]

To our knowledge, no large studies have examined the relationship between the presence of a comorbid MHC and hospital readmissions in children or adolescents hospitalized for a broad array of medical or procedure conditions. Therefore, we conducted this study to (1) assess the likelihood of 30-day hospital readmission in children with versus without MHC who were hospitalized for one of 10 medical or 10 procedure conditions, and (2) to assess which MHCs are associated with the highest likelihood of hospital readmission.

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TABLE. **Demographic, Clinical, and Hospital Characteristics of 2013 US Hospitalizations for Children with versus without a Mental Health Condition**

		MHC[b]	
Characteristic	**All 20 Index Admissions[a]**	**No**	**Yes[c]**
N (% of total cohort)	471,057 (100.0)	394,087 (83.7)	76,970 (16.3)
Length of index admission (median [IQR] days)	2 (1-4)	2 (1-4)	2 (1-4)
30-day, unplanned hospital readmission rate (%)	13.3	13.0	15.1
Demographic characteristics			
Age (median [IQR])	12 (7-17)	11 (6-16)	17 (12-19)
Female (%)	45.5	46.0	43.1
Payer (%)			
Public (Medicare/Medicaid)	49.2	49.9	45.9
Private	42.1	42.3	41.3
Other (self-pay/charity/other)	8.7	7.9	12.8
Patient location (%)			
Metropolitan area pop ≥ 1 million	53.3	54.0	49.8
Metropolitan area pop 50,000 to < 1million	30.6	30.1	33.0
Rural counties	16.1	15.9	17.2
Median income in patient's ZIP code (%)			
Lowest US quartile (≤$37,999)	31.9	32.1	30.6
Second US quartile ($38,00-$47,999)	27.1	27.0	27.4
Third US quartile ($48,000-$63,999)	23.5	23.4	23.8
Highest US quartile (≥$64,000)	17.6	17.4	18.2
Clinical characteristics[d]			
Complex chronic condition (%)	44.2	43.1	50.1
Number physical chronic conditions (median [IQR])	1 (1-2)	1(1-2)	2 (1-3)
Hospital characteristics			
Hospital location and teaching status (%)			
Rural	6.8	6.8	6.8
Urban nonteaching	19.2	19.0	20.1
Urban teaching	74.0	74.2	73.0
Hospital ownership (%)			
Public	14.5	14.6	14.2
Private, nonprofit	77.1	77.0	77.9
Private, for-profit	8.4	8.5	8.0

[a]Index admissions were for the 10 medical and procedure conditions that accounted for the most 30-day, unplanned hospital readmissions. Medical index admissions were for asthma, chemotherapy, constipation, diabetes, gastroenteritis, inflammatory bowel disease, neutropenia, pneumonia, seizure, and sickle cell crisis. Procedure index admissions were appendectomy, bone marrow transplant, bowel procedures, craniotomy, knee procedures, respiratory and chest procedures, spinal fusion, tumor biopsy, urinary tract procedures, and ventricular shunt procedures. All analyses were performed on the survey-weighted sample. The unweighted total number of index admissions was 163,480.

[b]Comorbid MHCs were identified from ICD-9-CM diagnosis codes by using AHRQ's Chronic Condition Indicator system.

[c]$P < .001$ for statistical comparisons between index admissions with and without a documented MHC for all demographic, hospital, and clinical characteristics.

[d]% with any complex chronic condition were identified by using ICD-9-CM diagnosis codes according to a scheme developed by Feudtner et al.[31] The number of physical chronic conditions was counted by using AHRQ's Chronic Condition Indicator system.

NOTE: Abbreviations: AHRQ, Agency for Healthcare Research and Quality; ICD-9-CM, *International Classification of Diseases, 9th Revision-Clinical Modification*; IQR, interquartile range; MHC, mental health condition; pop, population.

METHODS

Study Design and Setting

We conducted a national, retrospective cohort study of index hospitalizations for children ages 3 to 21 years who were discharged from January 1, 2013, to November 30, 2013, in the Agency for Healthcare Research and Quality's (AHRQ) Nationwide Readmissions Database (NRD). Admissions occurring in December 2013 were excluded because they did not have a 30-day timeframe available for readmission measurement. The 2013 NRD includes administrative data for a nationally represen-

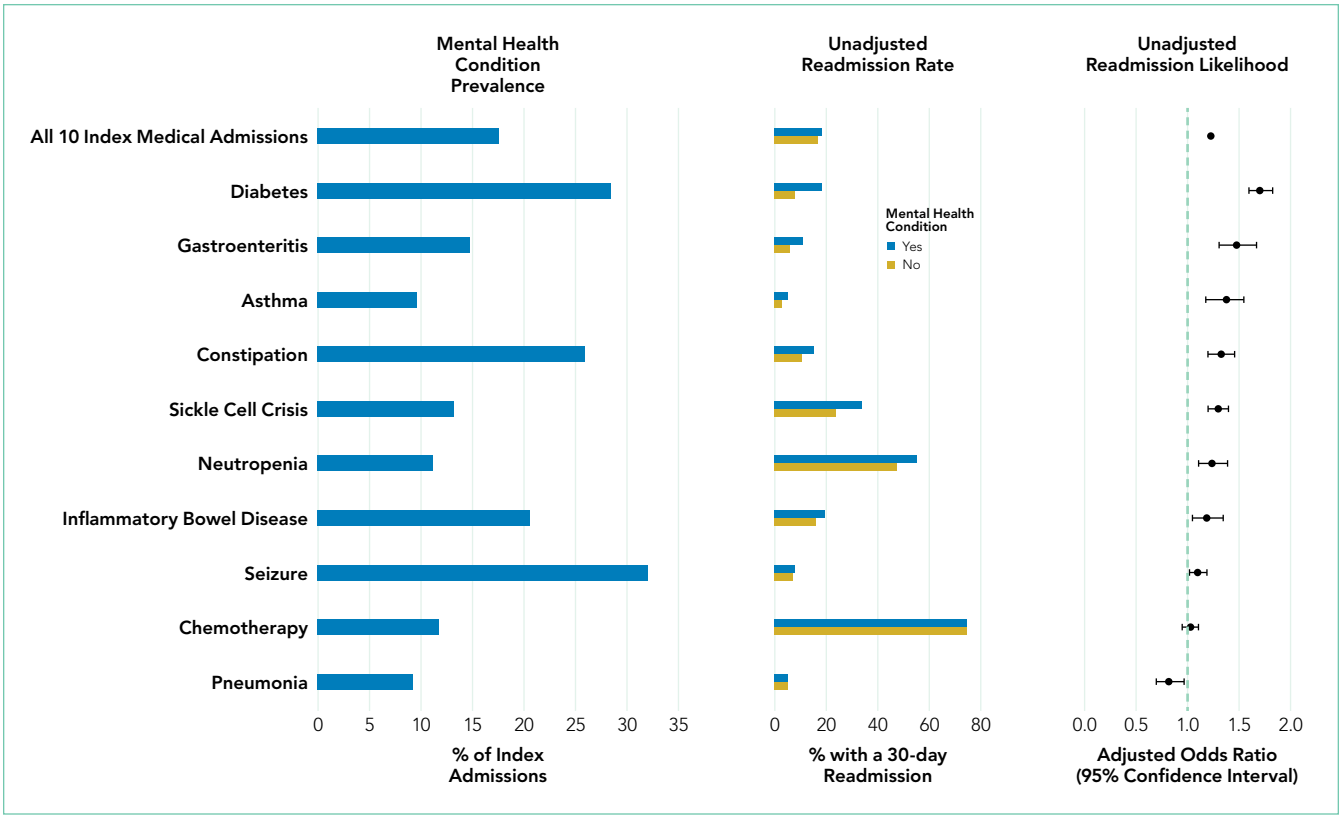

FIG 1. Medical Admissions: Relationship Between Mental Health Conditions and 30-day, Unplanned Hospital Readmissions. Index admissions were for the 10 medical conditions (n=346,960) that accounted for the most 30-day, unplanned hospital readmissions. Readmission likelihood was compared to no mental health condition and adjusted for demographic, clinical, and hospital characteristics.

tative sample of 14 million hospitalizations in 21 states, accounting for 49% of all US hospitalizations and weighted to represent 35.6 million hospitalizations. The database includes deidentified, verified patient linkage numbers so that patients can be tracked across multiple hospitalizations at the same institution or different institutions within a state. The NRD includes hospital information, patient demographic information, and the *International Classification of Diseases, 9th Revision-Clinical Modification* (ICD-9-CM) discharge diagnoses and procedures, with 1 primary diagnosis and up to 24 additional fields for comorbid diagnoses. This study was approved for exemption by the Children's Hospital of Philadelphia Institutional Review Board.

Index Admissions

We used the methods described below to create a study cohort of the 10 medical and 10 procedure index admissions associated with the highest volume (ie, the greatest absolute number) of 30-day hospital readmissions. Conditions with a high volume of readmissions were chosen in an effort to identify conditions in which readmission-prevention interventions had the greatest potential to reduce the absolute number of readmissions. We first categorized index hospitalizations for medical and procedure conditions by using the All Patient Refined Diagnosis Related Groups (APR-DRGs; 3M Health Information Systems, Wallingford, CT).[27] APR-DRGs use all diagnosis and/or procedure ICD-9-CM codes registered for a hospital discharge to assign 1 reason that best explains the need for hospitalization. We then excluded obstetric hospitalizations, psychiatric hospitalizations, and hospitalizations resulting in death or transfer from being considered as index admissions. Afterwards, we ranked each APR-DRG index hospitalization by the total number of 30-day hospital readmissions that occurred afterward and selected the 10 medical and 10 procedure index admissions with the highest number of readmissions. The APR-DRG index admissions are listed in Figures 1 and 2. For the APR-DRG "digestive system diagnoses," the most common diagnosis was constipation, and we refer to that category as "constipation." The most common diagnosis for the APR-DRG called "other operating room procedure for neoplasm" was tumor biopsy, and we refer to that category as "tumor biopsy."

Main Outcome Measure

The primary study outcome was unplanned, all-cause readmission to any hospital within 30 days of index hospitalization. All-cause readmissions include any hospitalization for the same or different condition as the index admission, including conditions not eligible to be considered as index admissions (obstetric, psychiatric, and hospitalizations resulting in death or transfer). Planned readmissions, identified by using pediatric-specific measure specifications endorsed by AHRQ and the National Quality Forum,[28] were excluded from measurement. For index admissions with multiple 30-day readmissions, only

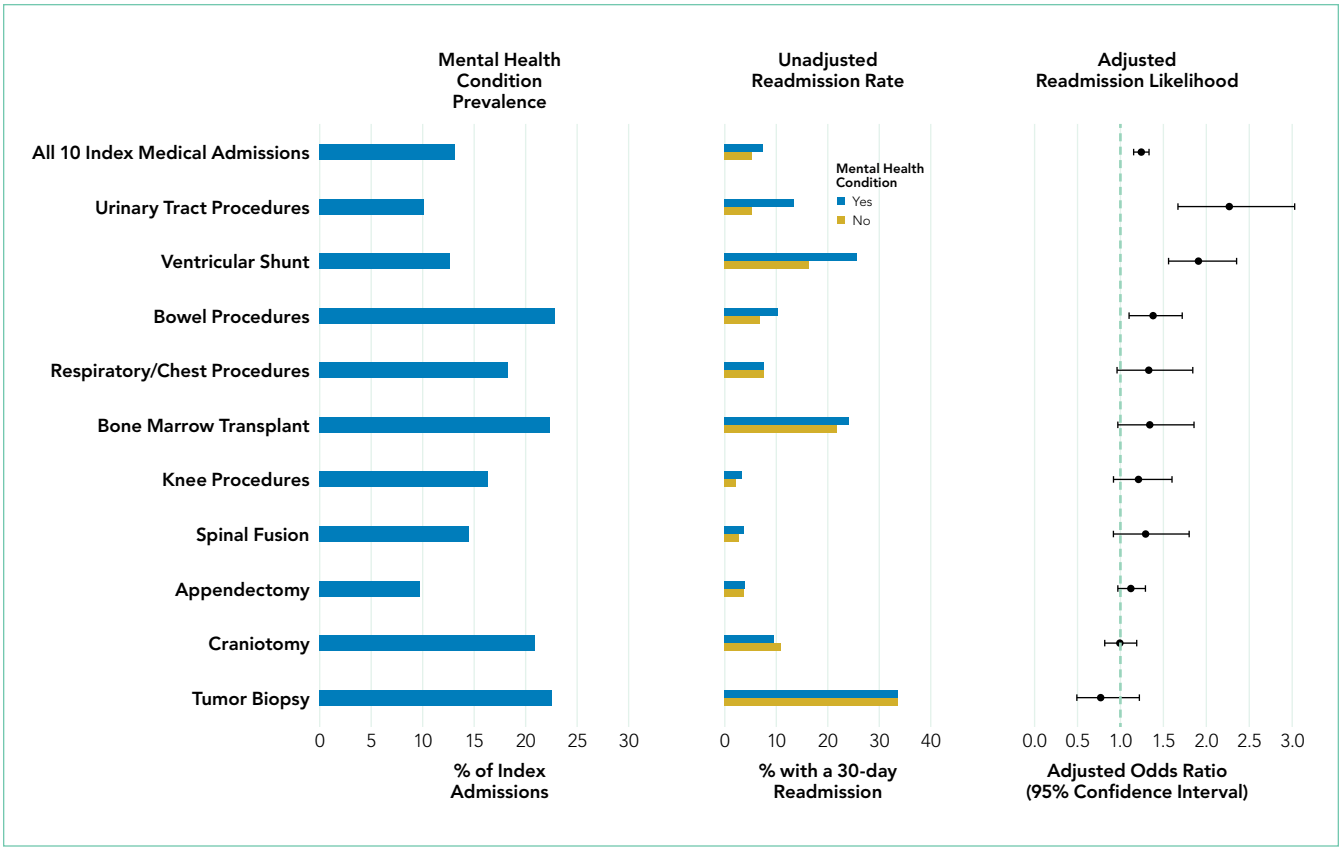

FIG 2. Procedure Admissions: Relationship Between Mental Health Conditions and 30-day, Unplanned Hospital Readmissions. Index admissions were for the 10 procedure conditions (n=124,097) that accounted for the most 30-day, unplanned hospital readmissions. Readmission likelihood was compared to no mental health condition and adjusted for demographic, clinical, and hospital characteristics.

the first readmission was counted. Each readmission was treated as an index admission.

Main Independent Variable

The main independent variable was the presence of an MHC documented during the index hospitalization. MHCs were identified and classified into diagnosis categories derived from the AHRQ Chronic Condition Indicator system by using ICD-9-CM codes.[29] MHC categories included anxiety disorders, attention-deficit/hyperactivity disorder (ADHD), autism, depression, and substance abuse. Less common MHCs included bipolar disorder, schizophrenia, disruptive behavior disorders, somatoform disorders, and eating disorders. These conditions are included in the group with any MHC, but we did not calculate the adjusted odds ratios (AORs) of readmission for these conditions. Children were identified as having multiple MHCs if they had more than 1 MHC.

Other Characteristics of Index Hospitalizations

A priori, we selected for analysis the known demographic, clinical, and hospital factors associated with the risk of readmission.[20-24] The demographic characteristics included patient age, gender, payer category, urban or rural residence, and the median income quartile for a patient's ZIP code. The hospital characteristics included location, ownership, and teaching hospital designation. The clinical characteristics included the number of chronic conditions[30] and indicators for the presence of a complex chronic condition in each of 12 organ systems.[31]

Statistical Analysis

We calculated descriptive summary statistics for the characteristics of index hospitalizations. We compared characteristics in index admissions of children with versus without MHC by using Wilcoxon Rank-Sum tests for continuous variables and Wald χ^2 tests for categorical variables. In the multivariable analysis, we derived logistic regression models to assess the relationship of 30-day hospital readmission with each type of MHC, adjusting for index admission demographic, hospital, and clinical characteristics. MHCs were modeled as binary indicator variables with the presence of any MHC, more than 1 MHC, or each of 5 MHC categories (anxiety disorders, ADHD, autism, depression, substance abuse) compared with no MHC. Four types of logistic regression models were derived (1) for the combined sample of all 10 index medical admissions with each MHC category versus no MHC as a primary predictor, (2) for each medical index admission with any MHC versus no MHC as the primary predictor, (3) for the combined sample of all 10 index procedure admissions with each MHC category versus no MHC as a primary predictor, and (4) for each procedure index

admission with any MHC versus no MHC as the primary predictor. All analyses were weighted to achieve national estimates and clustered by hospital by using AHRQ-recommended survey procedures. SAS version 9.4 (SAS Institute, Cary, NC) was used for all analyses. All tests were two-sided, and a $P < .05$ was considered statistically significant.

RESULTS

Study Population

The study sample included 471,057 index hospitalizations, including 346,960 medical and 124,097 procedure admissions (Table). The selected hospitalizations accounted for 39.6% of all index hospitalizations and 40.7% of all unplanned 30-day readmissions for patients ages 3 to <21 years in 2013. For all medical and procedure index admissions combined, median age at index admission was 12 years (interquartile range [IQR], 7-17); 49.2% used public insurance, and 74.0% were from urban teaching hospitals. Median LOS was 2 days (IQR, 1-4; Table).

Across all index admissions, 16.3% were for children with an MHC. Overall, children with MHCs were older and more likely to have a chronic[30] or complex chronic[31] physical health condition than children with no MHCs (Table).

Index Medical Admissions, Mental Health Conditions, and Hospital Readmission

The 10 index medical hospitalizations with the most readmissions for children ages 3 to 20 years were asthma, chemotherapy, constipation, diabetes, gastroenteritis, inflammatory bowel disease, neutropenia, pneumonia, seizure, and sickle cell crisis. Across all index medical hospitalizations, 17.5% were for patients with an MHC (Figure 1). Of index medical admissions with any MHC, 26.3% had ADHD, 22.9% had an anxiety disorder, 14.9% had autism, 18.3% had depression, and 30.9% had substance abuse. Among all admissions with MHCs, 28.9% had 2 or more MHCs.

Index Medical Admissions Combined

For all index medical hospitalizations combined, 17.0% (n = 59,138) had an unplanned, 30-day hospital readmission. The rate of 30-day hospital readmissions was higher with versus without an MHC (17.5 vs 16.8%; $P < .001$). In a multivariable analysis, presence of an MHC was associated with a higher likelihood of hospital readmission following an index medical admission (AOR, 1.23; 95% confidence interval [CI], 1.19-1.26); Figure 1). All MHCs except autism and ADHD had a higher likelihood of readmission (Figure 3).

Specific Index Medical Admissions

For specific index medical admissions, the rate of 30-day hospital readmission ranged from 2.9% for asthma to 74.3% for chemotherapy. For 8 of the 10 specific index medical hospitalizations (all aside from chemotherapy and pneumonia), an MHC was associated with higher adjusted odds of 30-day readmission (AOR range, 1.10-1.70; Figure 1). In pneumonia index admissions, having an MHC was associated with lower odds of readmission compared with having no MHC (AOR, 0.82; 95% CI, 0.69-0.97; Figure 1).

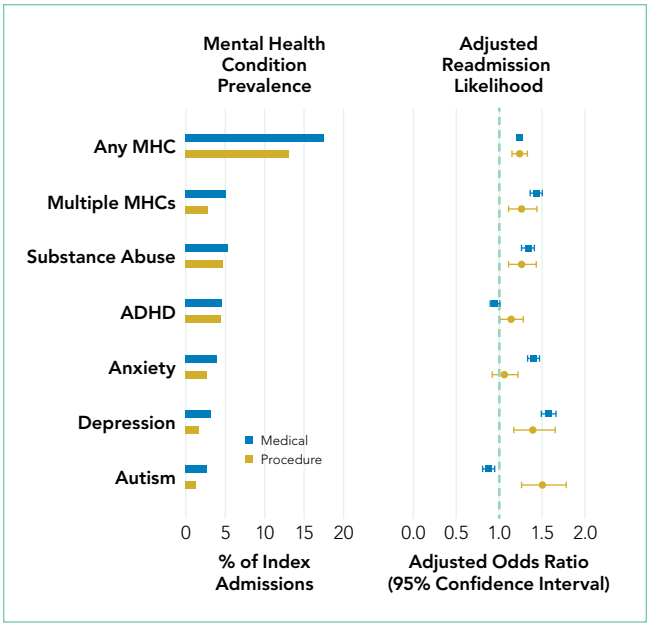

FIG 3. Adjusted 30-day, Unplanned Readmission Likelihood by Type and Number of Mental Health Conditions for Medical and Procedure Hospitalizations. Index admissions were for the 10 medical conditions (n=346,960) and 10 procedure conditions (n=124,097) that accounted for the most 30-day, unplanned hospital readmissions. Readmission likelihood was compared to no mental health condition and adjusted for demographic, clinical, and hospital characteristics. Abbreviations: ADHD, Attention Deficit Hyperactivity Disorder; MHC, mental health condition.

Index Procedure Admissions, Mental Health Conditions, and Hospital Readmission

The 10 index procedure hospitalizations with the most readmissions for children ages 3 to 20 years were appendectomy, bone marrow transplant, bowel procedures, craniotomy, knee procedures, respiratory and chest procedures, spinal fusion, tumor biopsy, urinary tract procedures, and ventricular shunt procedures. Across all index procedure hospitalizations, 13.1% were for patients with an MHC (Figure 2). Of index procedure admissions with any MHC, 35.8% had substance abuse, 33.5% had ADHD, 19.8% had an anxiety disorder, 12.2% had depression, 9.9% had autism, and 20.9% had more than 1 MHC.

Index Procedure Admissions Combined

For all index procedure hospitalizations combined, 6.2% (n = 7632) had an unplanned, 30-day hospital readmission. The rate of 30-day hospital readmissions was significantly higher with versus without an MHC (7.2 vs 5.1%; $P < .001$). In a multivariable analysis, MHCs were associated with a higher likelihood of hospital readmission following an index procedure admission (AOR, 1.24; 95% CI, 1.15-1.33; Figure 2). Among common MHCs, only anxiety disorders were not associated with higher odds of readmission (AOR, 1.06; 95% CI, 0.92-1.22; Figure 3).

Specific Index Procedure Admissions

For specific index procedure admissions, the rate of 30-day hospital readmission ranged from 2.2% for knee procedures

to 33.6% for tumor biopsy. For 3 (ie, urinary tract, ventricular shunt, and bowel procedures) of the 10 specific index procedure hospitalizations, having an MHC was associated with higher adjusted odds of 30-day readmission (AOR range, 1.38-2.27; Figure 2).

In total, adjusting for sociodemographic, clinical, and hospital characteristics, MHCs were associated with an additional 2501 medical readmissions and 217 procedure readmissions beyond what would have been expected if MHCs were not associated with readmissions.

DISCUSSION

MHCs are common among pediatric hospitalizations with the highest volume of readmissions; MHCs were present in approximately 1 in 5 medical and 1 in 7 procedure index hospitalizations. Across medical and procedure admissions, the adjusted likelihood of unplanned, all-cause 30-day readmission was 25% higher for children with versus without an MHC. The readmission likelihood varied by the type of medical or procedure admission and by the type of MHC. MHCs had the strongest associations with readmissions following hospitalization for diabetes and urinary tract procedures. The MHC categories associated with the highest readmission likelihood were depression, substance abuse, and multiple MHCs.

The current study complements existing literature by helping establish MHCs as a prevalent and important risk factor for hospital readmission in children. Estimates of the prevalence of MHCs in hospitalized children are between 10% and 25%,[10,11,32] and prevalence has increased by as much as 160% over the last 10 years.[29] Prior investigations have found that children with an MHC tend to stay longer in the hospital compared with children with no MHC.[32] Results from the present study suggest that children with MHCs also experience more inpatient days because of rehospitalizations. Subsequent investigations should strive to understand the mechanisms in the hospital, community, and family environment that are responsible for the increased inpatient utilization in children with MHCs. Understanding how the receipt of mental health services before, during, and after hospitalization influences readmissions could help identify opportunities for practice improvement. Families report the need for better coordination of their child's medical and mental health care,[33] and opportunities exist to improve attendance at mental health visits after acute care encounters.[34] Among adults, interventions that address posthospital access to mental healthcare have prevented readmissions.[35]

Depression was associated with an increased risk of readmission in medical and procedure hospitalizations. As a well-known risk factor for readmission in adult patients,[21] depression can adversely affect and exacerbate the physical health recovery of patients experiencing acute and chronic illnesses.[14,36,37] Depression is considered a modifiable contributor that, when controlled, may help lower readmission risk. Optimal adherence with behavior and medication treatment for depression is associated with a lower risk of unplanned 30-day readmissions.[14-16,19] Emerging evidence demonstrates how multifaceted, psychosocial approaches can improve patients' adherence with depression treatment plans.[38] Increased attention to depression in hospitalized children may uncover new ways to manage symptoms as children transition from hospital to home.

Other MHCs were associated with a different risk of readmission among medical and procedure hospitalizations. For example, ADHD or autism documented during index hospitalization was associated with an increased risk of readmission following procedure hospitalizations and a decreased risk following medical hospitalizations. Perhaps children with ADHD or autism who exhibit hyperactive, impulsive, or repetitive behaviors[39,40] are at risk for disrupting their postprocedure wound healing, nutrition recovery, or pain tolerance, which might contribute to increased readmission risk.

MHCs were associated with different readmission risks across specific types of medical or procedure hospitalizations. For example, among medical conditions, the association of readmissions with MHCs was highest for diabetes, which is consistent with prior research.[26] Factors that might mediate this relationship include changes in diet and appetite, difficulty with diabetes care plan adherence, and intentional nonadherence as a form of self-harm. Similarly, a higher risk of readmission in chronic medical conditions like asthma, constipation, and sickle cell disease might be mediated by difficulty adhering to medical plans or managing exacerbations at home. In contrast, MHCs had no association with readmission following chemotherapy. In our clinical experience, readmissions following chemotherapy are driven by physiologic problems, such as thrombocytopenia, fever, and/or neutropenia. MHCs might have limited influence over those health issues. For procedure hospitalizations, MHCs had 1 of the strongest associations with ventricular shunt procedures. We hypothesize that MHCs might lead some children to experience general health symptoms that might be associated with shunt malfunction (eg, fatigue, headache, behavior change), which could lead to an increased risk of readmission to evaluate for shunt malfunction. Conversely, we found no relationship between MHCs and readmissions following appendectomy. For appendectomy, MHCs might have limited influence over the development of postsurgical complications (eg, wound infection or ileus). Future research to better elucidate mediators of increased risk of readmission associated with MHCs in certain medical and procedure conditions could help explain these relationships and identify possible future intervention targets to prevent readmissions.

This study has several limitations. The administrative data are not positioned to discover the mechanisms by which MHCs are associated with a higher likelihood of readmission. We used hospital ICD-9-CM codes to identify patients with MHCs. Other methods using more clinically rich data (eg, chart review, prescription medications, etc.) may be preferable to identify patients with MHCs. Although the use of ICD-9-CM codes may have sufficient specificity, some hospitalized children may have an MHC that is not coded. Patients identified by using diagnosis codes could represent patients with a higher severity of illness, patients using medications, or patients whose outpatient records are accessible to make the hospital team aware of the MHC. If documentation of MHCs during hospitalization rep-

resents a higher severity of illness, findings may not extrapolate to lower-severity MHCs. As hospitals transition from ICD-9 -CM to ICD-10 coding, and health systems develop more integrated inpatient and outpatient EHRs, diagnostic specificity may improve. We could not analyze the relationships with several potential confounders and explanatory variables that may be related both to the likelihood of having an MHC and the risk of readmission, including medication administration, psychiatric consultation, and parent mental health. Postdischarge health services, including access to a medical home or a usual source of mental healthcare and measures of medication adherence, were not available in the NRD.

Despite these limitations, the current study underscores the importance of MHCs in hospitalized children upon discharge. As subsequent investigations uncover the key drivers explaining the influence of MHCs on hospital readmission risk, hospitals and their local outpatient and community practices may find it useful to consider MHCs when (1) developing contingency plans and establishing follow-up care at discharge,[41] (2) exploring opportunities of care integration between mental and physical health care professionals, and (3) devising strategies to reduce hospital readmissions among populations of children.

CONCLUSIONS

MHCs are prevalent in hospitalized children and are associated with an increased risk of 30-day, unplanned hospital readmission. Future readmission prevention efforts may uncover new ways to improve children's transitions from hospital to home by investigating strategies to address their MHCs.

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Shared Decision-Making During Inpatient Rounds: Opportunities for Improvement in Patient Engagement and Communication

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BACKGROUND: Shared decision-making (SDM) improves patient engagement and may improve outpatient health outcomes. Little is known about inpatient SDM.

OBJECTIVE: To assess overall quality, provider behaviors, and contextual predictors of SDM during inpatient rounds on medicine and pediatrics hospitalist services.

DESIGN: A 12-week, cross-sectional, single-blinded observational study of team SDM behaviors during rounds, followed by semistructured patient interviews.

SETTING: Two large quaternary care academic medical centers.

PARTICIPANTS: Thirty-five inpatient teams (18 medicine, 17 pediatrics) and 254 unique patient encounters (117 medicine, 137 pediatrics).

INTERVENTION: Observational study.

MEASUREMENTS: We used a 9-item Rochester Participatory Decision-Making Scale (RPAD) measured team-level SDM behaviors. Same-day interviews using a modified RPAD assessed patient perceptions of SDM.

RESULTS: Characteristics associated with increased SDM in the multivariate analysis included the following: service, patient gender, timing of rounds during patient's hospital stay, and amount of time rounding per patient ($P < .05$). The most frequently observed behaviors across all services included explaining the clinical issue and matching medical language to the patient's level of understanding. The least frequently observed behaviors included checking understanding of the patient's point of view, examining barriers to follow-through, and asking if the patient has any questions. Patients and guardians had substantially higher ratings for SDM quality compared to peer observers (7.2 vs 4.4 out of 9).

CONCLUSIONS: Important opportunities exist to improve inpatient SDM. Team size, number of learners, patient census, and type of decision being made did not affect SDM, suggesting that even large, busy services can perform SDM if properly trained. *Journal of Hospital Medicine* 2018;13:453-461. Published online first February 5, 2018. © 2018 Society of Hospital Medicine

The ethos of medicine has shifted from paternalistic, physician-driven care to patient autonomy and engagement, in which the physician shares information and advises.[1-3] Although there are ethical, legal, and practical reasons to respect patient preferences,[1-4] patient engagement also fosters quality and safety[5] and may improve clinical outcomes.[5-8] Patients whose preferences are respected are more likely to trust their doctor, feel empowered, and adhere to treatments.[9]

Providers may partner with patients through shared decision-making (SDM).[10,11] Several SDM models describe the process of providers and patients balancing evidence, preferences and context to arrive at a clinical decision.[12-15] The National Academy of Medicine and the American Academy of Pediatrics has called for more SDM,[16,17] including when clinical evidence is limited,[2] equally beneficial options exist,[18] clinical stakes are high,[19] and even with deferential patients.[20] Despite its value, SDM does not reliably occur[21,22] and SDM training is often unavailable.[4] Clinical decision tools, patient education aids, and various training interventions have shown promising, although inconsistent results.[23,24]

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Little is known about SDM in inpatient settings where unique patient, clinician, and environmental factors may influence SDM. This study describes the quality and possible predictors of inpatient SDM during attending rounds in 4 academic training settings. Although SDM may occur anytime during a hospitalization, attending rounds present a valuable opportunity for SDM observation given their centrality to inpatient care and teaching.[25,26] Because attending physicians bear ultimate responsibility for patient management, we examined whether SDM performance varies among attendings within each service. In addition, we tested the hypothesis that service-level, team-level, and patient-level features explain variation in SDM quality more than individual attending physicians. Finally, we compared peer-observer perspectives of SDM behaviors with patient and/or guardian perspectives.

METHODS

Study Design and Setting

This cross-sectional, observational study examined the diversity of SDM practice within and between 4 inpatient services during attending rounds, including the internal medicine and pediatrics services at Stanford University and the University of California, San Francisco (UCSF). Both institutions provide quaternary care to diverse patient populations with approximately half enrolled in Medicare and/or Medicaid.

One institution had 42 internal medicine (Med-1) and 15 pediatric hospitalists (Peds-1) compared to 8 internal medicine (Med-2) and 12 pediatric hospitalists (Peds-2) at the second location. Both pediatric services used family-centered rounds that included discussions between the patients' families and the whole team. One medicine service used a similar rounding model that did not necessarily involve the patients' families. In contrast, the smaller medicine service typically began rounds by discussing all patients in a conference room and then visiting select patients afterwards.

From August 2014 to November 2014, peer observers gathered data on team SDM behaviors during attending rounds. After the rounding team departed, nonphysician interviewers surveyed consenting patients' (or guardians') views of the SDM experience, yielding paired evaluations for a subset of SDM encounters. Institutional review board approval was obtained from Stanford University and UCSF.

Participants and Inclusion Criteria

Attending physicians were hospitalists who supervised rounds at least 1 month per year, and did not include those conducting the study. All provided verbal assent to be observed on 3 days within a 7-day period. While team composition varied as needed (eg, to include the nurse, pharmacist, interpreter, etc), we restricted study observations to those teams with an attending and at least one learner (eg, resident, intern, medical student) to capture the influence of attending physicians in their training role. Because services vary in number of attendings on staff, rounds assigned per attending, and patients per round, it was not possible to enroll equal sample sizes per service in the study.

Nonintensive care unit patients who were deemed medically stable by the team were eligible for peer observation and participation in a subsequent patient interview once during the study period. Pediatric patients were invited for an interview if they were between 13 and 21 years old and had the option of having a parent or guardian present; if the pediatric patients were less than 13 years old or they were not interested in being interviewed, then their parents or guardians were invited to be interviewed. Interpreters were on rounds, and thus, non-English participants were able to participate in the peer observations, but could not participate in patient interviews because interpreters were not available during afternoons for study purposes. Consent was obtained from all participating patients and/or guardians.

Data Collection

Round and Patient Characteristics

Peer observers recorded rounding, team, and patient characteristics using a standardized form. Rounding data included date, attending name, duration of rounds, and patient census. Patient level data included the decision(s) discussed, the seniority of the clinician leading the discussion, team composition, minutes spent discussing the patient (both with the patient and/or guardian and total time), hospitalization week, and patient's primary language. Additional patient data obtained from electronic health records included age, gender, race, ethnicity, date of admission, and admitting diagnosis.

SDM Measures

Peer-observed SDM behaviors were quantified per patient encounter using the 9-item Rochester Participatory Decision-Making Scale (RPAD), with credit given for SDM behaviors exhibited by anyone on the rounding team (team-level metric).[27] Each item was scored on a 3-point scale (0 = absent, 0.5 = partial, and 1 = present) for a maximum of 9 points, with higher scores indicating higher-quality SDM (Peer-RPAD Score). We created semistructured patient interview guides by adapting each RPAD item into layperson language (Patient-RPAD Score) and adding open-ended questions to assess the patient experience.

Peer-Observer Training

Eight peer-observers (7 hospitalists and 1 palliative care physician) were trained to perform RPAD ratings using videos of patient encounters. Initially, raters viewed videos together and discussed ratings for each RPAD item. The observers incorporated behavioral anchors and clinical examples into the development of an RPAD rating guide, which they subsequently used to independently score 4 videos from an online medical communication library.[28] These scores were discussed to resolve any differences before 4 additional videos were independently viewed, scored, and compared. Interrater reliability was achieved when the standard deviation of summed SDM scores across raters was less than 1 for all 4 videos.

Patient Interviewers

Interviewers were English-speaking volunteers without formal medical training. They were educated in hospital etiquette by a physician and in administering patient interviews through

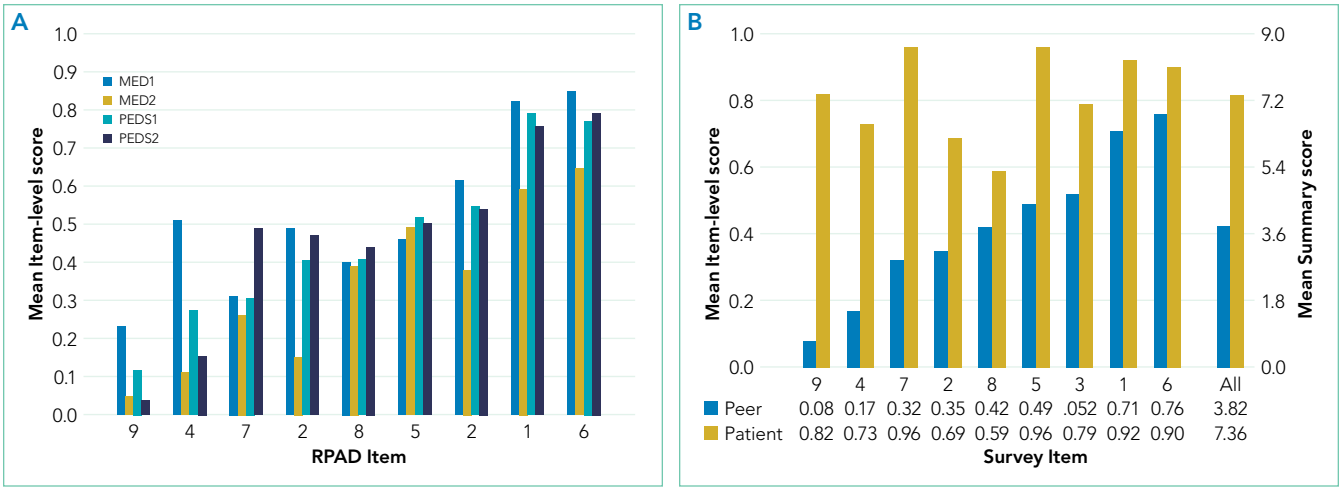

FIG. (A) Item-level Peer Ratings of Shared Decision Making by Service, among 254 SDM encounters, ordered by overall Peer-RPAD Scores. (B) Item-level Peer vs. Patient Ratings of Shared Decision Making, among 149 patient/guardian respondents to patient interviews, ordered by overall Peer-RPAD Scores.

NOTE: RPAD Items: 1=Team clearly explained medical issue or decision to be made; 2=Team discussed alternatives or uncertainties; 3=Team checked for patient agreement with plan; 4=Team examined barriers to follow through with treatment plan; 5=Team provided opportunity for patient to ask questions to ensure understanding; 6=Patient understood what Team was saying; 7=Team asked if patient had any questions; 8=Team asked open-ended questions; 9=Team checked own understanding of patient's point of view.

peer-to-peer role playing and an observation and feedback interview with at least 1 patient.

Data Analysis

The analysis set included every unique patient with whom a medical decision was made by an eligible clinical team. To account for the nested study design (patient-level scores within rounds, rounds within attending, and attendings within service), we used mixed-effects models to estimate mean (summary or item) RPAD score by levels of fixed covariate(s). The models included random effects accounting for attending-level and round-level correlations among scores via variance components, and allowing the attending-level random effect to differ by service. Analyses were performed using SAS version 9.4 (SAS Institute Inc, Cary, NC). We used descriptive statistics to summarize round- and patient-level characteristics.

SDM Variation by Attending and Service

Box plots were used to summarize raw patient-level, Peer-RPAD scores by service and attending. By using the methods described above, we estimated the mean score overall and by service. In both models, we examined the statistical significance of service-specific variation in attending-level random effects by using likelihood-ratio test (LRT) to compare models.

SDM Variation by Round and Patient Characteristics

We used the models described above to identify covariates associated with Peer-RPAD scores. We fit univariate models separately for each covariate, then fit 2 multivariable models, including (1) all covariates and (2) all effects significant in either model at $P \leq .20$ according to F tests. For uniformity of presentation, we express continuous covariates categorically; however, we report *P* values based on continuous versions. Means generated by the multivariable models were calculated at the mean values of all other covariates in model.

Patient-Level RPAD Data

A subsample of patients completed semistructured interviews with analogous RPAD questions. To identify possible selection bias in the full sample, we summarized response rates by service and patient language and modeled Peer-RPAD scores by interview response status. Among responders, we estimated the mean Peer-RPAD and Patient-RPAD scores and their paired differences and correlations, testing for non-zero correlations via the Spearman rank test.

RESULTS

All Patient Encounters

A total of 35 attendings (18 medicine, 17 pediatrics) were observed, representing 51% of 69 eligible attendings. By design, study observations included a median of 3 rounds per attending (range 1-5), summing to 88 total rounds (46 medicine, 42 pediatrics) and 783 patient encounters (388 medicine, 395 pediatrics; Table 1).

The median duration of rounding sessions was 1.8 hours, median patient census was 9, and median patient encounter was 13 minutes. The duration of rounds and minutes per patient were longest at Med-2 and shortest at Peds-1. See Table 1 for other team characteristics.

Peer Evaluations of SDM Encounters

Characteristics of Patients

We observed SDM encounters in 254 unique patients (117 medicine, 137 pediatrics), representing 32% of all observed encounters. Patient mean age was 56 years for medicine and 7.4 years for pediatrics. Overall, 54% of patients were white, 11% were Asian, and 10% were African American; race was not reported for 21% of patients. Pediatrics services had more SDM encounters with Hispanic patients (31% vs. 9%) and Spanish-speaking patients (14% vs < 2%; Table 2). Patient complexity ranged from case mix index (CMI) 1.17 (Med-1) to 2. 11 (Peds-1).

TABLE 1. **Characteristics of Rounding Sessions Observed During the Study**

Characteristics	Total	Med-1	Med-2	Peds-1	Peds-2
Attending hospitalists, n	35	6	12	9	8
Rounding sessions, n	88	13	33	24	18
Rounding sessions per attending, median (min-max)	3 (1-5)	2.5 (1-3)	3 (2-3)	3 (1-4)	2 (1-5)
Patients encounters per round, n, median, (min-max)	796 9 (3-14)	106 9 (3-14)	282 8 (4-11)	250 11 (5-14)	158 9 (4-13)
Duration of round (hours), median (min-max)	1.8 (0.4-4.5)	1.7 (0.8-3.7)	2.5 (1.4-4.5)	1.4 (0.4-2.5)	1.8 (1.0-2.4)
Minutes per patient encounter,[a] median (Q1, Q3)	13 (10-18)	15 (10-18)	18 (15-20)	8 (7-11)	13 (11-14)
Team size,[b] median (min-max)	8.4 (3-17)	6.4 (3-9)	6.8 (3-11)	10.2 (4-14)	10.3 (4-17)
Team members,[b] n (% of team size)					
Attending physicians/fellows	1.3 (15%)	1.1 (18%)	1.1 (19%)	1.3 (14%)	1.1 (11%)
Trainees[c]	4.0 (49%)	2.7 (45%)	3.2 (54%)	4.5 (47%)	4.7 (45%)
Nurses	0.5 (6%)	0 (0%)	0.2 (3%)	0.9 (9%)	0.8 (8%)
Respiratory therapists, pharmacists, case managers, social workers, interpreters	1.1 (14%)	0.6 (8%)	0.3 (6%)	1.3 (13%)	2.6 (25%)
Observers[d]	1.4 (17%)	1.7 (28%)	1.1 (18%)	1.4 (15%)	1.2 (11%)
Individual presenting the patient,[b] % of unique patients					
Medical student	35%	26%	30%	52%	29%
Intern	52%	50%	39%	48%	71%
Resident	12%	24%	27%	0%	0%
Attending	1.6%	0%	4.8%	0%	0%

[a]Round-level average minutes per patient was calculated as the round duration divided by the patient census.
[b]Team size and composition and presenting physician could vary among patients within a round.
[c]Resident/intern/medical student.
[d]Includes the peer observer.
NOTE: Abbreviations: min, minimum of the distribution of the characteristic; max, maximum of the distribution of the characteristic; Q1, first quartile; Q3, third quartile.

Teams spent a median of 13 minutes per SDM encounter, which was not higher than the round median. SDM topics discussed included 47% treatment, 15% diagnostic, 30% both treatment and diagnostic, and 7% other.

Variation in SDM Quality Among Attending Physicians

Overall Peer-RPAD Scores were normally distributed. After adjusting for the nested study design, the overall mean (standard error) score was 4.16 (0.11). Score variability among attendings differed significantly by service (LRT $P = .0067$). For example, raw scores were lower and more variable among attending physicians at Med-2 than other among attendings in other services (see Appendix Figure in Supporting Information). However, when service was included in the model as a fixed effect, mean scores varied significantly, from 3.0 at Med-2 to 4.7 at Med-1 ($P < .0001$), but the random variation among attendings no longer differed significantly by service ($P = .13$). This finding supports the hypothesis that service-level influences are stronger than influences of individual attending physicians, that is, that variation between services exceeded variation among attendings within service.

Aspects of SDM That Are More Prevalent on Rounds

Based on Peer-RPAD item scores, the most frequently observed behaviors across all services included "Matched medical language to the patient's level of understanding" (Item 6, 0.75) and "Explained the clinical issue or nature of the decision" (Item 1, 0.74; panel A of Figure). The least frequently observed behaviors included "Asked if patient had any questions" (Item 7, 0.34), "Examined barriers to follow-through with the treatment plan" (Item 4, 0.15), and "Checked understanding of the patient's point of view" (Item 9, 0.06).

Rounds and Patient Characteristics Associated With Peer-RPAD Scores

In univariate models, Peer-RPAD scores decreased significantly with round-level average minutes per patient and were elevated during a patient's second week of hospitalization. In the multivariable model including all covariates in Table 3, mean Peer-RPAD scores varied by service (lower at Med-2 than elsewhere), patient gender (slightly higher among women and girls), week of hospitalization (highest during the second week), and time spent with the patient and/or guardian (more

TABLE 2. **Rounding Characteristics of Unique Patient Encounters Involving SDM**

Characteristics	Total	Med-1	Med-2	Peds-1	Peds-2
Unique patients, n (% of patient encounters); median (min-max) per round	254 (32%) 3 (1-8)	34 (32%) 3 (1-5)	83 (29%) 2 (1-6)	62 (25%) 2 (1-6)	75 (47%) 4 (2-8)
Patient and/or guardian survey, n (%)	149 (59%)	9 (26%)	57 (69%)	29 (47%)	54 (72%)
Age of patient,[a] median (Q1-Q3)	17 (5.0-56)	54 (43-67)	60 (41-71)	4 (1.3-9.0)	7 (5.0-15)
Male patient, n (%)	128 (51%)	18 (55%)	27 (33%)	48 (77%)	35 (47%)
Race, n (%)					
White, n (%)	136 (54%)	18 (53%)	45 (54%)	35 (56%)	38 (51%)
Asian	28 (11%)	2 (5.9%)	12 (14%)	9 (15%)	5 (6.7%)
African American	26 (10%)	7 (21%)	15 (18%)	1 (1.6%)	3 (4.0%)
Pacific Islander/Native American	10 (3.9%)	1 (2.9%)	3 (3.6%)	4 (6.4%)	2 (2.7%)
Other	54 (21%)	6 (18%)	8 (9.6%)	13 (21%)	27 (36%)
Hispanic, n (%)	52 (20%)	5 (15%)	5 (6.0%)	35 (56%)	22 (29%)
Language					
English	220 (87%)	31 (91%)	73 (88%)	51 (82%)	65 (87%)
Spanish	21 (8.3%)	1 (2.9%)	1 (1.2%)	10 (16%)	9 (12%)
Other	13 (5.1%)	2 (5.9%)	9 (11%)	1 (1.6%)	1 (1.3%)
CMI, mean		1.17	1.49	2.11	1.31
Hospitalization day, median (Q1-Q3)	2 (1-4)	2 (1-8)	2 (1-6)	1 (1-3)	3 (1-4)
Total minutes rounding per patient, median (Q1-Q3)	13 (9-18)	12 (7-18)	15 (12-25)	14 (12-18)	10 (6-13)
Minutes with patient and/or guardian present, per patient, median (Q1-Q3)	12 (8-17)	9 (6-17)	13 (9-21)	14 (12-18)	10 (6-13)
Types of decisions discussed					
Treatment[b]	120 (47%)	11 (32%)	49 (59%)	34 (55%)	26 (35%)
Diagnosis[b]	39 (15%)	10 (29%)	10 (12%)	10 (16%)	9 (12%)
Diagnosis and treatment[b]	77 (30%)	9 (26%)	19 (23%)	16 (26%)	33 (44%)
Other[b]	18 (7.1%)	4 (12%)	5 (6.0%)	2 (3.2%)	7 (9.3%)

[a]Missing for one patient.
[b]Can include discussion of other decisions, such as discharge.
NOTE: Abbreviations: CMI, case mix index; Q1, first quartile; Q3, third quartile.

time correlated with higher scores). In a reduced multivariable model restricted to the covariates that were statistically significant in either model ($P \leq .20$), all 5 associations remained significant $P \leq .05$. However, the difference in means by gender was only 0.3, and only 18% of patients were hospitalized for more than 1 week.

Patient-RPAD Results: Dissimilar Perspectives of Patients and/or Guardians and Physician Observers

Of 254 peer-evaluated SDM encounters, 149 (59%) patients and/or guardians were available and consented to same-day interviews, allowing comparison of paired peer and patient evaluations of SDM in this subset. The response rate was 66% among patients whose primary language was English versus 15% among others. Peer-RPAD scores by interview response status were similar overall (responders, 4.17; nonresponders, 4.13; $P = .83$) and by service (interaction $P = .30$).

Among responders, mean Patient-RPAD scores were 6.8 to 7.1 for medicine services and 7.6 to 7.8 for pediatric services ($P = .01$). The overall mean Patient-RPAD score, 7.46, was significantly greater than the paired Peer-RPAD score by 3.5 ($P = .011$); however, correlations were not statistically significantly different from 0 (by service, each $P > .12$).

To understand drivers of the differences between Peer-RPAD and Patient-RPAD scores, we analyzed findings by item. Each mean patient-item score exceeded its peer counterpart ($P \leq .01$; panel B of Figure). Peer-item scores fell below 33% on 2 items (Items 9 and 4) and only exceeded 67% on 2 items (Items 1 and 6), whereas patient-item scores ranged from 60% (Item 8) to 97% (Item 7). Three paired differences exceeded 50% (Items 9, 4, and 7) and 3 were below 20% (Items 6, 8 and 1), underlying the lack of correlation between peer and patient scores.

TABLE 3. **Associations of Peer-RPAD Scores with Levels of Rounding and Team Characteristics**

		Univariate Models		Full Multivariable Model		Reduced Multivariable Model	
Characteristics	**Patients (% of SDM encounters)**	**RPAD Score, mean**	**F test *P* value (nDF)**	**RPAD Score, mean**	**F test *P* value (nDF)**	**RPAD Score, mean**	**F test *P* value (nDF)**
Overall	254 (100%)	4.16		4.32		4.35	
Round Characteristics							
Service			< .001 (3)		.0003 (3)		< .0001 (3)
Med-1	34 (13%)	4.72		4.74		5.03	
Med-2	83 (33%)	3.04		3.27		3.42	
Peds-1	62 (24%)	4.26		4.64		4.44	
Peds-2	75 (30%)	4.14		4.64		4.53	
Round census[a]			.48 (1)[b]		.87 (1)[b]		
3-7	51 (20%)	4.12		4.10			
8-9	95 (37%)	4.16		4.20			
10-11	53 (21%)	4.26		4.62			
12-14	55 (22%)	4.13		4.37			
Round duration[a]			.25 (1)[b]		.38 (1)[b]		
< 1.5 hours	54 (21%)	4.32		4.71			
1.5-1.99 hours	80 (32%)	4.27		4.52			
2.0-2.49 hours	63 (25%)	3.83		3.98			
≥ 2.5 hours	57 (22%)	3.85		4.07			
Average minutes per patient[a]			.038 (1)[b]		0.24 (1)[b]		.033 (1)[b]
< 10 minutes	56 (22%)	4.20		4.23		4.49	
10.0-14.9	107 (42%)	4.17		4.80		4.74	
15.0-19.9	53 (21%)	3.70		4.29		4.24	
≥ 20.0	38 (15%)	3.51		3.97		3.94	
Team characteristics							
Team size			.77 (1)[b]		.25 (1)[b]		
3-6 members	87 (34%)	4.20		4.52			
7-8 members	62 (24%)	4.23		4.61			
9-10 members	53 (21%)	4.06		4.10			
11-17 members	52 (20%)	4.18		4.05			
Trainee percentage on team			.27 (1)[b]		.57 (1)[b]		
< 40%	52 (20%)	4.29		4.50			
40.0% to 49.9%	55 (22%)	4.27		4.34			
50.0% to 59.9%	91 (36%)	4.01		4.28			
≥ 60%	56 (22%)	3.92		4.17			
Presenting MD			.95 (3)		.86 (3)		
Medical student	88 (35%)	4.11		4.18			
Intern	132 (52%)	4.19		4.22			
Resident	30 (12%)	4.24		4.25			
Attending	4 (2%)	4.24		4.63			

[a]Because the outcome is patient-level, patient-level distributions are tabled for round-level covariates.

[b]Test for linear association uses continuous version of covariate, thus nDF of F test has 1 DF.

NOTE: According to univariate models (include 1 covariate) and 2 multivariable models, these characteristics are illustrated via mean Peer-RPAD scores and *P* values from F tests. The full multivariable model includes all covariates tabulated, and the reduced multivariable model includes covariates that were statistically significant at $P \leq .20$ in either univariate or the full multivariable model according to F tests. Abbreviations: DF, degrees of freedom; MD, medical doctor; nDF, numerator degrees of freedom; RPAD, Rochester Participatory Decision-Making Scale; SDM, shared decision making.

TABLE 4. **Associations of Peer-RPAD Scores with Levels of Patient Characteristics**

Patient Characteristics	N	Peer-RPAD Score, mean	F test *P* value (nDF)	Peer-RPAD Score, mean	F test *P* value (nDF)	Peer-RPAD Score, mean	F test *P* value (nDF)
Age			.92 (1)		.67 (1)		
Pediatric	137 (54%)	4.17					
Adult	72 (28%)	3.21					
Geriatric	45 (18%)	3.33					
Gender[a]			.19 (1)		.052 (1)		.028 (1)
Female	122 (49%)	4.27		4.49		4.52	
Male	128 (51%)	4.06		4.15		4.19	
Race			.81 (4)		.68 (4)		
White	136 (54%)	4.24		4.45			
Asian	28 (11%)	4.18		4.19			
African American	26 (10%)	4.19		4.50			
Pacific Islander/Native American	10 (3.9%)	3.85		4.20			
Other	54 (21%)	4.05		4.26			
Week of rounding encounter			.090 (2)		.023 (2)		.024 (2)
0-6 days	209 (82%)	4.10		4.00		4.02	
7-13 days	28 (11%)	4.60		4.67		4.59	
14-161 days	17 (7%)	4.38		4.29		4.46	
Decision type			.33 (3)		.31 (3)		
Treatment and Diagnosis	77 (30%)	4.29		4.55			
Treatment	120 (47%)	4.05		4.30			
Diagnosis	39 (15%)	3.92		3.97			
Other	18 (7%)	4.31		4.47			
Duration of patient encounter, including time on SDM					.0096 (1)[b]		
	76 (30%)	4.04	.30 (1)	3.90		3.96	.024 (1)[b]
< 10 minutes	69 (27%)	4.20		4.19		4.25	
10.0-14.9 minutes	53 (21%)	4.47		4.51		4.54	
15.0-19.9 minutes	21 (8.3%)	3.88		3.80		3.97	
20.0-24.9 minutes	21 (4.7%)	4.39		4.86		4.74	
25.0-29.9 minutes	23 (9.1%)	4.26		4.66		4.66	
≥ 30 minutes							

[a]Unspecified: age for 1 patient at Med-1.

[b]Test for linear association uses continuous version of covariate, thus nDF of F test has 1 DF.

NOTE: According to univariate models (include 1 covariate) and 2 multivariable models, these characteristics are illustrated via mean Peer-RPAD scores and *P* values from F tests. The full multivariable model includes all covariates tabulated, and the reduced multivariable model includes covariates that were statistically significant at $P \leq .20$ in either univariate or the full multivariable model according to F tests. Abbreviations: DF, degrees of freedom; nDF, numerator degrees of freedom; RPAD, Rochester Participatory Decision-Making Scale; SDM, shared decision making.

DISCUSSION

In this multisite study of SDM during inpatient attending rounds, SDM quality, specific SDM behaviors, and factors contributing to SDM were identified. Our study found an adjusted overall Peer-RPAD Score of 4.4 out of 9, and found the following 3 SDM elements most needing improvement according to trained peer observers: (1) "Checking understanding of the patient's perspective", (2) "Examining barriers to follow-through with the treatment plan", and (3) "Asking if the patient has questions." Areas of strength included explaining the clinical issue or nature of the decision and matching medical language to the patient's level of understanding, with each rated highly by both peer-observers and patients. Broadly speaking, physicians were skillful in delivering information to patients but failed to solicit input from patients. Characteristics associated with increased SDM in the multivariate analysis included the following: service, patient gender, timing of rounds during patient's hospital stay, and amount of time rounding with each patient.

Patients similarly found that physicians could improve their abilities to elicit information from patients and families, noting the 3 lowest patient-rated SDM elements were as follows: (1) asking open-ended questions, (2) discussing alternatives or uncertainties, and (3) discussing barriers to treatment plan follow through. Overall, patients and guardians perceived the quantity and quality of SDM on rounds more favorably than peer observers, which is consistent with other studies of patient perceptions

of communication.[29-31] It is possible that patient ratings are more influenced by demand characteristics, fear of negatively impacting their patient-provider relationships, and conflation of overall satisfaction with quality of communication.[32] This difference in patient perception of SDM is worthy of further study.

Prior work has revealed that SDM may occur infrequently during inpatient rounds.[11] This study further elucidates specific SDM behaviors used along with univariate and multivariate modeling to explore possible contributing factors. The strengths and weaknesses found were similar at all 4 services and the influence of the service was more important than variability across attendings. This study's findings are similar to a study by Shields et al.,[33] in which the findings in a geographically different outpatient setting 10 years earlier suggesting global and enduring challenges to SDM. To our knowledge, this is the first published study to characterize inpatient SDM behaviors and may serve as the basis for future interventions.

Although the item-level components were ranked similarly across services, on average the summary Peer-RPAD score was lowest at Med-2, where we observed high variability within and between attendings, and was highest at Med-1, where variability was low. Med-2 carried the highest caseload and held the longest rounds, while Med-1 carried the lowest caseload, suggesting that modifiable burdens may hamper SDM performance. Prior studies suggest that patients are often selected based on teaching opportunities, immediate medical need and being newly admitted.[34] The high scores at Med-1 may reflect that service's prediscussion of patients during card-flipping rounds or their selection of which patients to round on as a team. Consistent with prior studies[29,35] of SDM and the family-centered rounding model, which includes the involvement of nurses, respiratory therapists, pharmacists, case managers, social workers, and interpreters on rounds, both pediatrics services showed higher SDM scores.

In contrast to prior studies,[34,36] team size and number of learners did not affect SDM performance, nor did decision type. Despite teams having up to 17 members, 8 learners, and 14 complex patients, SDM scores did not vary significantly by team. Nonetheless, trends were in the directions expected: Scores tended to decrease as the team size or the percentage of trainees grew, and increased with the seniority of the presenting physician. Interestingly, SDM performance decreased with round-average minutes per patient, which may be measuring on-going intensity across cases that leads to exhaustion. Statistically significant patient factors for increased SDM included longer duration of patient encounters, second week of hospital stay, and female patient gender. Although we anticipated that the high number of decisions made early in hospitalization would facilitate higher SDM scores, continuity and stronger patient-provider relationships may enhance SDM.[36] We report service-specific team and patient characteristics, in addition to SDM findings in anticipation that some readers will identify with 1 service more than others.

This study has several important limitations. First, our peer observers were not blinded and primarily observed encounters at their own site. To minimize bias, observers periodically rated videos to recalibrate RPAD scoring. Second, additional SDM conversations with a patient and/or guardian may have occurred outside of rounds and were not captured, and poor patient recall may have affected Patient-RPAD scores despite interviewer prompts and timeliness of interviews within 12 hours of rounds. Third, there might have been a selection bias for the one service who selected a smaller number of patients to see, compared with the three other services that performed bedside rounds on all patients. It is possible that attending physicians selected patients who were deemed most able to have SDM conversations, thus affecting RPAD scores on that service. Fourth, study services had fewer patients on average than other academic hospitals (median 9, range 3-14), which might limit its generalizability. Last, as in any observational study, there is always the possibility of the Hawthorne effect. However, neither teams nor patients knew the study objectives.

Nevertheless, important findings emerged through the use of RPAD Scores to evaluate inpatient SDM practices. In particular, we found that to increase SDM quality in inpatient settings, practitioners should (1) check their understanding of the patient's perspective, (2) examine barriers to follow-through with the treatment plan, and (3) ask if the patient has questions. Variation among services remained very influential after adjusting for team and patient characteristics, which suggests that "climate" or service culture should be targeted by an intervention, rather than individual attendings or subgroups defined by team or patient characteristics. Notably, team size, number of learners, patient census, and type of decision being made did not affect SDM performance, suggesting that even large, busy services can perform SDM if properly trained.

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Impact of a Multicenter, Mentored Quality Collaborative on Hospital-Associated Venous Thromboembolism

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BACKGROUND: Reliable prophylaxis of hospital-associated venous thromboembolism (HA-VTE) is not achieved in many hospitals. Efforts to improve prophylaxis have had uneven results.

OBJECTIVE: To reduce HA-VTE with a scalable quality improvement collaborative.

DESIGN: A prospective, unblinded, open-intervention study with historical controls.

PARTICIPANTS AND SETTING: All adult inpatients at 35 community hospitals in California, Arizona, and Nevada.

INTERVENTIONS: A centrally supported collaborative implementing standardized VTE risk assessment and prophylaxis. Protocols were developed with 9 "pilot" sites, which received individualized mentoring. Finished protocols were disseminated to 26 "spread" sites, which received improvement webinars without mentoring. Active surveillance for real-time correction of suboptimal prophylaxis was funded in pilot sites and encouraged in spread sites. Planning and minimal improvement work began in 2011; most implementation occurred in 2012 and 2013.

MEASUREMENTS: Rates of per-protocol prophylaxis (at pilot sites), and compliance with The Joint Commission VTE measures (all sites), were monitored starting in January 2012. The International Classification of Diseases, 9th Edition-Clinical Modification codes were used to determine the rates of HA-VTE within 30 days of discharge, heparin-induced thrombocytopenia, and anticoagulation adverse events; preimplementation (2011) rates were compared with postimplementation (2014) rates.

RESULTS: Protocol-appropriate prophylaxis rates and The Joint Commission measure compliance both reached 97% in 2014, up from 70% to 89% in 2012 and 2013. Five thousand three hundred and seventy HA-VTEs occurred during 1.16 million admissions. Four hundred twenty-eight fewer HA-VTEs occurred in 2014 than in 2011 (relative risk 0.78; 95% confidence interval, 0.73-0.85). HA-VTEs fell more in pilot sites than spread sites (26% vs 20%). The rates of adverse events were reduced or unchanged.

CONCLUSIONS: Collaborative efforts were associated with improved prophylaxis rates and fewer HA-VTEs. *Journal of Hospital Medicine* 2018;13:462-469. Published online first February 13, 2018. © 2018 Society of Hospital Medicine

Deep venous thrombosis and pulmonary embolism, collectively known as venous thromboembolism (VTE), affect up to 600,000 Americans a year.[1] Most of these are hospital-associated venous thromboembolisms (HA-VTE).[1,2] VTE poses a substantial risk of mortality and long-term morbidity, and its treatment poses a risk of major bleeding.[1] As appropriate VTE prophylaxis ("prophylaxis") can reduce the risk of VTE by 40% to 80% depending on the patient population,[3] VTE risk assessment and prophylaxis is endorsed by multiple guidelines[4-7] and supported by regulatory agencies.[8-10]

However, despite extensive study, consensus about the impact of prophylaxis[4,11] and the optimal method of risk assessment[4,5,7,12] is lacking. Meanwhile, implementation of prophylaxis in real-world settings is poor; only 40% to 60% of at-risk patients receive prophylaxis,[13] and as few as <20% receive optimal prophylaxis.[14] Both systematic reviews[15,16] and experience with VTE prevention collaboratives[17,18] found that multifaceted interventions and alerts may be most effective in improving prophylaxis rates, but without proof of improved VTE rates.[15] There is limited experience with large-scale VTE prevention. Organizations like The Joint Commission (TJC)[8] and the Surgical Care Improvement Project have promoted quality measures but without clear evidence of improvement.[19] In addition, an analysis of over 20,000 medical patients at 35 hospitals found no difference in VTE rates between high- and low-performing hospitals,[20] suggesting that aggressive prophylaxis efforts may not reduce VTE, at least among medical patients.[21] However, a 5-hospital University of California collaborative was associated

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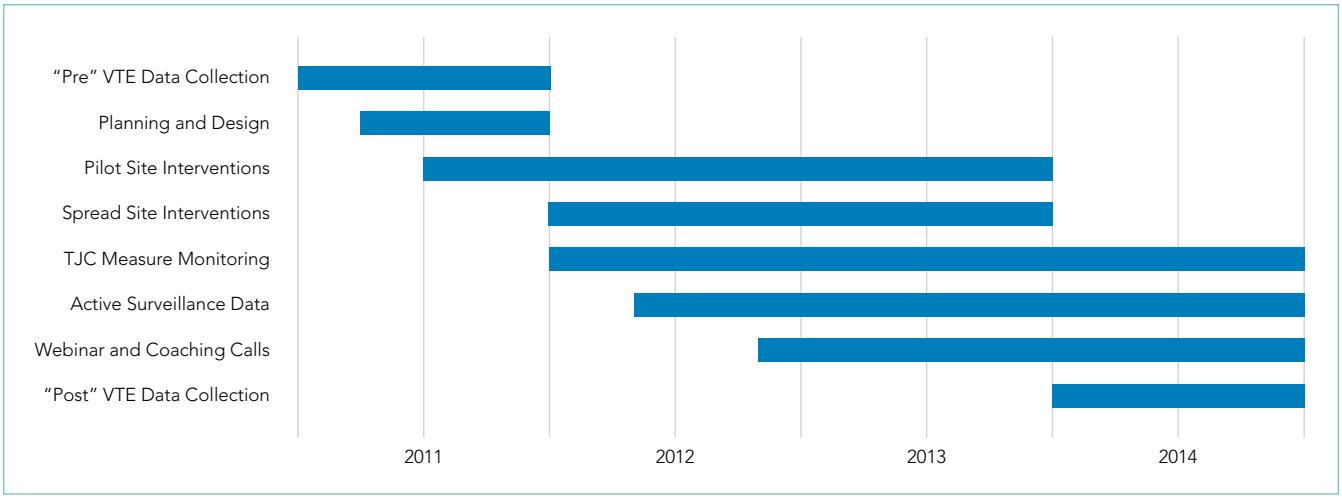

FIG 1. Gantt chart showing the timeframe of interventions across the 4-year study period. TJC measure monitoring: monitoring of The Joint Commission VTE-1 and 2 metric compliances. Active surveillance data: monitoring of protocol compliant prophylaxis rates. Webinar and coaching calls continued after the study timeframe.

with improved VTE rates, chiefly among surgical patients.[22]

In 2011, Dignity Health targeted VTE for improvement after investigations of potentially preventable HA-VTE revealed variable patterns of prophylaxis. In addition, improvement seemed feasible because there is a proven framework for VTE quality improvement (QI) projects[17,18] and a record of success with the following 3 specific strategies: quality mentorship,[23] use of a simple VTE risk assessment method, and active surveillance (real-time monitoring targeting suboptimal prophylaxis with concurrent intervention). This active surveillance technique has been used successfully in prior improvement efforts, often termed measure-vention.[17,18,22,24]

METHODS

Setting and Participants

The QI collaborative was performed at 35 Dignity Health community hospitals in California, Arizona, and Nevada. Facilities ranged from 25 to 571 beds in size with a mixture of teaching and nonteaching hospitals. Prior to the initiative, prophylaxis improvement efforts were incomplete and inconsistent at study facilities. All adult acute care inpatients at all facilities were included except rehabilitation, behavioral health, skilled nursing, hospice, other nonacute care, and inpatient deliveries.

Design Overview

We performed a prospective, unblinded, open-intervention study of a QI collaborative in 35 community hospitals and studied the effect on prophylaxis and VTE rates with historical controls. The 35 hospitals were organized into 2 cohorts. In the "pilot" cohort, 9 hospitals (chosen to be representative of the various settings, size, and teaching status within the Dignity system) received funding from the Gordon and Betty Moore Foundation (GBMF) for intensive, individualized QI mentorship from experts as well as active surveillance (see "Interventions"). The pilot sites led the development of the VTE risk assessment and prophylaxis protocol ("VTE protocol"), measures, order sets, implementation tactics, and lessons learned, assisted by the mentor experts. Dissemination to the 26-hospital "spread" cohort was facilitated by the Dignity Health Hospital Engagement Network (HEN) infrastructure.

Timeline

Two of the pilot sites, acting as leads on the development of protocol and order set tools, formed improvement teams in March 2011, 6 to 12 months earlier than other Dignity sites. Planning and design work occurred from March 2011 to September 2012. Most implementation at the 35 hospitals occurred in a staggered fashion during calendar year (CY) 2012 and 2013 (see Figure 1). As few changes were made until mid-2012, we considered CY 2011 the baseline for comparison, CY 2012 to 2013 the implementation years, and CY 2014 the post-implementation period.

The project was reviewed by the Institutional Review Board (IRB) of Dignity Health and determined to be an IRB-exempt QI project.

Interventions

Collaborative Infrastructure

Data management, order set design, and hosted webinar support were provided centrally. The Dignity Health Project Lead (T.O.) facilitated monthly web conferences for all sites beginning in November 2012 and continuing past the study period (Figure 1), fostering a monthly sharing of barriers, solutions, progress, and best practices. These calls allowed for data review and targeted corrective actions. The Project Lead visited each hospital to validate that the recommended practices were in place and working.

Multidisciplinary Teams

Improvement teams formed between March 2011 and September 2012. Members included a physician champion, front-line nurses and physicians, an administrative liaison, pharmacists, quality and data specialists, clinical informatics staff, and stakeholders from key clinical services. Teams met at least monthly at each site.

Physician Mentors

The 9 pilot sites received individualized mentorship provided by outside experts (IJ or GM) based on a model pioneered by the Society of Hospital Medicine's (SHM) Mentored Implementation programs.[23] Each pilot site completed a self-assessment survey[17] (see supplementary Appendix A) about past efforts, team composition, current performance, aims, barriers, and opportunities. The mentors reviewed the completed questionnaire with each hospital and provided advice on the VTE protocol and order set design, measurement, and benchmarking during 3 webinar meetings scheduled at 0, 3, and 9 months, plus as-needed e-mail and phone correspondence. After each webinar, the mentors provided detailed improvement suggestions (see supplementary Appendix B). Several hospitals received mentor site visits, which focused on unit rounding, active surveillance, staff and provider education, and problem-solving sessions with senior leadership, physician leadership, and the improvement team.

VTE Protocol

After a literature review and consultation with the mentors, Dignity Health developed and implemented a VTE protocol, modified from a model used in previous improvement efforts.[18,22-24] Its risk assessment method is often referred to as a "3 bucket" model because it assigns patients to high-, moderate-, or low-risk categories based on clinical factors (eg, major orthopedic surgery, prior VTE, and others), and the VTE protocol recommends interventions based on the risk category (see supplementary Appendix C). Dignity Health was transitioning to a single electronic health record (Cerner Corporation, North Kansas City, MO) during the study, and study hospitals were using multiple platforms, necessitating the development of both paper and electronic versions of the VTE protocol. The electronic version required completion of the VTE protocol for all inpatient admissions and transfers. The VTE protocol was completed in November 2011 and disseminated to other sites in a staggered fashion through November 2012. Completed protocols and improvement tips were shared by the project lead and by webinar sessions. Sites were also encouraged to implement a standardized practice that allowed nurses to apply sequential compression devices to at-risk patients without physician orders when indicated by protocol, when contraindications such as vascular disease or ulceration were absent.

Education

Staff were educated about the VTE protocol by local teams, starting between late 2011 and September 2012. The audience (physicians, nurses, pharmacists, etc.) and methods (conferences, fliers, etc.) were determined by local teams, following guidance by mentors and webinar content. Active surveillance provided opportunities for in-the-moment, patient-specific education and protocol reinforcement. Both mentors delivered educational presentations at pilot sites.

Active Surveillance

Sites were encouraged to perform daily review of prophylaxis adequacy for inpatients and correct lapses in real time (both under- and overprophylaxis). Inappropriate prophylaxis orders were addressed by contacting providers to change the order or document the rationale not to. Lapses in adherence to prophylaxis were addressed by nursing correction and education of involved staff. Active surveillance was funded for 10 hours a week at pilot sites. Spread sites received only minimal support from HEN monies. All sites used daily prophylaxis reports, enhanced to include contraindications like thrombocytopenia and coagulopathy, to facilitate efforts. Active surveillance began in May 2012 in the lead pilot hospitals and was implemented in other sites between October 2012 and February 2013.

Metrics

Prophylaxis Rates

Measurement of prophylaxis did not begin until 2012 to 2013; thus, the true baseline rate for prophylaxis was not captured. TJC metrics (VTE-1 and VTE-2)[25] were consolidated into a composite TJC prophylaxis rate from January 2012 to December 2014 for both pilot and spread hospitals. These measures assess the percentage of adult inpatients who received VTE prophylaxis or have documentation of why no prophylaxis was given the day of or day after hospital admission (VTE-1) or the day of or day after ICU admission or transfer (VTE-2). These measures are met if any mechanical or pharmacologic prophylaxis was delivered.

In addition to the TJC metric, the 9 pilot hospitals monitored rates of protocol-compliant prophylaxis for 12 to 20 months. Each patient's prophylaxis was considered protocol compliant if it was consistent with the prophylaxis protocol at the time of the audit or if contraindications were documented (eg, patients eligible for, but with contraindications to, pharmacologic prophylaxis had to have an order for mechanical prophylaxis or documented contraindication to both modalities). As this measure was initiated in a staggered fashion, the rate of protocol-compliant prophylaxis is summarized for consecutive months of measurement rather than consecutive calendar months.

HA-VTE Rates

VTE events were captured by review of electronic coding data for the *International Classification of Diseases, 9th Revision* (ICD-9) codes 415.11-415.19, 453.2, 453.40-453.42, and 453.8-453.89. HA-VTE was defined as either new VTE not present on admission (NPOA HA-VTE) or new VTE presenting in a readmitted patient within 30 days of discharge (Readmit HA-VTE). Cases were stratified based on whether the patient had undergone a major operation (surgery patients) or not (medical patients) as identified by Medicare Services diagnosis-related group codes.

Control Measures

Potential adverse events were captured by review of electronic coding data for ICD-9 codes 289.84 (heparin-induced thrombocytopenia [HIT]) and E934.2 (adverse effects because of anticoagulants).

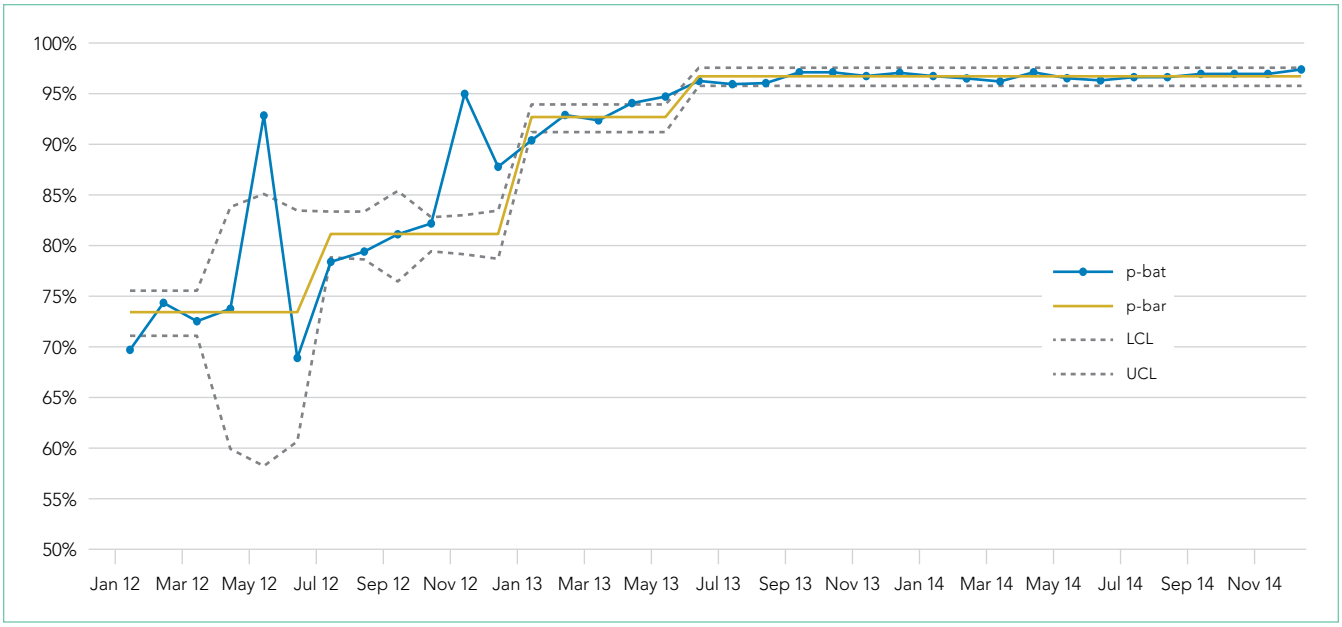

FIG 2. The Joint Commission (TJC) composite VTE-1 and VTE-2 rates of VTE prophylaxis compliance in the 35-site cohort (mean 1397 observations per month). Measured proportion in the sample, p-hat; average proportion in the sampled time-frame, p-bar. Abbreviations: LCL, lower confidence limit; UCL, upper confidence limit.

Statistical Analysis

Statistical process control charts were used to depict changes in prophylaxis rates over the 3 years for which data was collected. For VTE and safety outcomes, Pearson χ^2 value with relative risk (RR) calculations and 95% confidence intervals (CIs) were used to compare proportions between groups at baseline (CY 2011) versus postimplementation (CY 2014). Differences between the means of normally distributed data were calculated, and a 95% CI for the difference between the means was performed to assess statistical difference. Nonparametric characteristics were described by quartiles and interquartile range, and the 2-sided Mann-Whitney U test was performed to assess statistical difference between the CY 2011 and CY 2014 period.

Role of the Funding Source

The GBMF funded the collaborative and supported authorship of the manuscript but had no role in the design or conduct of the intervention, the collection or analysis of data, or the drafting of the manuscript.

RESULTS

Population Demographics

There were 1,155,069 adult inpatient admissions during the 4-year study period (264,280 in the 9 pilot sites, 890,789 in the 26 spread sites). There were no clinically relevant changes in gender distribution, mortality rate, median age, case mix index, or hospital length of stay in 2011 versus 2014. Men comprised 47.1% of the patient population in 2011 and 47.7% in 2014. The mortality rate was 2.7% in both years. Median age was 62 in 2011 and 63 in 2014. The mean case mix index (1.58 vs 1.65) and mean length of stay (4.29 vs 4.33 days) were similar in the 2 time periods.

Prophylaxis Rates

TJC Prophylaxis rates

There were 46,418 observations of TJC prophylaxis rates between January 2012 and December 2014 (mean of 1397 observations per month) in the cohort. Early variability gave way to consistent performance and tightened control limits, coinciding with widespread implementation and increased number of audits. TJC prophylaxis rates climbed from 72.2% in the first quarter of 2012 to 95% by May 2013. TJC prophylaxis rates remained >95% thereafter, improving to 96.8% in 2014 (Pearson χ^2 $P < .001$) (Figure 2).

Rates of Protocol-Compliant Prophylaxis

There were 34,071 active surveillance audits across the 20 months of reporting in the pilot cohort (mean, 1817 audits per month). The rate of protocol-compliant prophylaxis improved from 89% at month 1 of observation to 93% during month 2 and 97% by the last 3 months (Pearson χ^2 $P < .001$ for both comparisons).

HA-VTE

HA-VTE characteristics

Five thousand three hundred and seventy HA-VTEs occurred during the study. The HA-VTE rate was higher in surgical patients (7.4/1000) than medical patients (4.2/1000) throughout the study (Figure 3). Because only 32.8% of patients were surgical, however, 51% (2740) of HA-VTEs occurred in medical patients and 49% occurred (2630) in surgical patients. In medical patients, most HA-VTEs occurred postdischarge (2065 of 2740; 75%); in surgical patients, most occurred during the index admission (1611 of 2630; 61%).

Improved HA-VTE over Time

Four hundred twenty-eight fewer HA-VTEs occurred in 2014 than in 2011 (RR 0.78; 95% CI, 0.73-0.85) (Table and Figure 3). Re-

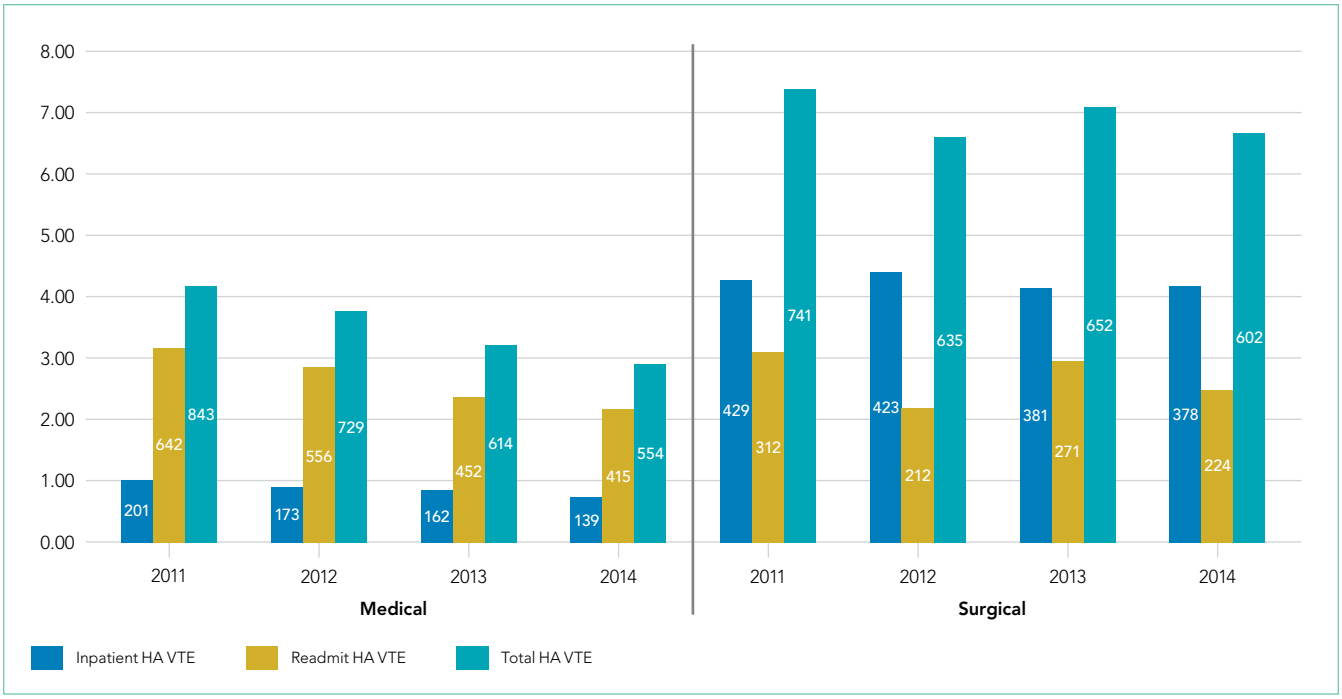

FIG 3. Medical versus surgical HA-VTE rates per 1000 admissions, all 35 sites (pilot and spread sites combined). Hospital-associated venous thromboembolism (HA-VTE) are broken out into inpatient HA-VTE (not present on admission) and Readmit HA-VTE (no VTE on index admission, but readmitted within 30 days with new VTE).

admission HA-VTEs were reduced by 315 (RR 0.72; 95% CI, 0.65-0.80), while the reduction in NPOA HA-VTEs was less robust (RR 0.88; 95% CI, 0.79-0.99). Pilot sites enjoyed a more robust reduction in HA-VTEs than spread sites (26% vs 20%), largely because the pilot cohort enjoyed a 34% reduction in NPOA HA-VTEs and a 20% reduction in Readmit HA-VTEs, while the spread cohort only achieved reductions in Readmit HA-VTEs.

In medical patients, 289 fewer HA-VTEs occurred in 2014 than in 2011 (RR 0.69; 95% CI, 0.62-0.77). There was a 27% improvement in NPOA HA-VTEs and a 32% reduction in Readmit HA-VTEs. In surgical patients, 139 fewer HA-VTEs occurred in 2014 versus 2011, which just failed to reach statistical significance (RR 0.90; 95% CI, 0.81-1.01). Surgical NPOA HA-VTE stayed essentially unchanged, while Readmit HA-VTE declined from 312 to 224 (RR 0.80; 95% CI, 0.67-0.95).

Safety

Rates of HIT and adverse effects because of anticoagulants were low (Table). The rate of HIT declined from 178 events in 2011 to 109 in 2014 (RR 0.66; 95% CI, 0.52-0.84), and the RR of anticoagulant adverse events remained stable (RR 1.01; 95% CI, 0.87-1.15).

DISCUSSION

Our QI project, based on a proven collaborative approach and mentorship,[18,22,24] order set redesign, and active surveillance, was associated with 26% less VTEs in the pilot cohort and 20% less VTEs in the spread cohort. These gains, down to a final rate of approximately 4 HA-VTEs per 1000 admissions, occurred despite a low baseline HA-VTE rate. Dignity Health achieved these improvements in 35 hospitals with varied sizes, settings, ordering systems, and teaching statuses, achieving what is to our knowledge the largest VTE QI initiative yet reported.

Implementation experiences were not systematically recorded, and techniques were not compared with a control group. However, we believe that Dignity Health's organizational commitment to improvement and centralized support were crucial for success. In addition, the pilot sites received grant support from the GBMF for intensive quality mentoring, a strategy with demonstrated value.[23] Mentors and team members noted that system-wide revision to the computerized physician order entry system was easiest to implement, while active surveillance represented the most labor-intensive intervention. Other experiences echoed lessons from previous VTE mentorship efforts.[17,18]

The selection of a VTE protocol conducive to implementation and provider use was a key strategy. The ideal approach to VTE risk assessment is not known,[12,26] but guidelines either offer no specific guidance[7] or would require implementation of 3 different systems per hospital.[4,5] Several of these are point scoring systems, which may have lower clinician acceptance or require programming to improve real-world use[18,26,27]; the Padua score was derived from a patient population that differs significantly from those in the United States.[12] Our study provides more practical experience with a "3-bucket" model, which has previously shown high interobserver reliability, good clinician acceptance, and meaningful reductions of VTE, including in American patient populations.[18,22,24]

The value of VTE prophylaxis is still disputed in many inpatient groups. The overall rate of HA-VTE is low, so the per-patient benefit of prophylaxis is low, and many patients may be

TABLE. **Rates of HA-VTE, HIT, and Adverse Anticoagulant Effect Events**

	2011	2012	2013	2014	RR 2014 vs 2011 (95% CI)
9 Pilot Sites (Mentored Implementation)					
Inpatient encounters	66,436	65,405	66,038	66,401	
NPOA HA-VTE	146	107	97	97	0.66
(rate/1000 admits)	2.20	1.64	1.47	1.46	(0.51-0.86)[a]
Readmit HA-VTE	173	157	174	138	0.80
(rate/1000 admits)	2.60	2.40	2.63	2.08	(0.63-0.99)[a]
Total HA-VTE	319	264	271	235	0.74
(rate/1000 admits)	4.80	4.04	4.10	3.54	(0.62-0.87)[a]
26 Spread Sites					
Inpatient encounters	235,532	224,755	216,178	214,324	
NPOA HA-VTE	484	489	446	420	0.95
(rate/1000 admits)	2.20	1.64	1.47	1.46	(0.84-1.09) NS
Readmit HA-VTE	781	611	549	501	0.71
(rate/1000 admits)	2.60	2.40	2.63	2.08	(0.63-0.79)[a]
Total HA-VTE	1265	1100	995	921	0.80
(rate/1000 admits)	5.37	4.89	4.60	4.30	(0.74-0.87)[a]
	2011	**2012**	**2013**	**2014**	**RR 2014 vs 2011 (95% CI)**
All 35 Sites Combined					
Inpatient encounters	301,968	290,160	282,216	280,725	
NPOA HA-VTE	630	596	543	517	0.88
(rate/1000 admits)	2.09	2.05	1.92	1.84	(0.79-0.99)[a]
Readmit HA-VTE	954	768	723	639	0.72
(rate/1000 admits)	3.16	2.65	2.56	2.28	(0.65-0.80)[a]
Total HA-VTE	1584	1364	1266	1156	0.78
(rate/1000 admits)	5.25	4.70	4.49	4.12	(0.73-0.85)[a]
HIT events	178	157	140	109	0.66
(rate/1000 admits)	0.59	0.54	0.50	0.39	(0.52-0.84)[a]
Adverse AC effect	348	348	361	328	1.01
(rate/1000 admits)	1.15	1.20	1.28	1.17	(0.87-1.18) NS

[a]Statistically significant.

NOTE: HIT and Adverse AC effect derived from administrative coding data and reflects impact of both therapeutic and prophylactic anticoagulant agents. Abbreviations: AC, anticoagulant; CI, confidence interval; HA-VTE, hospital associated venous thromboembolism; HIT, heparin-induced thrombocytopenia; NPOA, not present on admission (acquired during the inpatient stay); NS, not statistically significant; RR, relative risk.

overprophylaxed.[4,11,12] Recently, Flanders et al.[20] reported that HA-VTE rates among 20,800 medical inpatients in Michigan were low (about 1%) and similar at hospitals in the top (mean prophylaxis rate 86%) or bottom (mean prophylaxis rate 56%) tertiles of performance. Possible explanations for the differences between their multicenter experience and ours include our sample size (55 times larger) and the possibility that targeting prophylaxis to patients at highest need (captured in our protocol-compliant prophylaxis rates) matters more than prophylaxing a percent of the population.

Further research is needed to develop simple, easy-to-implement methods to identify inpatients who do not, or no longer, require prophylaxis.[12] Hospital systems also need methods to determine if prophylaxis improvement efforts can lower their HA-VTE rates and in which subpopulations. For example, a collaborative effort at the University of California lowered HA-VTE rates toward a common improved rate of 0.65% to 0.73%,[22] while Dignity Health achieved improvement despite starting with an even lower baseline. In the University of California collaborative, benefits were limited chiefly to surgical patients, while Dignity Health achieved most improvement in medical patients, particularly in Readmit HA-VTE. If future re-

search uncovers the reasons for these differences, it could help hospitals decide where to target improvement efforts.

Our study has several limitations. First, we used a nonrandomized time series design, so we cannot exclude other potential explanations for the change in VTE rates. However, there were no major changes in patient populations or concurrent projects likely to have influenced event rates. While we did not collect detailed demographic information on subjects, the broad inclusion criteria and multicenter design suggests a high degree of generalizability. Second, we followed inpatient VTE events and VTE-related readmissions, but not VTE treated in the outpatient setting. This did not change over the study, but the availability of all-oral therapy for VTE could have caused underdetection if clinic or emergency room doctors sent home more patients on oral therapy instead of readmitting them to the hospital. Third, implementation was enhanced by GBMF funds (at 9 sites, with the remainder benefitting from their experience), a shared electronic medical record at many sites, and a strong organizational safety culture, which may limit generalizability. However, spread sites showed similar improvement, paper-based sites were included, and the mentorship and quality collaborative models are scalable at low cost. Fourth, some QI efforts began at some pilot sites in CY 2011, so we could not compare completely clean pre- and postproject timeframes. However, early improvement would have resulted in an underestimation of the project's impact. Lastly, the reason for a decline in HIT rates is not known. Standardized order sets promoted preferential use of low molecular weight heparin, which is less likely to induce HIT, and active surveillance targeted overprophylaxis as well as underprophylaxis, but we do not have data on heparin utilization patterns to confirm or refute these possibilities.

Strengths of our study include reductions in HA-VTE, both with and without access to GBMF funds, by using broadly available QI strategies.[17] This real-world success and ease of dissemination are particularly important because the clinical trials of prophylaxis have been criticized for using highly selected patient populations,[11] and prophylaxis QI studies show an inconsistent impact on VTE outcomes.[15] In previous studies, two of the authors monitored orders for prophylaxis[22,24]; during this project, delivery for both pharmacologic and mechanical VTE prophylaxis was monitored, confirming that patient care actually changed.

CONCLUSION

Our multicenter VTE prophylaxis initiative, featuring a "3-bucket" VTE protocol, QI mentorship, and active surveillance as key interventions, was associated with improved prophylaxis rates and a reduction in HA-VTE by 22% with no increase in adverse events. This project provides a model for hospital systems seeking to optimize their prophylaxis efforts, and it supports the use of collaborative QI initiatives and SHM's quality mentorship program as methods to drive improvement across health systems.

Disclosure: None of the authors have any conflicts of interest related to any topics or products discussed in the article. Dignity Health provided a stipend for writing the manuscript to GM and IJ, as noted in the article, but had no role in data analysis, writing, or decision to submit.

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A Method for Attributing Patient-Level Metrics to Rotating Providers in an Inpatient Setting

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BACKGROUND: Individual provider performance drives group metrics, and increasingly, individual providers are held accountable for these metrics. However, appropriate attribution can be challenging, particularly when multiple providers care for a single patient.

OBJECTIVE: We sought to develop and operationalize individual provider scorecards that fairly attribute patient-level metrics, such as length of stay and patient satisfaction, to individual hospitalists involved in each patient's care.

DESIGN: Using patients cared for by hospitalists from July 2010 through June 2014, we linked billing data across each hospitalization to assign "ownership" of patient care based on the type, timing, and number of charges associated with each hospitalization (referred to as "provider day weighted"). These metrics were presented to providers via a dashboard that was updated quarterly with their performance (relative to their peers). For the purposes of this article, we compared the method we used to the traditional method of attribution, in which an entire hospitalization is attributed to 1 provider, based on the attending of record as labeled in the administrative data.

RESULTS: Provider performance in the 2 methods was concordant 56% to 75% of the time for top half versus bottom half performance (which would be expected to occur by chance 50% of the time). While provider percentile differences between the 2 methods were modest for most providers, there were some providers for whom the methods yielded dramatically different results for 1 or more metrics.

CONCLUSION: We found potentially meaningful discrepancies in how well providers scored (relative to their peers) based on the method used for attribution. We demonstrate that it is possible to generate meaningful provider-level metrics from administrative data by using billing data even when multiple providers care for 1 patient over the course of a hospitalization. *Journal of Hospital Medicine* 2018;13:470-475. Published online first December 20, 2017. © 2018 Society of Hospital Medicine

Hospitalists' performance is routinely evaluated by third-party payers, employers, and patients. As hospitalist programs mature, there is a need to develop processes to identify, internally measure, and report on individual and group performance. We know from Society of Hospital Medicine (SHM) data that a significant amount of hospitalists' total compensation is at least partially based on performance. Often this is based at least in part on quality data. In 2006, SHM issued a white paper detailing the key elements of a successful performance monitoring and reporting process.[1,2] Recommendations included the identification of meaningful operational and clinical performance metrics, and the ability to monitor and report both group and individual metrics was highlighted as an essential component. There is evidence that comparison of individual provider performance with that of their peers is a necessary element of successful provider dashboards.[3] Additionally, regular feedback and a clear, visual presentation of the data are important components of successful provider feedback dashboards.[3-6]

Much of the literature regarding provider feedback dashboards has been based in the outpatient setting. The majority of these dashboards focus on the management of chronic illnesses (eg, diabetes and hypertension), rates of preventative care services (eg, colonoscopy or mammogram), or avoidance of unnecessary care (eg, antibiotics for sinusitis).[4,5] Unlike in the outpatient setting, in which 1 provider often provides a majority of the care for a given episode of care, hospitalized patients are often cared for by multiple providers, challenging the appropriate attribution of patient-level metrics to specific providers. Under the standard approach, an entire hospitalization is attributed to one physician, generally the attending of record for the hospitalization, which may be the admitting provider or the discharging provider, depending on the approach used by the hospital. However, assigning responsibility for an entire hospitalization to a provider who may have only seen the pa-

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tient for a small percentage of a hospitalization may jeopardize the validity of metrics. As provider metrics are increasingly being used for compensation, it is important to ensure that the method for attribution correctly identifies the providers caring for patients. To our knowledge there is no gold standard approach for attributing metrics to providers when patients are cared for by multiple providers, and the standard attending of record–based approach may lack face validity in many cases.

We aimed to develop and operationalize a system to more fairly attribute patient-level data to individual providers across a single hospitalization even when multiple providers cared for the patient. We then compared our methodology to the standard approach, in which the attending of record receives full attribution for each metric, to determine the difference on a provider level between the two models.

TABLE 1. **Metrics**[a]

Assigned to the Admitting Provider
Appropriate VTE prophylaxis
Assigned to the Discharging Provider
Percentage of discharges per day
Readmissions (observed to expected)
Time to signature for discharge summaries
Percentage of patients discharged before 3 pm
Provider Day Weighted
LOS (observed to expected)
Communication with the primary care physician
Depth of coding
Patient satisfaction

[a]Please refer to the supplementary Appendix for scales 1 through 9 for each metric.
NOTE: Abbreviations: LOS, length of stay; VTE, venous thromboembolism.

METHODS

Clinical Setting

The Johns Hopkins Hospital is a 1,145-bed, tertiary-care hospital. Over the years of this project, the Johns Hopkins Hospitalist Program was an approximately 20-physician group providing care in a variety of settings, including a dedicated hospitalist floor, where this metrics program was initiated. Hospitalists in this setting work Monday through Friday, with 1 hospitalist and a moonlighter covering on the weekends. Admissions are performed by an admitter, and overnight care is provided by a nocturnist. Initially 17 beds, this unit expanded to 24 beds in June 2012. For the purposes of this article, we included all general medicine patients admitted to this floor between July 1, 2010, and June 30, 2014, who were cared for by hospitalists. During this period, all patients were inpatients; no patients were admitted under observation status. All of these patients were cared for by hospitalists without housestaff or advanced practitioners. Since 2014, the metrics program has been expanded to other hospitalist-run services in the hospital, but for simplicity, we have not presented these more recent data.

Individual Provider Metrics

Metrics were chosen to reflect institutional quality and efficiency priorities. Our choice of metrics was restricted to those that (1) plausibly reflect provider performance, at least in part, and (2) could be accessed in electronic form (without any manual chart review). Whenever possible, we chose metrics with objective data. Additionally, because funding for this effort was provided by the hospital, we sought to ensure that enough of the metrics were related to cost to justify ongoing hospital support of the project. SAS 9.2 (SAS Institute Inc, Cary, NC) was used to calculate metric weights. Specific metrics included American College of Chest Physicians (ACCP)–compliant venous thromboembolism (VTE) prophylaxis,[7] observed-to-expected length of stay (LOS) ratio, percentage of discharges per day, discharges before 3 PM, depth of coding, patient satisfaction, readmissions, communication with the primary care provider, and time to signature for discharge summaries (Table 1).

Appropriate prophylaxis for VTE was calculated by using an algorithm embedded within the computerized provider order entry system, which assessed the prescription of ACCP-compliant VTE prophylaxis within 24 hours following admission. This included a risk assessment, and credit was given for no prophylaxis and/or mechanical and/or pharmacologic prophylaxis per the ACCP guidelines.[7]

Observed-to-expected LOS was defined by using the University HealthSystem Consortium (UHC; now Vizient Inc) expected LOS for the given calendar year. This approach incorporates patient diagnoses, demographics, and other administrative variables to define an expected LOS for each patient.

The percent of patients discharged per day was defined from billing data as the percentage of a provider's evaluation and management charges that were the final charge of a patient's stay (regardless of whether a discharge day service was coded).

Discharge prior to 3 PM was defined from administrative data as the time a patient was discharged from the electronic medical system.

Depth of coding was defined as the number of coded diagnoses submitted to the Maryland Health Services Cost Review Commission for determining payment and was viewed as an indicator of the thoroughness of provider documentation.

Patient satisfaction was defined at the patient level (for those patients who turned in patient satisfaction surveys) as the pooled value of the 5 provider questions on the hospital's patient satisfaction survey administered by Press Ganey: "time the physician spent with you," "did the physician show concern for your questions/worries," "did the physician keep you informed," "friendliness/courtesy of the physician," and "skill of the physician."[8]

Readmission rates were defined as same-hospital readmissions divided by the total number of patients discharged by a given provider, with exclusions based on the Centers for Medicare and Medicaid Services hospital-wide, all-cause readmission measure.[1] The expected same-hospital readmission rate was defined for each patient as the observed readmission rate in the entire UHC (Vizient) data set for all patients

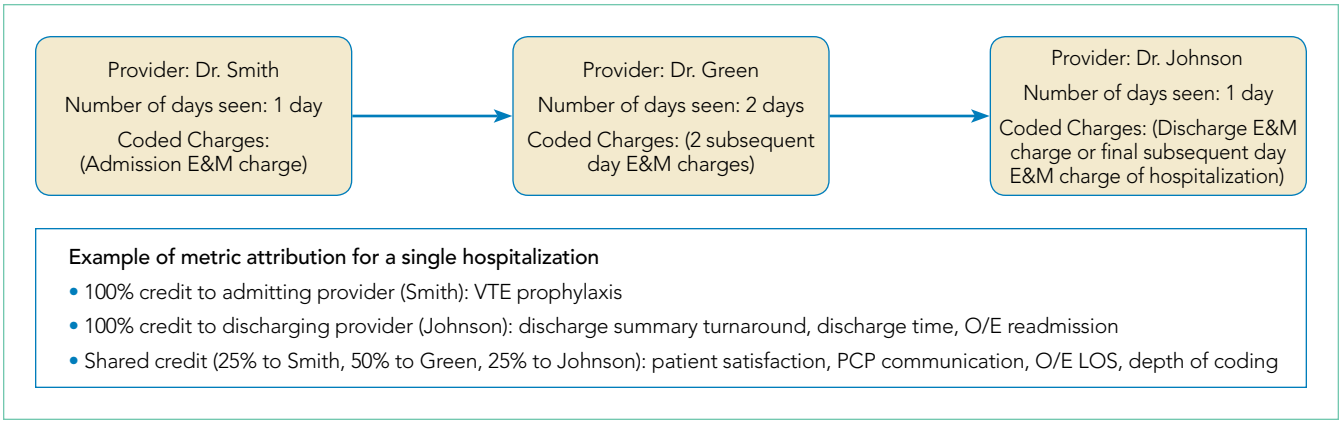

FIG 1. Example of attribution across providers (Provider day weighted metrics) for a hypothetical patient cared for by 3 providers.

NOTE: Abbreviations: E&M, evaluation and management; LOS, length of stay; O/E, observed over expected; PCP, Primary Care Provider.

with the same All Patient Refined Diagnosis Related Group and severity of illness, as we have described previously.[9]

Communication with the primary care provider was the only self-reported metric used. It was based on a mandatory prompt on the discharge worksheet in the electronic medical record (EMR). Successful communication with the outpatient provider was defined as verbal or electronic communication by the hospitalist with the outpatient provider. Partial (50%) credit was given for providers who attempted but were unsuccessful in communicating with the outpatient provider, for patients for whom the provider had access to the Johns Hopkins EMR system, and for planned admissions without new or important information to convey. No credit was given for providers who indicated that communication was not indicated, who indicated that a patient and/or family would update the provider, or who indicated that the discharge summary would be sufficient.[9] Because the discharge worksheet could be initiated at any time during the hospitalization, providers could document communication with the outpatient provider at any point during hospitalization.

Discharge summary turnaround was defined as the average number of days elapsed between the day of discharge and the signing of the discharge summary in the EMR.

Assigning Ownership of Patients to Individual Providers

Using billing data, we assigned ownership of patient care based on the type, timing, and number of charges that occurred during each hospitalization (Figure 1). Eligible charges included all history and physical (codes 99221, 99222, and 99223), subsequent care (codes 99231, 99232, and 99233), and discharge charges (codes 99238 and 99239).

By using a unique identifier assigned for each hospitalization, professional fees submitted by providers were used to identify which provider saw the patient on the admission day, discharge day, as well as subsequent care days. Providers' productivity, bonus supplements, and policy compliance were determined by using billing data, which encouraged the prompt submittal of charges.

The provider who billed the admission history and physical (codes 99221, 99222, and 99223) within 1 calendar date of the patient's initial admission was defined as the admitting provider. Patients transferred to the hospitalist service from other services were not assigned an admitting hospitalist. The sole metric assigned to the admitting hospitalist was ACCP-compliant VTE prophylaxis.

The provider who billed the final subsequent care or discharge code (codes 99231, 99232, 99233, 99238, and 99239) within 1 calendar date of discharge was defined as the discharging provider. For hospitalizations characterized by a single provider charge (eg, for patients admitted and discharged on the same day), the provider billing this charge was assigned as both the admitting and discharging physician. Patients upgraded to the intensive care unit (ICU) were not counted as a discharge unless the patient was downgraded and discharged from the hospitalist service. The discharging provider was assigned responsibility for the time of discharge, the percent of patients discharged per day, the discharge summary turnaround time, and hospital readmissions.

Metrics that were assigned to multiple providers for a single hospitalization were termed "provider day–weighted" metrics. The formula for calculating the weight for each provider day–weighted metric was as follows: weight for provider A = [number of daily charges billed by provider A] divided by [LOS +1]. The initial hospital day was counted as day 0. LOS plus 1 was used to recognize that a typical hospitalization will have a charge on the day of admission (day 0) and a charge on the day of discharge such that an LOS of 2 days (eg, a patient admitted on Monday and discharged on Wednesday) will have 3 daily charges. Provider day–weighted metrics included patient satisfaction, communication with the outpatient provider, depth of coding, and observed-to-expected LOS.

Our billing software prevented providers from the same group from billing multiple daily charges, thus ensuring that there were no duplicated charges submitted for a given day.

Presenting Results

Providers were only shown data from the day-weighted approach. For ease of visual interpretation, scores for each met-

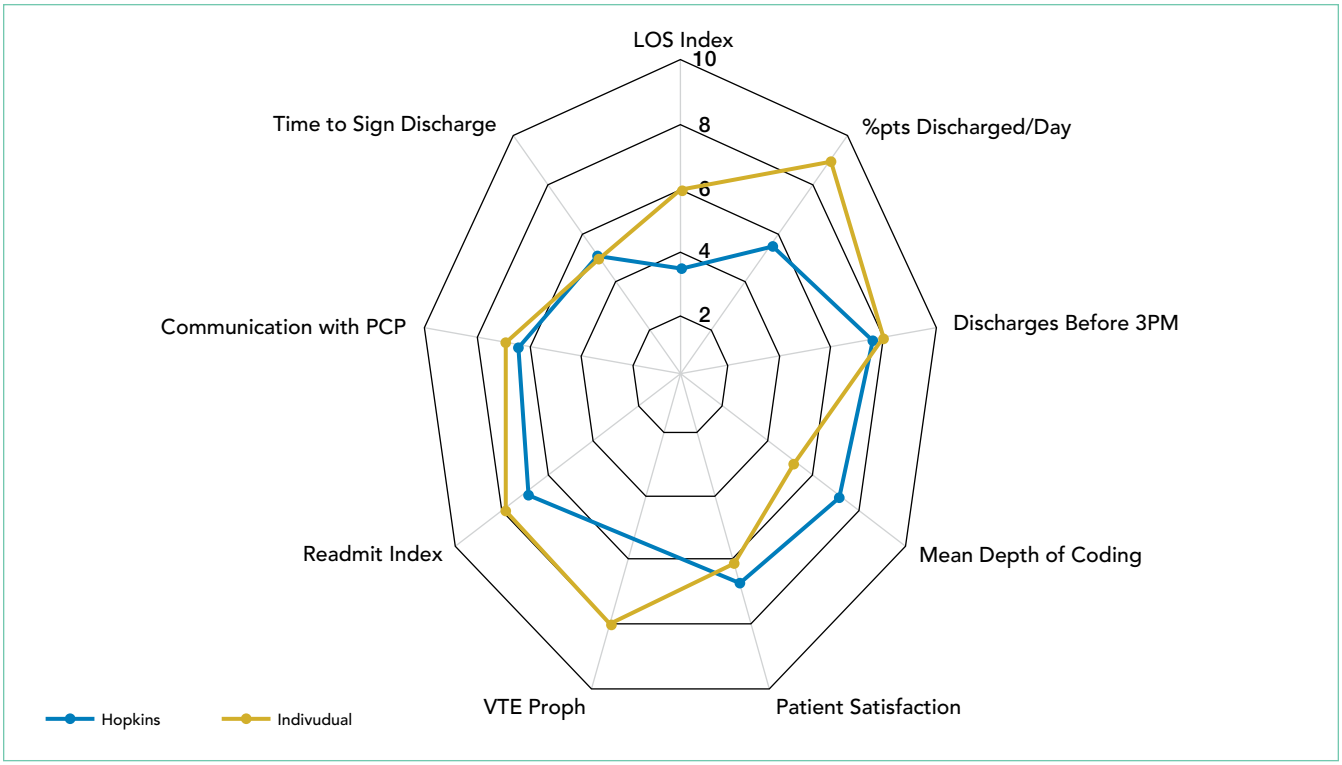

FIG 2. Visual display of provider performance

NOTE: Abbreviations: LOS, length of stay; PCP, Primary Care Physician; VTE, Venous Thromboembolism. Results are scaled to benchmarked values and displayed in a spiderweb plot on a scale from 1 to 9. All are scaled such that higher values are "good", even when a low value for the metric is desirable (such as observed/expected length-of-stay).

ric were scaled ordinally from 1 (worst performance) to 9 (best performance; Table 1). Data were displayed in a dashboard format on a password-protected website for each provider to view his or her own data relative to that of the hospitalist peer group. The dashboard was implemented in this format on July 1, 2011. Data were updated quarterly (Figure 2).

Results were displayed in a polyhedral or spider-web graph (Figure 2). Provider and group metrics were scaled according to predefined benchmarks established for each metric and standardized to a scale ranging from 1 to 9. The scale for each metric was set based on examining historical data and group median performance on the metrics to ensure that there was a range of performance (ie, to avoid having most hospitalists scoring a 1 or 9). Scaling thresholds were periodically adjusted as appropriate to maintain good visual discrimination. Higher scores (creating a larger-volume polygon) are desirable even for metrics such as LOS, for which a low value is desirable. Both a spider-web graph and trends over time were available to the provider (Figure 2). These graphs display a comparison of the individual provider scores for each metric to the hospitalist group average for that metric.

Comparison with the Standard (Attending of Record) Method of Attribution

For the purposes of this report, we sought to determine whether there were meaningful differences between our day-weighted approach versus the standard method of attribution, in which the attending of record is assigned responsibility for each metric that would not have been attributed to the discharging attending under both methods. Our goal was to determine where and whether there was a meaningful difference between the 2 methodologies, recognizing that the degree of difference between these 2 methodologies might vary in other institutions and settings. In our hospital, the attending of record is generally the discharging attending. In order to compare the 2 methodologies, we arbitrarily picked 2015 to retrospectively evaluate the differences between these 2 methods of attribution. We did not display or provide data using the standard methodology to providers at any point; this approach was used only for the purposes of this report. Because these metrics are intended to evaluate relative provider performance, we assigned a percentile to each provider for his or her performance on the given metric using our attribution methodology and then, similarly, assigned a percentile to each provider using the standard methodology. This yielded 2 percentile scores for each provider and each metric. We then compared these percentile ranks for providers in 2 ways: (1) we determined how often providers who scored in the top half of the group for a given metric (above the 50th percentile) also scored in the top half of the group for that metric by using the other calculation method, and (2) we calculated the absolute value of the difference in percentiles between the 2 methods to characterize the impact on a provider's ranking for that metric that might result from switching to the other method. For instance, if a provider scored at the 20th percentile for the group in patient satisfaction with 1 attribution method and scored at

TABLE 2. **A Comparison of Standard (Physician-of-Record–Based) Attribution to Billing-Based Attribution in Provider Performance**[a]

Metric	Percent Top- and Bottom-Half Performer Concordance Between the 2 Methods[b]	Percentile Differences at the Provider Level Between the 2 Methods,[c] Median (IQR); Maximum
VTE prophylaxis	63	22 (8-42); 94
Depth of coding	75	16 (6-23); 56
Patient satisfaction	56	13 (6-13); 50
Communication with PCPs	75	13 (6-19); 31
Observed-to-expected LOS	75	13 (6-25); 88

[a]Metrics included are those that would be expected to have discordance between our methodology and the standard methodology. See text for details.

[b]This is the probability that a provider who scores above (or below) the median (50th percentile) for the group with 1 attribution methodology will also score above (or below) the median with the other methodology. Providers who scored above the median with both methodologies or below the median with both methodologies were considered concordant. Fifty percent concordance would be expected by chance.

[c]The percentile difference was the absolute value of the percentile difference each provider earned between the 2 methods. For example, a provider who scored at the 75th percentile on a metric by 1 methodology and at the 45th percentile on that metric with the other methodology would have a 30-point percentile difference.

NOTE: Abbreviations: IQR, interquartile range; LOS, length of stay; PCP, primary care physician; VTE, venous thromboembolism.

the 40th percentile for the group in patient satisfaction using the other method, the absolute change in percentile would be 20 percentile points. But, this provider would still be below the 50th percentile by both methods (concordant bottom half performance). We did not perform this comparison for metrics assigned to the discharging provider (such as discharge summary turnaround time or readmissions) because the attending of record designation is assigned to the discharging provider at our hospital.

RESULTS

The dashboard was successfully operationalized on July 1, 2011, with displays visible to providers as shown in Figure 2. Consistent with the principles of providing effective performance feedback to providers, the display simultaneously showed providers their individual performance as well as the performance of their peers. Providers were able to view their spider-web plot for prior quarters. Not shown are additional views that allowed providers to see quarterly trends in their data versus their peers across several fiscal years. Also available to providers was their ranking relative to their peers for each metric; specific peers were deidentified in the display.

There was notable discordance between provider rankings between the 2 methodologies, as shown in Table 2. Provider performance above or below the median was concordant 56% to 75% of the time (depending on the particular metric), indicating substantial discordance because top-half or bottom-half concordance would be expected to occur by chance 50% of the time. Although the provider percentile differences between the 2 methods tended to be modest for most providers (the median difference between the methods was 13 to 22 percentile points for the various metrics), there were some providers for whom the method of calculation dramatically impacted their rankings. For 5 of the 6 metrics we examined, at least 1 provider had a 50-percentile or greater change in his or her ranking based on the method used. This indicates that at least some providers would have had markedly different scores relative to their peers had we used the alternative methodology (Table 2). In VTE prophylaxis, for example, at least 1 provider had a 94-percentile change in his or her ranking; similarly, a provider had an 88-perentile change in his or her LOS ranking between the 2 methodologies.

DISCUSSION

We found that it is possible to assign metrics across 1 hospital stay to multiple providers by using billing data. We also found a meaningful discrepancy in how well providers scored (relative to their peers) based on the method used for attribution. These results imply that hospitals should consider attributing performance metrics based on ascribed ownership from billing data and not just from attending of record status.

As hospitalist programs and providers in general are increasingly being asked to develop dashboards to monitor individual and group performance, correctly attributing care to providers is likely to become increasingly important. Experts agree that principles of effective provider performance dashboards include ranking individual provider performance relative to peers, clearly displaying data in an easily accessible format, and ensuring that data can be credibly attributed to the individual provider.[3,4,6] However, there appears to be no gold standard method for attribution, especially in the inpatient setting. Our results imply that hospitals should consider attributing performance metrics based on ascribed ownership from billing data and not just from attending of record status.

Several limitations of our findings are important to consider. First, our program is a relatively small, academic group with handoffs that typically occur every 1 to 2 weeks and sometimes with additional handoffs on weekends. Different care patterns and settings might impact the utility of our attribution methodology relative to the standard methodology. Additionally, it is important to note that the relative merits of the different methodologies cannot be ascertained from our comparison. We can demonstrate discordance between the attribution methodologies, but we cannot say that 1 method is correct and the

other is flawed. Although we believe that our day-weighted approach feels fairer to providers based on group input and feedback, we did not conduct a formal survey to examine providers' preferences for the standard versus day-weighted approaches. The appropriateness of a particular attribution method needs to be assessed locally and may vary based on the clinical setting. For instance, on a service in which patients are admitted for procedures, it may make more sense to attribute the outcome of the case to the proceduralist even if that provider did not bill for the patient's care on a daily basis. Finally, the computational requirements of our methodology are not trivial and require linking billing data with administrative patient-level data, which may be challenging to operationalize in some institutions.

These limitations aside, we believe that our attribution methodology has face validity. For example, a provider might be justifiably frustrated if, using the standard methodology, he or she is charged with the LOS of a patient who had been hospitalized for months, particularly if that patient is discharged shortly after the provider assumes care. Our method addresses this type of misattribution. Particularly when individual provider compensation is based on performance on metrics (as is the case at our institution), optimizing provider attribution to particular patients may be important, and face validity may be required for group buy-in.

In summary, we have demonstrated that it is possible to use billing data to assign ownership of patients to multiple providers over 1 hospital stay. This could be applied to other hospitalist programs as well as other healthcare settings in which multiple providers care for patients during 1 healthcare encounter (eg, ICUs).

Disclosure: The authors declare they have no relevant conflicts of interest.

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Mortality, Length of Stay, and Cost of Weekend Admissions

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BACKGROUND: Apparent increase in mortality associated with being admitted to hospital on a weekend compared to weekdays has led to controversial policy changes to weekend staffing in the United Kingdom. Studies in the United States have been inconclusive and diagnosis specific, and whether to implement such changes is subject to ongoing debate.

OBJECTIVE: To compare mortality, length of stay, and cost between patients admitted on weekdays and weekends.

DESIGN: Retrospective cohort study.

SETTING: National Inpatient Sample, an administrative claims database of a 20% stratified sample of discharges from all hospitals participating in the Healthcare Cost and Utilization Project.

PATIENTS: Adult patients who were emergently admitted from 2012 to 2014.

INTERVENTION: The primary predictor was whether the admission was on a weekday or weekend.

MEASUREMENT: The primary outcome was in-hospital mortality and secondary outcomes were length of stay and cost.

RESULTS: We included 13,505,396 patients in our study. After adjusting for demographics and disease severity, we found a small difference in inpatient mortality rates on weekends versus weekdays (odds ratio [OR] 1.029; 95% confidence interval [CI], 1.020-1.039; $P < .001$). There was a statistically significant but clinically small decrease in length of stay (2.24%; 95% CI, 2.16-2.33; $P < .001$) and cost (1.14%; 95% CI, 1.05-1.24; $P < .001$) of weekend admissions. A subgroup analysis of the most common weekend diagnoses showed substantial heterogeneity between diagnoses.

CONCLUSIONS: Differences in mortality of weekend admissions may be attributed to underlying differences in patient characteristics and severity of illness and is subject to large between-diagnoses heterogeneity. Increasing weekend services may not result in desired reduction in inpatient mortality rate. *Journal of Hospital Medicine* 2018;13:476-481. Published online first January 25, 2018.

The "weekend effect" refers to the association between weekend hospital admissions and poorer outcomes, such as higher mortality rates. Analysis of National Health Service claims data from the United Kingdom suggested a 10% increase in 30-day mortality in patients admitted on Saturdays and 15% in patients admitted on Sundays,[1] leading to the push for a 7-day work week and invoking controversial changes in their junior doctor (residency) working contract. Studies in the United States highlighting differences in outcomes for patients admitted on weekends compared to weekdays have mostly focused on specific diagnoses and results have been variable. Few have gone on to look at the association of weekend hospital admissions on cost[2,3] and length of stay[3] but results are overall inconclusive. Some have suggested that such poorer outcomes for patients admitted on weekends are due to reduced staffing and delayed procedures on weekends compared to weekdays, although this has been debated.[4] The lack of consensus has made it difficult for hospitals to plan if and how to expand weekend manpower or services.

In the United States, increase in mortality rate for patients admitted on weekends has been demonstrated for a range of diagnoses, including pulmonary embolism,[5] intracerebral hemorrhage,[6] upper gastrointestinal hemorrhage,[7,8] ruptured aortic aneurysm,[9] heart failure,[10] and acute kidney injury.[11] However, other diagnoses such as atrial flutter or fibrillation,[2] hip fractures,[12] ischemic stroke,[13] and esophageal variceal hemorrhage,[14] show no difference in mortality between weekday and weekend admissions. Yet, other conditions such as myocardial infarction[15,16] and subarachnoid hemorrhage[17,18] have multiple studies with conflicting results. None of these studies have comprehensively looked at the effect of weekend admissions across all diagnoses nor compared the effect size between common diagnoses in the United States using the same risk adjustment. Reporting of differences in length of stay and cost is also rare.

We postulated that the weekend admissions are associated with increased mortality and length of stay, but that the effect would be heterogeneous between different diagnosis groups. Using a large nationally representative inpatient database, we investigated the association between weekend versus weekday admissions on in-hospital mortality, length of stay, and cost for acute hospitalizations in the United States. We performed

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subgroup analyses of the top 20 diagnoses to determine which diagnoses, if any, should be targeted for expanded weekend manpower or services.

METHODS

Data Sources

We used information from the National Inpatient Sample (NIS) database for this study,[19] which is the largest all-payer inpatient healthcare database in the United States. It contains administrative claims information on a 20% stratified sample of discharges from all hospitals participating in the Healthcare Cost and Utilization Project (HCUP), which includes over 90% of hospitals and 95% of discharges in the country. The NIS contains clinical and nonclinical data elements, including diagnoses, severity and comorbidity measures, demographics, admission characteristics, and charges.

Study Patients

The study included all patients who were 18 years or older and were admitted to hospitals participating in HCUP from 2012 to 2014. Elective or planned admissions were excluded from this study because of the anticipated degree of unmeasured confounding that would be present between patients electively admitted on weekends compared to weekdays.

Study Variables

The primary exposure variable was admission on weekends (defined as Friday midnight to Sunday midnight) compared to the rest of the week. The primary outcome variable was in-hospital mortality. The secondary outcome variables were length of stay (measured in integer days) and cost. Length of stay was compared only using only patients who survived the hospital admission to eliminate the effect of death in shortening the length of stay. Cost was calculated by using charges available in the NIS and multiplied by the accompanying cost-to-charge ratios. Charges reflect total amount that hospitals billed for services but do not reflect how much these services actually cost. The HCUP cost-to-charge ratios are hospital-specific data based on hospital accounting reports collected by the Centers for Medicare & Medicaid Services.[19]

Covariates included age, sex, race, income, payer, presence or absence of comorbidities as defined by the Elixhauser comorbidity index,[20] risk of mortality, and severity of illness scores as defined by the 3M Health Information Systems.[21] Mortality risk and severity of illness groups are defined by using a proprietary iterative process developed by 3M Health Information Systems using *International Classification of Diseases, 9th Revision-Clinical Modification* (ICD-9-CM) principal and secondary diagnosis codes and procedure codes, age, sex, and discharge disposition, evaluated with historical data.[21] Severity of illness refers to the extent of physiologic decompensation or loss of function of an organ system, whereas risk of mortality refers to the likelihood of dying.

Statistical Analysis

We compared patient characteristics and other covariates between patients emergently admitted on weekends and

TABLE 1. **Baseline Demographics of Weekday and Weekend Admissions**

Demographics	Weekday (n = 10,242,614)	Weekend (n = 3,262,782)
Age, median [IQR]	61 [43,76]	61 [43,77]
Sex		
Male	43.3%	44.0%
Female	56.7%	56.0%
Race		
White	67.3%	67.3%
Black	15.9%	17.0%
Hispanic	10.7%	10.8%
Asian or Pacific Islander	2.5%	2.5%
Native American	0.6%	0.7%
Other	3.0%	2.9%
Income		
1st quartile	31.0%	31.0%
2nd quartile	26.3%	26.3%
3rd quartile	23.2%	23.2%
4th quartile	19.6%	19.5%
Payer		
Medicare	49.8%	50.1%
Medicaid	16.6%	16.3%
Private insurance	24.0%	23.4%
Self-pay	5.8%	6.5%
No charge	0.6%	0.6%
Other	3.1%	3.0%
Risk of Mortality		
Minor likelihood of dying	44.7%	43.9%
Moderate likelihood of dying	28.2%	27.9%
Major likelihood of dying	20.2%	20.5%
Extreme likelihood of dying	7.0%	7.7%
Severity of illness		
Minor loss of function	22.8%	22.3%
Moderate loss of function	40.0%	40.0%
Major loss of function	29.1%	29.0%
Extreme loss of function	8.1%	8.7%
Total number of comorbidities		
0	15.0%	14.5%
1	16.2%	16.2%
2	18.9%	19.1%
3	17.4%	17.6%
≥4	32.5%	32.7%

NOTE: Mortality risk and severity of illness groups are defined using a proprietary iterative process developed by 3M Health Information Systems using ICD-9-CM diagnosis and procedure codes, age, sex and discharge disposition, and further evaluated with historical data.[21] Severity of illness refers to the extent of physiologic decompensation or loss of function of an organ system, whereas risk of mortality refers to the likelihood of dying. Abbreviations: ICD-9-CM, *International Classification of Diseases, 9th Revision-Clinical Modification*; IQR, interquartile range.

TABLE 2. **Effect of Weekend Admission on Mortality**

Mortality Rate		Crude		Adjusted for Demographics, Severity, and Comorbidities	
Weekday	Weekend	OR (95% CI)	*P* value	OR (95% CI)	*P* value
2.54%	2.80%	1.110 (1.105-1.113)	<.0001	1.029 (1.020-1.039)	<.0001

NOTE: Abbreviations: CI, confidence interval; OR, odds ratio.

weekdays. Continuous variables that were not normally distributed were either categorized (age, risk of mortality, and severity of illness scores) or log-transformed if right skewed (length of stay and cost). Categorical data were reported as percentages and continuous data as medians (interquartile range). We compared the inpatient mortality rate between weekend and weekday admissions by using χ^2 tests. Multivariable logistic regression was used to adjust for covariates of age, gender, race, payer, income, risk of mortality and severity of illness scores, number of comorbidities, and the presence or absence of each of the 29 comorbidities available in the database to determine an adjusted odds ratio (OR), *P* values, and confidence intervals (CIs).

We also compared the length of stay amongst survivors and costs between weekend and weekday admissions. Multivariable linear regression was applied to the natural log of these outcome variables and the coefficients exponentiated to determine the difference in length of stay and cost of weekend admissions as compared to weekday. Covariates in the model were the same as those used for the primary outcome.

To determine if particular diagnoses had a pronounced weekend effect, the above analyses were repeated in subgroups of the top 20 most prevalent diagnoses on weekends by using the Clinical Classifications Software for ICD-9-CM diagnosis groups. For subgroup analyses, a Bonferroni correction was used, so *P* values of <.0025 were considered significant.

Statistical analyses were performed by using SAS version 9.4 (SAS Institute Inc, Cary, NC). All regression models were run using PROC SURVEYREG for continuous outcomes and PROC SURVEYLOGISTIC for binary outcomes to account for the sampling structure of NIS. Two-sided *P* values of .05 were considered significant, apart from the Bonferroni correction applied to the subgroup analysis. As this study involved publicly available deidentified data, our study was exempt from institutional board review.

RESULTS

Patient Characteristics

We included 13,505,396 patients in our study, 24.2% of whom were admitted on weekends. Patients who were admitted on weekends tended to be slightly older, more likely to be female, more likely to be black, had lower risks of mortality and severity of illness scores, and had fewer comorbidities and procedures (Table 1). The income and payer distribution were similar between weekend and weekday admissions.

Mortality

The crude in-hospital mortality rate was 2.8% for patients admitted on weekends and 2.5% for patients admitted on weekdays (unadjusted OR, 1.110; 95% CI, 1.105-1.113; $P < .0001$). This relationship was attenuated after adjustment for demographics, severity, and comorbidities, but remained statistically significant (OR 1.029; 95% CI, 1.020-1.039; $P < .0001$; Table 2), which corresponds to an adjusted risk difference of 0.07% increase in mortality of weekend admissions. The OR for mortality on weekends compared to weekdays was further calculated for each of the top 20 diagnoses (Table 3). Out of all the diagnosis groups, only 1 (urinary tract infection) had a statistically significant *P* value after Bonferroni correction. We also looked separately at patients who were electively admitted—there was a highly significant OR of mortality of 1.67 (95% CI, 1.60-1.74). Patients classified as elective admissions were excluded for subsequent analyses.

Length of Stay

The median length of stay was 3 days in both the weekend and weekday group. Patients who survived the hospital admission had a 2.24% (95% CI, 2.16%-2.33%) shorter length of stay than those admitted on weekdays after adjustment ($P < .0001$; Table 4). Subgroup analyses for the top 20 diagnoses revealed a marked heterogeneity in length of stay amongst different diagnoses (Table 3), ranging from 8.91% shorter length of stay (mood disorders) to 7.14% longer length of stay (nonspecific chest pain). Diagnoses associated with longer length of stay in weekend admissions included acute myocardial infarction (3.90% increase in length of stay), acute cerebrovascular disease (2.15%), cardiac dysrhythmias (1.39%), nonspecific chest pain (7.14%), biliary tract disease (4.88%), and gastrointestinal hemorrhage (1.97%). All other diagnoses groups had a significantly shorter length of stay, except for intestinal obstruction which showed no significant difference.

Cost

The median cost was $6609 in the weekday group and $6562 in the weekend group. Patients admitted on weekends incurred 1.14% (95% CI, 1.05%-1.24%) lower costs compared to those admitted on weekday after adjustment ($P < .0001$; Table 4). Subgroup analyses showed a side range from 8.0% lower cost (mood disorders) to 1.73% higher cost (biliary tract disease; Table 3). Fourteen of the 20 top diagnoses were associated with a significant decrease in cost of weekend admissions compared to weekdays. Weekend admissions for cerebrovascular disease, biliary tract disease, and gastrointestinal hemorrhage

TABLE 3. **Subgroup Analysis of Top 20 Diagnoses on Effect of Weekend Admission Mortality, Length of Stay, and Cost**

Diagnosis	% of Weekend Admissions	Mortality		Length of Stay		Cost	
		OR	*P* value	% Increase	*P* value	% Increase	*P* value
Sepsis	6.07	1.00	.68	−1.78	<.0001	−0.98	<.0001
Pneumonia	3.74	1.02	.40	−2.10	<.0001	−0.81	<.0001
Congestive heart failure	3.61	0.99	.77	−2.36	<.0001	−1.55	<.0001
Acute myocardial infarction	2.8	1.04	.06	3.90	<.0001	−0.85	<.0001
COPD and bronchiectasis	2.76	0.99	.70	−1.16	<.0001	−0.50	.0007
Cerebrovascular disease	2.68	1.00	.87	2.15	<.0001	1.61	<.0001
Cardiac dysrhythmias	2.56	1.07	.09	1.39	<.0001	−1.51	<.0001
Mood disorders	2.32	0.81	.61	−8.91	<.0001	−8.00	<.0001
Skin and subcutaneous tissue infection	2.27	0.99	.94	−2.88	<.0001	−1.24	<.0001
Urinary tract infection	2.23	1.09	<.0001	−2.05	<.0001	−0.95	<.0001
Diabetes with complications	2.03	1.04	.55	−2.47	<.0001	−1.45	<.0001
Renal failure	1.91	1.05	.09	−2.82	<.0001	−0.09	.64
Respiratory failure	1.73	1.02	.22	−0.71	.001	−0.13	.55
Nonspecific chest pain	1.7	1.01	.95	7.14	<.0001	−0.98	.002
Biliary tract disease	1.64	1.18	.04	4.88	<.0001	1.73	<.0001
Complication of device	1.58	1.01	.78	−1.71	<.0001	−7.46	<.0001
Gastrointestinal hemorrhage	1.57	1.08	.02	1.97	<.0001	0.92	<.0001
Intestinal obstruction	1.52	1.00	.95	0.19	.62	0.01	.98
Complications of care	1.51	0.89	.03	−2.99	<.0001	−4.58	<.0001
Fracture of neck of femur	1.47	0.96	.27	−3.70	<.0001	−0.90	.002

NOTE: Abbreviations: COPD, chronic obstructive pulmonary disease; OR, odds ratio.

were associated with a significant increase in cost of 1.61%, 1.73%, and 0.92%, respectively.

DISCUSSION

Our analysis of more than 13 million patients in the NIS showed a clinically small difference in overall mortality (OR 1.029), but there were no differences in diagnosis-specific mortality for the 20 most prevalent diagnoses for patients admitted on weekends compared to weekdays after adjustment for confounders. We also found that there was a large heterogeneity between different diagnoses on the effect of being admitted on weekdays on length of stay and cost of hospital admission.

The magnitude of association between weekend admissions and mortality in this large administrative database contradicts existing literature, which some believe conclusively proves the international phenomenon of the weekend effect.[22,23] However, our results support a minimal increase in odds of death of 2.9%, with no consistent effect amongst the top 20 diagnoses. Only 1 diagnosis group (urinary tract infection) showed a statistically significant increase in mortality, which could be due to chance. In contrast, the policy-influencing paper in the United Kingdom reports that patients admitted on Saturdays and Sundays have an increased risk of death of 10% and 15%, respectively, compared to patients admitted on Wednesdays.[24] They also repeated their measurements on a United Health Care Systems database, comprising 254 leading managed care hospitals in the US, over a time period of 3 months in 2010, and found a hazard ratio of 1.18 (95% CI, 1.11-1.26). Ruiz et al.[22] combined almost 3 million medical records from 28 metropolitan hospitals in 5 different countries in the Global Comparators Project, including 5 in the United States, and showed increased mortality on weekends in all countries, concluding that the weekend effect is a systematic phenomenon.

There are several possible explanations for differences in our findings. Freemantle's study differed to ours by comparing outcomes of weekends to an index of Wednesday; they also found an increased mortality on Mondays and Fridays, which could suggest the presence of residual confounding and

TABLE 4. **Effect of Weekend Admission on Length of Stay and Cost**

	Median [IQR]		Crude		Adjusted for Demographics, Severity, and Comorbidities	
	Weekday	Weekend	% Increase on Weekends (95% CI)	*P* value	% Increase on Weekends (95% CI)	*P* value
Length of stay	3 [2,6]	3 [2,5]	−1.72% (−1.82 to −1.62]	<.0001	−2.24 (−2.33 to −2.16)	<.0001
Cost	$6609 [3974, 11,888]	$6562 [3985, 11,669]	−0.45% (−0.56 to −0.34)	.00049	−1.14 (−1.24 to −1.05)	<.0001

NOTE: Abbreviations: CI, confidence interval; IQR, interquartile range.

doubt as to whether Wednesday is the ideal control group. A further difference is the definition of mortality—we looked at in-hospital mortality, as compared to 30-day mortality. In addition, Freemantle's study included elective admissions. When we looked at the effect of weekend admissions on mortality, we found a highly significant OR of 1.67, compared to 1.03 in emergency admissions. We attributed this discrepancy to unmeasured confounding, such as preference of physicians or difference in classification of elective admissions in different hospitals. Because of significant effect modification of elective compared to emergency admissions, we decided to restrict our analysis to emergency admissions only. This also enabled direct associations with potential policy recommendations on whether to expand weekend clinical care, which is most relevant to emergency admissions. Finally, the Global Comparators Project only samples a small proportion of hospitals in each country, leading to limited generalizability; in addition, international comparisons are difficult to interpret due to differing health systems.

The overall and diagnosis-specific difference in length of stay was small and of doubtful clinical significance. With an adjusted decrease in length of stay in patients admitted on weekends of 2.24%, when applied to a median length of stay of 3 days, it translates into a 1.7-hour difference in length of stay. However, there was striking heterogeneity noted between diagnoses, with a difference ranging from 8.91% decrease in length of stay (mood disorders) to 7.14% increase in length of stay (nonspecific chest pain), which is likely to explain the overall small magnitude of effect. We noted that the diagnoses associated with increased length of stay for weekend admissions tended to be those requiring inpatient procedures or investigations, such as acute myocardial infarction (3.90% increase), acute cerebrovascular disease (2.15% increase), cardiac dysrhythmias (1.39% increase), nonspecific chest pain (7.14% increase), and biliary tract disease (4.88% increase). As hospitals often do not provide certain nonemergent procedures or investigations on weekends, delay in procedures or investigations may explain the increase in length of stay. These include percutaneous coronary intervention or stress testing for evaluation of cardiac ischemia and endoscopic procedures for biliary tract disease and gastrointestinal hemorrhage. It must, however, be noted in conjunction that numerous studies have established higher complication rates when nonemergent surgeries are performed out of hours or on weekends.[25-28] Therefore, we suggest further studies to compare the effect of weekends on increased procedural complications as to any morbidity caused by increased length of stay, which the present dataset was unable to capture. Another potential explanation for the heterogeneity in length of stay could be the greater availability of caregivers to assist with discharge on weekends, such as for patients admitted for mood disorders.

Surprisingly, weekend admissions appeared to be less costly than weekday admissions overall. Because of the large sample size, very minor differences in cost are likely to be statistically significant. Indeed, for the absolute difference of 0.45%, given a median cost of $6562 on weekends, this only represents a cost saving of approximately $30 per patient admission. There was also heterogeneity observed amongst the different diagnosis groups, and cerebrovascular disease, biliary tract disease and gastrointestinal hemorrhage, which were also associated with increase length of stay, were associated with an increased cost. However, our study is unable to establish causation, and differences in staffing numbers and reimbursement on weekends may confound cost estimates. We propose that further studies using hospital databases with greater granularity in data are necessary to determine the etiology of cost differences between weekends and weekdays.

Our study's key strengths are the large sample size and generalizability to the US. As a large administrative database, we recognize the likelihood of inconsistencies in hospital coding for covariates, diagnoses, and charges, which may lead to misclassification bias. The NIS definition of weekend (Friday midnight to Sunday midnight) may differ from other definitions of weekend; ideally Friday 5 PM to Monday 8 AM may be more clinically representative. This cohort of hospital admissions also does not account for the day of presentation to the emergency department, but rather only the day that ward admission was documented. The variable delays in emergency department, for example if emergency departments are busier on weekends, leading to delays in ward admission, may confound our results. Our exclusion of elective admissions was dependent on the administrative coding of elective versus emergency admissions, of which the definition may differ between hospitals. Finally, despite adjustment on clinical and sociodemographic covariates, there is a possibility of residual confounding in this retrospective comparison between weekend and weekday admissions.

CONCLUSION

Our study does not suggest that system-wide policies to increase weekend service coverage will impact mortality, although effects on length of stay and cost are inconclusive. Hospitals wishing to improve coverage may consider focusing on procedural diagnoses as listed above which may shorten length of stay, although the out-of-hours complication rate should be carefully monitored.

Disclosure: The authors declare no conflicts of interest.

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Lean-Based Redesign of Multidisciplinary Rounds on General Medicine Service

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BACKGROUND: Multidisciplinary rounds (MDR) facilitate timely communication amongst the care team and with patients. We used Lean techniques to redesign MDR on the teaching general medicine service.

OBJECTIVE: To examine if our Lean-based new model of MDR was associated with change in the primary outcome of length of stay (LOS) and secondary outcomes of discharges before noon, documentation of estimated discharge date (EDD), and patient satisfaction.

DESIGN, SETTING, AND PATIENTS: This is a pre-post study. The preperiod (in which the old model of MDR was followed) comprised 4000 patients discharged between September 1, 2013, and October 22, 2014. The postperiod (in which the new model of MDR was followed) comprised 2085 patients between October 23, 2014, and April 30, 2015.

INTERVENTION: Lean-based redesign of MDR.

MEASUREMENTS: LOS, discharges before noon, EDD, and patient satisfaction.

RESULTS: There was no change in the mean LOS. Discharges before noon increased from 6.9% to 10.7% ($P < .001$). Recording of EDD increased from 31.4% to 41.3% ($P < .001$). There was no change in patient satisfaction.

CONCLUSIONS: Lean-based redesign of MDR was associated with an increase in discharges before noon and in recording of EDD. *Journal of Hospital Medicine* 2018;13:482-485. Published online first February 2, 2018.

Given that multiple disciplines are often involved in caring for patients admitted to the hospital, timely communication, collaboration, and coordination amongst various disciplines is necessary for safe and effective patient care.[1] With the focus on improving patient satisfaction and throughput in hospitals, it is also important to make more accurate predictions of the discharge date and allow time for patients and their families to prepare for discharge.[2-4]

Multidisciplinary rounds (MDR) are defined as structured daily communication amongst key members of the patient's care team (eg, nurses, physicians, case managers, social workers, pharmacists, and rehabilitation services). MDR have shown to be a useful strategy for ensuring that all members of the care team are updated on the plan of care for the patient.[5] During MDR, a brief "check-in" discussing the patient's plan of care, pending needs, and barriers to discharge allows all team members, patients, and families to effectively coordinate care and plan and prepare for discharge.

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Multiple studies have reported increased collaboration and improved communication between disciplines with the use of such multidisciplinary rounding.[2,5-7] Additionally, MDR have been shown to improve patient outcomes[8] and reduce adverse events,[9] length of stay (LOS),[6,8] cost of care,[8] and readmissions.[1]

We redesigned MDR on the general medicine wards at our institution in October 2014 by using Lean management techniques. Lean is defined as a set of philosophies and methods that aim to create transformation in thinking, behavior, and culture in each process, with the goal of maximizing the value for the patients and providers, adding efficiency, and reducing waste and waits.[10]

In this study, we evaluate whether this new model of MDR was associated with a decrease in the LOS. We also evaluate whether this new model of MDR was associated with an increase in discharges before noon, documentation of estimated discharge date (EDD) in our electronic health record (EHR), and patient satisfaction.

METHODS

Setting, Design, and Patients

The study was conducted on the teaching general medicine service at our institution, an urban, 484-bed academic hospital. The general medicine service has patients on 4 inpatient units (total of 95 beds) and is managed by 5 teaching service teams.

We performed a pre-post study. The preperiod (in which the old model of MDR was followed) included 4000 patients discharged between September 1, 2013, and October 22, 2014. The postperiod (in which the new model of MDR was followed)

TABLE 1. **Interventions Performed in the Old and New Model of MDR**

Old Model of MDR	New Model of MDR
Rounds were conducted away from the inpatient unit in a conference room.	Rounds were conducted at the nurse's station on each inpatient unit.
Rounds started at 11 am and were conducted Monday to Friday, excluding holidays.	Rounds started at 10 am and were conducted Monday to Friday, excluding holidays.
Rounds usually lasted about 10 minutes.	Rounds lasted up to 30 minutes per team.
Rounds did not incorporate a visibility board (a tool used to provide at-a-glance visual display of work of the organization and allow for quick recognition of information being communicated and abnormal conditions in order to maximize efficiency and clarity and promote collaboration and team work).	Rounds were done in front of a large visibility board. This board was updated in real time during rounds by the case manager and included the estimated date and time of discharge.
Rounds were attended by a general medicine housestaff from each of the 5 teams and a case manager and had inconsistent representation from some of the clinical support services (such as clinical nutrition or rehabilitation services). Rounds did not include the bedside nurse or the general medicine attending physician.	Rounds were attended by each team's general medicine case manager, social worker, pharmacist, attending physician, respiratory therapist, rehabilitation services, clinical nutritionist, charge nurse, and bedside nurse.
There was no consistent format to identify the pending needs of the patients and potential barriers to discharge or provide relevant communication to the patients and/or their families after rounds. Either the inpatient unit charge nurse or the bedside nurse updated the EDD on the EHR.	Standard work was developed to create a consistent format to identify pending needs of the patients and potential barriers to discharge. The bedside nurse provided relevant communication to the patients and/or their families after these rounds and also updated the EDD in our EHR.
The general medicine housestaff usually facilitated the discussion at rounds.	The case manager facilitated the discussion at rounds.

NOTE: Abbreviations: EDD, estimated discharge date; EHR, electronic health record; MDR, multidisciplinary rounds.

included 2085 patients discharged between October 23, 2014, and April 30, 2015. We excluded 139 patients that died in the hospital prior to discharge and patients on the nonteaching and/or private practice service.

All data were provided by our institution's Digital Solutions Department. Our institutional review board issued a letter of determination exempting this study from further review because it was deemed to be a quality improvement initiative.

Use of Lean Management to Redesign our MDR

Our institution has incorporated the Lean management system to continually add value to services through the elimination of waste, thus simultaneously optimizing the quality of patient care, cost, and patient satisfaction.[11] Lean, derived from the Toyota Production System, has long been used in manufacturing and in recent decades has spread to healthcare.[12] We leveraged the following 3 key Lean techniques to redesign our MDR: (1) value stream management (VSM), (2) rapid process improvement workshops (RPIW), and (3) active daily management (ADM), as detailed in supplementary Appendix 1.

Interventions

Our interventions comparing the old model of the MDR to the new model are shown in Table 1. The purpose of these interventions was to (1) increase provider engagement and input in discharge planning, (2) improve early identification of patient discharge needs, (3) have clearly defined roles and responsibilities for each team member, and (4) have a visual feedback regarding patient care plan for all members of the care team, even if they were not present at MDR.

Outcomes

The primary outcome was mean LOS. The secondary outcomes were (1) discharges before noon, (2) recording of the EDD in our EHR within 24 hours of admission (as time stamped on our EHR), and (3) patient satisfaction.

Data for patient satisfaction were obtained using the Press Ganey survey. We used data on patient satisfaction scores for the following 2 relevant questions on this survey: (1) extent to which the patient felt ready to be discharged and (2) how well staff worked together to care for the patient. Proportions

TABLE 2. **Patient Characteristics**

Characteristic	Preperiod (N = 4000)	Postperiod (N = 2085)	*P* value for Differences
Age, years (mean ± SD)	59.6 ± 19.7	60.0 ± 19.8	.365
Females (n, %)	2043 (51.1%)	1039 (49.9%)	.367
Race/ethnicity (n, %)			.769
Asian	493 (12.3%)	239 (11.5%)	
African American	398 (10.0%)	222 (10.6%)	
Hispanic	785 (19.6%)	409 (19.6%)	
Non-Hispanic white	1839 (46.0%)	968 (46.4%)	
Pacific Islander	138 (3.4%)	62 (3.0%)	
Other/Unknown	347 (8.7%)	185 (8.9%)	
Spoken language (n, %)			.137
English	3224 (80.6%)	1693 (81.2%)	
Spanish	436 (10.9%)	197 (9.4%)	
Other	340 (8.5%)	195 (9.4%)	
CMI (mean ± SD)	1.35 ± 1.11	1.40 ± 1.06	.071
Discharge volume (average per day)	9.6	10.9	<.001

NOTE: Abbreviations: CMI, case mix index; SD, standard deviation.

TABLE 3. **Primary and Secondary Outcomes**

Outcomes	Preperiod (N = 4000)	Postperiod (N = 2085)	Absolute Difference (95% CI)	*P* value for Differences
Mean LOS (days)	4.66	4.81	0.15 (–0.10 to 0.40)	.227
Mean length of stay (CMI adjusted days)	—	—	0.05 (–0.17 to 0.26)	.665
Discharges before noon (n, %)	275 (6.9%)	224 (10.7%)	3.9% (2.4 to 5.3)	<.001
Estimated discharge date recorded on our EHR within 24 hours of admission (n, %)	1256 (31.4%)	861 (41.3%)	9.9% (7.4 to 12.4)	<.001
Patient satisfaction				
(1) Extent to which patient felt ready to be discharged (n, %)	275 (61.1%)	106 (58.9%)	-2.2% (–10.7 to 6.2)	.607
(2) How well staff worked together to care for patient (n, %)	342 (74.5%)	137 (74.5%)	0.0% (–7.5 to 7.4)	.989

NOTE: Abbreviations: CI, confidence interval; CMI, case mix index; EHR, electronic health record; LOS, length of stay.

of the "top-box" ("very good") were used for the analysis. These survey data were available on 467 patients (11.7%) in the preperiod and 188 patients (9.0%) in the postperiod.

Data Analysis

Absolute difference in days (mean LOS) or change in percentage and their corresponding 95% confidence intervals (CIs) were calculated for all outcome measures in the pre-post periods. Two-tailed t tests were used to calculate *P* values for continuous variables. LOS was truncated at 30 days to minimize the influence of outliers. A multiple regression model was also run to assess change in mean LOS, adjusted for the patient's case mix index (CMI), a measure of patient acuity (Table 3). CMI is a relative value assigned to a diagnosis-related group of patients in a medical care environment and is used in determining the allocation of resources to care for and/or treat the patients in the group.

A sensitivity analysis was conducted on a second cohort that included a subset of patients from the preperiod between November 1, 2013, and April 30, 2014, and a subset of patients from the postperiod between November 1, 2014, and April 1, 2015, to control for the calendar period (supplementary Appendix 2).

All analyses were conducted in R version 3.3.0, with the linear mixed-effects model lme4 statistical package.[13,14]

RESULTS

Table 2 shows patient characteristics in the pre- and postperiods. There were no significant differences between age, sex, race and/or ethnicity, language, or CMI between patients in the pre- and postperiods. Discharge volume was higher by 1.3 patients per day in the postperiod compared with the preperiod ($P < .001$).

Table 3 shows the differences in the outcomes between the pre- and postperiods. There was no change in the LOS or LOS adjusted for CMI. There was a 3.9% increase in discharges before noon in the postperiod compared with the preperiod (95% CI, 2.4% to 5.3%; $P < .001$). There was a 9.9% increase in the percentage of patients for whom the EDD was recorded in our EHR within 24 hours of admission (95% CI, 7.4% to 12.4%; $P < .001$). There was no change in the "top-box" patient satisfaction scores.

There were only marginal differences in the results between the entire cohort and a second subset cohort used for sensitivity analysis (supplementary Appendix 2).

DISCUSSION

In our study, there was no change in the mean LOS with the new model of MDR. There was an increase in discharges before noon and in recording of the EDD in our EHR within 24 hours of admission in the postperiod when the Lean-based new model of MDR was utilized. There was no change in patient satisfaction. With no change in staffing, we were able to accommodate the increase in the discharge volume in the postperiod.

We believe our results are attributable to several factors, including clearly defined roles and responsibilities for all participants of MDR, the inclusion of more experienced general medicine attending physician (compared with housestaff), Lean management techniques to identify gaps in the patient's journey from emergency department to discharge using VSM, the development of appropriate workflows and standard work on how the multidisciplinary teams would work together at RPIWs, and ADM to ensure sustainability and engagement among frontline members and institutional leaders. In order to sustain this, we planned to continue monitoring data in daily, weekly, and monthly forums with senior physician and administrative leaders. Planning for additional interventions is underway, including moving MDR to the bedside, instituting an afternoon "check-in" that would enable more detailed action planning, and addressing barriers in a timely manner for patients ready to discharge the following day.

Our study has a few limitations. First, this is an observational study that cannot determine causation. Second, this is a single-center study conducted on patients only on the general medicine teaching service. Third, there were several

concurrent interventions implemented at our institution to improve LOS, throughput, and patient satisfaction in addition to MDR, thus making it difficult to isolate the impact of our intervention. Fourth, in the new model of MDR, rounds took place only 5 days per week, thereby possibly limiting the potential impact on our outcomes. Fifth, while we showed improvements in the discharges before noon and recording of EDD in the post period, we were not able to achieve our target of 25% discharges before noon or 100% recording of EDD in this time period. We believe the limited amount of time between the pre- and postperiods to allow for adoption and learning of the processes might have contributed to the underestimation of the impact of the new model of MDR, thereby limiting our ability to achieve our targets. Sixth, the response rate on the Press Ganey survey was low, and we did not directly survey patients or families for their satisfaction with MDR.

Our study has several strengths. To our knowledge, this is the first study to embed Lean management techniques in the design of MDR in the inpatient setting. While several studies have demonstrated improvements in discharges before noon through the implementation of MDR, they have not incorporated Lean management techniques, which we believe are critical to ensure the sustainability of results.[1,3,5,6,8,15] Second, while it was not measured, there was a high level of provider engagement in the process in the new model of MDR. Third, because the MDR were conducted at the nurse's station on each inpatient unit in the new model instead of in a conference room, it was well attended by all members of the multidisciplinary team. Fourth, the presence of a visibility board allowed for all team members to have easy access to visual feedback throughout the day, even if they were not present at the MDR. Fifth, we believe that there was also more accurate estimation of the date and time of discharge in the new model of MDR because the discussion was facilitated by the case manager, who is experienced in identifying barriers to discharge (compared with the housestaff in the old model of MDR), and included the more experienced attending physician. Finally, the consistent presence of a multidisciplinary team at MDR allowed for the incorporation of everyone's concerns at one time, thereby limiting the need for paging multiple disciplines throughout the day, which led to quicker resolution of issues and assignment of pending tasks.

In conclusion, our study shows no change in the mean LOS when the Lean-based model of MDR was utilized. Our study demonstrates an increase in discharges before noon and in recording of EDD on our EHR within 24 hours of admission in the post period when the Lean-based model of MDR was utilized. There was no change in patient satisfaction. While this study was conducted at an academic medical center on the general medicine wards, we believe our new model of MDR, which leveraged Lean management techniques, may successfully impact patient flow in all inpatient clinical services and nonteaching hospitals.

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Accuracy Comparisons between Manual and Automated Respiratory Rate for Detecting Clinical Deterioration in Ward Patients

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Respiratory rate is the most accurate vital sign for predicting adverse outcomes in ward patients.[1,2] Though other vital signs are typically collected by using machines, respiratory rate is collected manually by caregivers counting the breathing rate. However, studies have shown significant discrepancies between a patient's respiratory rate documented in the medical record, which is often 18 or 20, and the value measured by counting the rate over a full minute.[3] Thus, despite the high accuracy of respiratory rate, it is possible that these values do not represent true patient physiology. It is unknown whether a valid automated measurement of respiratory rate would be more predictive than a manually collected respiratory rate for identifying patients who develop deterioration. The aim of this study was to compare the distribution and predictive accuracy of manually and automatically recorded respiratory rates.

METHODS

In this prospective cohort study, adult patients admitted to one oncology ward at the University of Chicago from April 2015 to May 2016 were approached for consent (Institutional Review Board #14-0682). Enrolled patients were fit with a cableless, FDA-approved respiratory pod device (Philips IntelliVue clResp Pod; Philips Healthcare, Andover, MA) that automatically recorded respiratory rate and heart rate every 15 minutes while they remained on the ward. Pod data were paired with vital sign data documented in the electronic health record (EHR) by taking the automated value closest, but prior to, the manual value up to a maximum of 4 hours. Automated and manual respiratory rate were compared by using the area under the receiver operating characteristic curve (AUC) for whether an intensive care unit (ICU) transfer occurred within 24 hours of each paired observation without accounting for patient-level clustering.

RESULTS

A total of 1402 paired respiratory rate observations from 51 patient admissions were included, of which 5 patients (9.8%) experienced an ICU transfer. Paired heart rate values were highly correlated (r = 0.86), while paired respiratory rate values were less correlated (r = 0.38). The automated values had a median of 21 (interquartile range [IQR] of 17-25), while the manual values had a median of 18 (IQR of 16-21). Manual respiratory rates were significantly more accurate for predicting ICU transfer than automated respiratory rates (AUC 0.67 [95% CI, 0.62-0.73] vs 0.60 [95% CI, 0.55-0.65]; $P = .011$). As shown in the Figure, accuracy was similar between manual and automated respiratory rates until 18 breaths per minute, above which the manual respiratory rates were more predictive. At a threshold with similar specificity, manual respiratory rates >22 had a sensitivity of 45% and specificity of 84%, while automated respiratory rates >26 had a sensitivity of 22% and specificity of 81%. At a threshold with similar sensitivity, manual respiratory rates >20 had a sensitivity of 54% and specificity of 75%, while automated respiratory rates >22 had a sensitivity of 52% and specificity of 64%.

DISCUSSION

In this prospective cohort study, we found that manual respiratory rates were different than those collected from an automated system and, yet, were significantly more accurate for predicting ICU transfer. These results suggest that the predictive accuracy of respiratory rates documented in the EHR is due to more than just physiology. Our findings have important implications for the risk stratification of ward patients.

Though previous literature has suggested that respiratory rate is the most accurate predictor of deterioration, this may not be true.[1] Respiratory rates manually recorded by clinical staff may contain information beyond pure physiology, such as a proxy of clinician concern, which may inflate the predictive value. Nursing staff may record standard respiratory rate values for patients that appear to be well (eg, 18) but count actual rates for those patients they suspect have a more severe disease, which is one possible explanation for our findings. In addition, automated assessments are likely to be more sensitive to intermittent fluctuations in respiratory rate associated with patient movement or emotion. This might explain the improved accuracy at higher rates for manually recorded vital signs.

Although limited by its small sample size, our results have important implications for patient monitoring and early warning scores designed to identify high-risk ward patients given that both simple scores and statistically derived models include respiratory rates as a predictor.[4] As hospitals move to use newer technologies to automate vital sign monitoring and decrease nursing workload, our findings suggest that accuracy for identifying high-risk patients may be lost. Additional methods for

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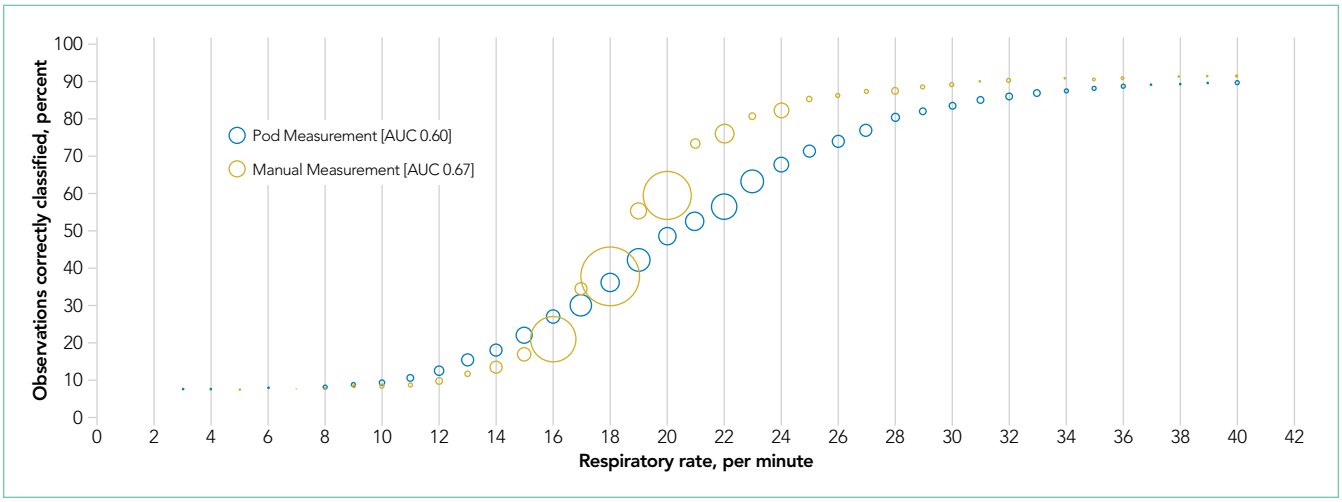

FIG. Accuracy of automated (pod) and manual respiratory rates across different respiratory rate thresholds. The graph illustrates the percent of observations correctly classified as being within 24 hours of intensive care unit transfer (y-axis) across different respiratory rate thresholds. For example, a manual respiratory rate threshold ≥20 correctly classified 59.4% of the observations compared to 48.6% for the automated (pod). The size of the circles is scaled to the number of observations with that respiratory rate value. As shown, the larger size of the 16, 18, and 20 values for the manual respiratory rates as compared to the automated values illustrates the overrepresentation of these values in the manual data.

capturing subjective assessments from clinical providers may be necessary and could be incorporated into risk scores.[5] For example, the 7-point subjective Patient Acuity Rating has been shown to augment the Modified Early Warning Score for predicting ICU transfer, rapid response activation, or cardiac arrest within 24 hours.[6]

Manually recorded respiratory rate may include information beyond pure physiology, which inflates its predictive value. This has important implications for the use of automated monitoring technology in hospitals and the integration of these measurements into early warning scores.

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TXT2STAYQUIT: Pilot Randomized Trial of Brief Automated Smoking Cessation Texting Intervention for Inpatient Smokers Discharged from the Hospital

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Hospitalization requires smokers to quit temporarily and offers healthcare professionals an opportunity to provide cessation treatment.[1] However, it is important that encouragement continues after the patient has been discharged from the hospital.[2] Studies have shown that text messaging interventions for smoking cessation are efficacious in increasing biochemically confirmed cessation rates at 6-month follow-up.[3-5] Utilizing technology such as automated voice calls postdischarge has been shown to increase smoking cessation rates; however, text messaging has not been applied to this population.[6] This randomized controlled trial of automated smoking cessation support at discharge, coupled with brief advice among hospital inpatients, aimed to assess whether text messaging is a feasible method for providing smoking cessation support and monitoring smoking status postdischarge.

METHODS

Six hundred fifty-five inpatients accepted cessation counseling, 248 were eligible for study participation (including smoking ≥20 cigarettes in 30 days prior to admission and being willing to make a quit attempt and send and/or receive texts), 158 consented to the study, and 140 were included in the analysis (participant removal from analysis was due to technical difficulties prohibiting the participants from receiving the intervention). Participants received texts via an automated system maintained through the College of Information Sciences and Technology at Pennsylvania State University starting at discharge and continuing for 1 month. Control participants received weekly text message smoking status questions. Intervention participants received weekly smoking status questions in addition to daily smoking cessation tips and had the option to interact with the system for additional support. Quit status was based on self-reported, past-week abstinence 28 days after discharge with subsample biochemical verification via carbon monoxide (CO) reading. Intent-to-treat analysis was utilized, and those who did not complete the follow-up phone call were classified as smokers.[7] Power was calculated based on the magnitude of change found in the largest published randomized controlled trial of texts for smoking cessation that reported results using a similar 28-day definition.[4] This study had 63% power to detect a difference in 28-day abstinence (measured using past 7-day abstinence) of 28.7% in the intervention group compared with 12.1% in the control group.

RESULTS

Participants were 60% female, 81% white, had a mean age of 42 years, and smoked an average of 14 cigarettes per day. Follow-up data were obtained for 115 participants (82% of the sample). Biochemical verification via CO reading <10 parts per million (ppm) was offered to 31 of the participants who self-reported having quit (n = 60). Ten participants refused biochemical verification, and 21 completed the CO reading. Three participants had a CO ≥10 ppm and were classified as smokers. Smoking cessation and text messaging system results can be found in the Table. Of participants, 56% (n = 78) responded to at least 4 of the 5 smoking status questions. Of the intervention group participants, 20% (n = 14) interacted with the text messaging system.

DISCUSSION

This study demonstrates that texting may be a feasible method for following up with hospitalized smokers postdischarge. A majority of participants responded to at least 4 of the 5 outcome questions. Additionally, participants in the intervention group who completed the 1-month follow-up were more likely than those in the control group to rate the texts favorably and to say that they would recommend similar texts to family or friends, indicating that those in the intervention group found the program helpful. However, a majority of participants in the control group also rated the texts favorably and reported they would recommend similar texts to friends or family. This implies that the limited texts provided to the control group may have provided more benefit than researchers previously anticipated.

This study also illustrates the importance of biochemical verification of quit status. Of participants who completed CO verification, 14% did not meet the requirement to be classified as nonsmokers. Other studies of text messaging interventions, including Abroms et al.[3] and Free et al.,[4] utilized biochemical verification via salivary cotinine and found that of participants

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TABLE. **Smoking Cessation and Text Messaging System Outcomes**

Outcome Measure	Overall (n = 140)	Control (n = 70)	Intervention (n = 70)	*P* value
Quit at 1-month follow-up, n (%)[a]	57 (40.7)	26 (37.1)	31 (44.3)	.390
Responded to all outcome questions, n (%)	49 (35.0)	36 (51.4)	13 (18.6)	<.0001
Texted "stop" during program, n (%)	12 (8.6)	2 (2.9)	10 (14.3)	.016
Rated texts as "satisfactory," "good," or "excellent," n (%)[b,c,d]	103 (90.4)	44 (83.0)	59 (96.7)	.014
Would recommend similar texts to family and/or friends, n (%)[b,c]	100 (87.7)	43 (81.1)	57 (93.4)	.046
Reported reading all messages, n (%)[b,c]	96 (84.2)	46 (86.8)	50 (82.0)	.481

[a]Intent-to-treat analysis was with biochemical verification of 21 participants.
[b]Data were only available for those who completed the 1-month follow-up (N = 115 [control n = 53; intervention n = 61]).
[c]Intervention, n = 60.
[d]Compared to response of "poor."

who self-reported having quit at follow-up, 24.4% and 28% failed the verification, respectively. In the current study, 10 participants refused verification. It is possible that those who were unwilling to comply may not truly have quit.

While researchers have found that text messaging interventions are efficacious, they have not applied them to an inpatient setting. A limitation is that 62% (n = 407) of the patients counseled were ineligible, and 36% (n = 90) of those who were eligible were not interested in participating. This may indicate that the intervention format is of interest to a limited audience that is already familiar with text messaging. Another limitation is that this was a pilot study conducted with limited power. However, it does provide useful preliminary data for consideration in the development of future text-based smoking cessation interventions.

In conclusion, this study shows that automated text messaging may be a feasible way to monitor smoking status as well as provide smoking cessation support after smokers are discharged from the hospital.

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Hospital Readmissions in Patients with Cirrhosis: A Systematic Review

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BACKGROUND: Hospital readmission is a significant problem for patients with complex chronic illnesses such as liver cirrhosis.

PURPOSE: We aimed to describe the range of readmission risk in patients with cirrhosis and the impact of the model for end-stage liver disease (MELD) score.

DATA SOURCES: We conducted a systematic review of studies identified in Ovid MEDLINE, PubMed, EMBASE, CINAHL, the Cochrane Library, Scopus, Google Scholar, and ClinicalTrials.gov from 2000 to May 2017.

STUDY SELECTION: We examined studies that reported early readmissions (up to 90 days) in patients with cirrhosis. Studies were excluded if they did not examine the association between readmission and at least 1 variable or intervention.

DATA EXTRACTION: Two reviewers independently extracted data on study design, setting, population, interventions, comparisons, and detailed information on readmissions.

DATA SYNTHESIS: Of the 1363 records reviewed, 26 studies met the inclusion and exclusion criteria. Of these studies, 21 were retrospective, and there was significant variation in the inclusion and exclusion criteria. The pooled estimate of 30-day readmissions was 26%(95% confidence interval [CI], 22%-30%). Few studies examined readmission preventability or the relationship between readmissions and social determinants of health. Reasons for readmission were highly variable. An increased MELD score was associated with readmissions in most studies. Readmission was associated with increased mortality.

CONCLUSION: Hospital readmissions frequently occur in patients with cirrhosis and are associated with liver disease severity. The impact of functional and social factors on readmissions is unclear. *Journal of Hospital Medicine* 2018;13:490-495. Published online first April 25, 2018. © 2018 Society of Hospital Medicine

Cirrhosis is a morbid condition characterized by complications such as ascites, gastrointestinal bleeding, and hepatic encephalopathy. These complications frequently require hospitalization, which is a substantial burden to the healthcare system. In 2012, liver disease was responsible for nearly 250,000 admissions across the United States, costing $3 billion.[1] Despite this substantial resource utilization, outcomes remain poor, with an inpatient mortality of 6%. For those that survive, many experience hospital readmission.

More generally, early readmission reflects poor quality of care in the US. In 2004, 30-day readmissions occurred in nearly 20% of Medicare beneficiaries and costed over $17 billion.[2] In response to this problem, the Affordable Care Act established the Hospital Readmissions Reduction Program (HRRP), which reduces Centers for Medicare & Medicaid Services (CMS) payments to hospitals with excess 30-day readmissions for high-risk conditions, including pneumonia and heart failure.[3] Heart failure, in particular, has been the subject of numerous studies detailing risk factors and interventions to predict and prevent readmission.[4-6] Based on this extensive evidence, guidelines recommend disease management programs to reduce readmissions in this population.[7] In contrast, readmission in the cirrhosis population has received limited attention.

We therefore conducted a systematic review aiming to examine the range of readmission risk noted in the literature, with a focus on the model for end-stage liver disease (MELD) score as a risk factor for readmission.

METHODS

Search Strategy

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines for conducting and reporting systematic reviews.[8] A literature search was performed by a medical librarian using the following databases: Ovid MEDLINE, PubMed, EMBASE, CINAHL, the full Cochrane Library, Scopus, Google Scholar, and ClinicalTrials.gov. All the databases were searched from 2000 to May 2017. We did not include older reports because the review focused on contemporary care; earlier studies may not reflect current cirrhosis management. To ensure literature saturation, included articles' reference lists were reviewed.

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Search strategies were developed by combining database-specific subject headings and keywords for readmissions with those for cirrhosis or its complications (Supplementary Material). Google Scholar and ClinicalTrials.gov were searched using keywords only. All results were limited to the English language and those published in 2000 or later, but no other limits were applied.

Identified records were reviewed based on strict criteria. We excluded case reports, case series, reviews, editorials, letters, and meeting abstracts without final peer-reviewed publication. We also excluded studies of pediatric populations (age < 18 years), patients without cirrhosis, and patients with liver transplants. We excluded studies in which patients were not hospitalized at study onset and those where the index admission was for an elective procedure. Because our interest was to identify factors associated with early readmission, we excluded studies that did not report readmissions within 90 days or those with a mean or median follow-up of less than 30 days. We also excluded studies that did not examine the association between readmission and at least 1 independent variable or intervention. Duplicate reports of a common sample were excluded unless the duplicate provided additional information, and such reports were examined together in our synthesis.

Two authors identified potentially eligible records by independently screening titles and abstracts. At this stage, records that did not meet the eligibility criteria were excluded, and the reasons for exclusion were not recorded. Records with disagreement were retained for full-text review. After this initial exclusion of records, the remaining full-text records were reviewed independently. For this full-text review, we recorded exclusion reasons and disagreements were resolved through discussion.

Data Collection

Data were abstracted from each study by 2 authors independently and recorded in a REDCap database.[9] Discrepancies were resolved through discussion. We recorded study characteristics, including study design, setting, population (including the inclusion/exclusion criteria, sample size, and patient and hospitalization characteristics), interventions, and comparisons. To facilitate comparisons across studies, we employed validated methods to approximate means and standard deviations (SD).[10] We recorded detailed information on outcomes including readmissions, preventability, independent variables, and mortality. Studies that focused on a single independent factor or intervention were classified as "focused," while those that examined multiple factors were classified as "broad." We used the Newcastle–Ottawa Scale to assess the risk of bias in each study.[11] This instrument uses a 9-point scale to gauge methodological quality based on selection, group comparability, and exposure/outcome assessment.

Statistical Analysis

Analyses were performed using Stata 13.1 (StataCorp LP, College Station, Texas). We determined the pooled proportion of patients with 30-day readmission using a random-effects model, with the Freeman–Tukey double-arcsine transformation for meta-analysis of proportions.[12] We investigated the heterogeneity by stratifying analyses according to prespecified study characteristics, including "broad" versus "focused." However, the readmission risk was not different in the stratified analysis; therefore, we chose to pool the findings. For point estimates, 95% confidence intervals (CIs) were calculated, and a *P*-value < .05 was considered statistically significant.

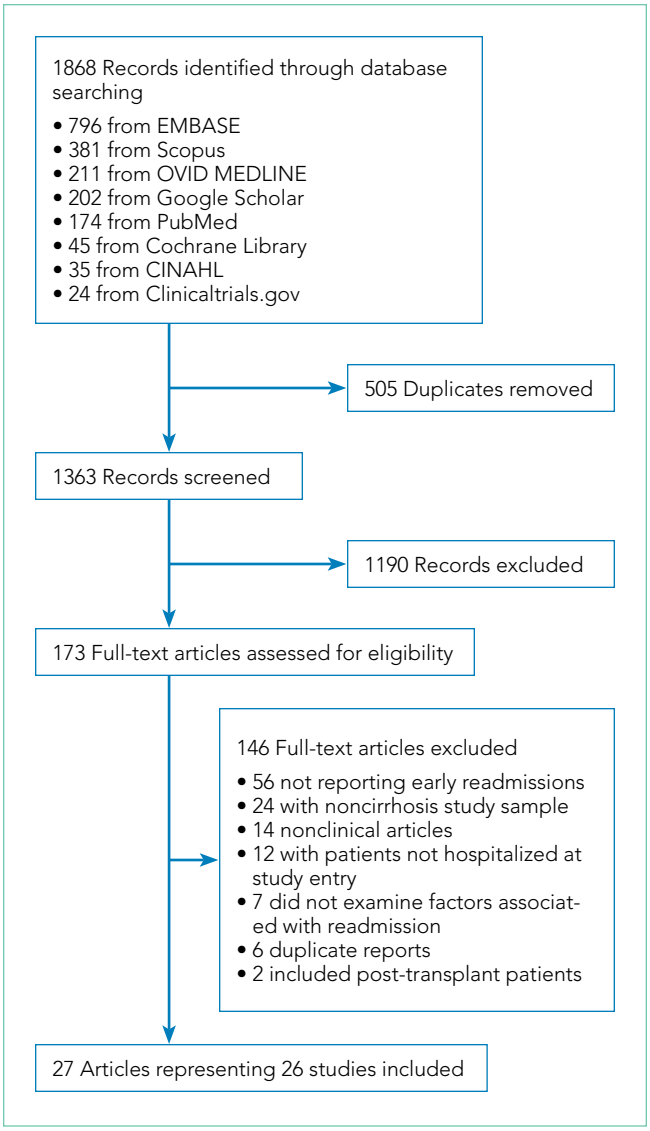

FIG 1. Study flow.

RESULTS

Search Results

The initial search yielded 1363 records, of which 173 full-text articles were assessed for eligibility. Twenty-seven articles representing 26 studies of 180,049 patients were included (Figure 1).[13-39]

Study Characteristics

Two studies were performed in Australia, 4 in Europe, and the remainder in North America. Twenty one of the 26 studies were

TABLE 1. **Study Characteristics**

Study	Study Design	Sample Size	Age (mean)	Males (%)	MELD (mean)	30-day Readmissions, 95% CI (%)
Bini 2001[13]	Prospective cohort	197	57	97	NR	20 (15–26)
Berman 2011[14]	Retrospective cohort	554	54	57	19	20 (17–24)
Johnson 2011[15]	Quasi-experimental	99	54	67	NR	27 (19–36)
Volk 2012[16]	Retrospective cohort	402	54	57	19	37 (32–42)
Barsuk 2013[17]	Retrospective cohort	502	57	60	23	44 (39–48)
Deitelzweig 2013[18]	Retrospective cohort	21,864	55	64	NR	28 (27–29)
Morando 2013[19]	Quasi-experimental	100	60	58	16	32 (23–41)
Singal 2013[20]	Retrospective cohort	836	53	68	15	27 (24–30)
Desai 2014[21]	Quasi-experimental	56	57	63	22	25 (16–38)
Fagan 2014[22]	Retrospective cohort	41	54	78	17	42 (29–58)
Gaduputi 2014[23]	Retrospective cohort	447	60	66	12	28 (24–32)
Ghaoui 2014/2015[24, 25]	Quasi-experimental	303	54	60	16	36 (31–42)
Agrawal 2015[26]	Retrospective cohort	111	59	98	14	27 (20–36)
Tapper 2015[27]	Retrospective cohort	734	57	62	18	32 (29–36)
Atla 2016[28]	Retrospective cohort	189	54	69	12	50 (43–57)
Bajaj 2016[29]	Prospective cohort	1013	57	64	18	NR
Courson 2016[30]	Retrospective cohort	149	59	60	20	24 (17–31)
Graupera 2016[31]	Prospective cohort	218	60	65	16	NR
Kanwal 2016[32]	Retrospective cohort	25,217	62	97	NR	14 (13–14)
Le 2016[33]	Retrospective cohort	302	57	69	15	29 (24–34)
Moon 2016[34]	Retrospective cohort	6451	61	97	12	22 (21–23)
Rassameehiran 2016[35]	Retrospective cohort	140	56	62	18	10 (6–16)
Tapper 2016[36]	Retrospective cohort	119,722	61	56	NR	13 (13–13)
Lyon 2017[37]	Retrospective cohort	226	57	62	21	10 (6–14)
Morales 2017[38]	Retrospective cohort	112	65	57	15	30 (22–39)
Strömdahl 2017[39]	Retrospective cohort	64	58	74	NR	19 (11–30)

Abbreviations: CI, confidence index; MELD, Model for End-Stage Liver Disease; NR, not reported.

retrospective cohort studies (Table 1). Twenty studies were single-center studies (of which half were performed at transplant centers), and 4 of the 6 multicenter studies were based on administrative data with large samples (173,254 patients). The inclusion/exclusion criteria varied widely (Supplementary Material). Some studies only included patients admitted for specific cirrhosis complications, while others included those admitted for any reason. Two studies excluded patients admitted in the prior 30 days, and 6 excluded patients discharged to hospice. The mean risk of bias score was 7.5 (SD 1.3) out of a possible 9 points, with most lacking an adequate description of follow-up and several lacking adjustment for confounders.

The mean age of patients ranged from 53 to 65 years, and males comprised 56%-78% (except for 4 Veterans Affairs studies). The mean MELD score ranged from 12 to 23. Hepatitis C accounted for 14%-100% of cirrhosis, alcohol accounted for 25%-67%, and nonalcoholic fatty liver disease accounted for 0%-20%. Hepatocellular carcinoma was present in 6%-30% of the patients. Reasons for the index admission varied widely and were dependent on the inclusion/exclusion criteria.

Outcomes

Thirty-day readmissions ranged from 10% to 50%, with a pooled estimate of 26% (95% CI, 22%-30%; Figure 2). Five

TABLE 2. **Comparison of MELD Scores According to Readmission Status**

		Index Admission MELD Score			Index Discharge MELD sScore		
Study	**Outcome**	**Not Readmitted**	**Readmitted**	***P* Value**	**Not Readmitted**	**Readmitted**	***P* Value**
Berman 2011[14]	30-day readmission	NR	NR		17.8 (6.4)	20.4 (8.5)	.001
Fagan 2014[22]	30-day readmission	14.5 (6.0)	18.9 (7.7)	.03	NR	NR	
Agrawal 2015[26]	30-day readmission	NR	NR		13.4 (4.5)	14.8 (4.6)	NS
Atla 2016[28]	30-day readmission	9.8 (3.2)	13.1 (6.7)	.001	NR	NR	
Bajaj 2016[29]	90-day readmission	17.2 (6.6)	19.0 (6.6)	.0001	16.3 (6.6)	18.7 (6.5)	.0001
Graupera 2016[31]	90-day readmission	15 (7)	18 (7)	.003	NR	NR	
Rassameehiran 2016[35]	90-day readmission	16.7 (7.0)	17.8 (6.4)	.41	NR	NR	
Morales 2017[38,a]	30-day readmission	NR	NR		13.8 (4.6)	16.9 (5.0)	.002

[a]The study by Morales et al. examined the discharge MELD-sodium score in relation to 30-day readmission.
NR; not reported.

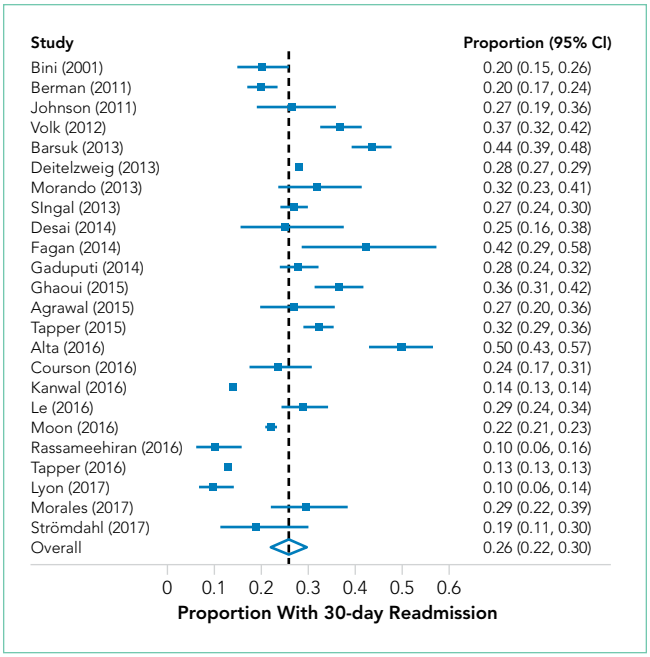

FIG 2. Forest plot of the proportion of patients with cirrhosis with a 30-day hospital readmission.

studies reported 90-day readmissions, ranging from 21% to 71%.[29,31,33,35,36] Only 4 of the 20 single-center studies captured readmissions at centers aside from the index admission hospital. Two studies assessed readmission preventability: 1 through independent chart review by 2 physicians (22% preventable), the other based on the judgement of 1 physician (37%).[16,26] Reasons for readmission were reported in 12 studies and were highly variable: hepatic encephalopathy in 6%-100%, ascites/volume overload in 2%-38%, and decompensated liver disease (without further elaboration) in 25%-100%. The studies that focused on single risk factors or interventions reported a wide range of possible readmission risk factors, ranging from biomarkers to clinical processes of care. Although multiple putative risk factors were reported, few conclusions can be drawn due to the heterogeneity in the findings. In 5 studies, 90-day mortality was reported and ranged from 10.3% to 18.6%. The relationship between readmission and subsequent mortality was examined in 5 studies, and all were statistically significant.[14,16,20,33,38]

Readmission and MELD

The MELD score was examined in numerous studies as a risk factor for readmissions and was found to be significantly associated with readmission in most studies (Table 2). Notably, even small differences in the MELD score are associated with a higher risk for readmission, though no cutoff point can be discerned. In addition, this association is seen regardless whether the MELD score is assessed at index admission or discharge. Several studies did not report the absolute differences in the MELD score listed in Table 2, but did find associations between increased MELD score and readmission in adjusted models.[16,20,27,34] One study found that a higher MELD score was associated with decreased readmissions over 6 months, but this study did not account for the competing risk of death.[37]

DISCUSSION

Hospital readmission is a costly and common problem in the US.[2] In addition to the negative impact that readmissions have on patients' lives,[40] readmissions are increasingly being used to measure quality. Unplanned 30-day readmissions are posted publicly, and excess readmissions for high-risk conditions are penalized through HRRP.[3] Although HRRP does not currently include cirrhosis, the program has expanded to include several conditions that were not included in the initial iteration. Whether cirrhosis will be included in future iterations remains to be seen; however, increasing scrutiny is likely to continue. Of specific populations at risk, patients with cirrhosis are particularly vulnerable due to several features. Ascites management

often requires hospitalization due to diuretic titration and poor access to paracentesis, and hepatic encephalopathy treatment requires complex lactulose titration.[16] Other features of cirrhosis, such as gastrointestinal bleeding, infections, and renal failure, also place patients at risk of poor outcomes. The resulting readmission burden is high, with a pooled 30-day readmission rate of 26%. Other associated outcomes are also poor, with a consistent relationship between readmission and subsequent mortality.

We found striking heterogeneity in various aspects. First, the inclusion/exclusion criteria varied widely, both cirrhosis-specific (eg, spontaneous bacterial peritonitis) and more general (patients admitted within the prior 30 days). Some of these criteria may bias readmission estimates; the risk of readmission may be reduced in those on hospice, as patients forgo curative therapy. Additionally, an established risk factor for readmission is prior hospitalization[41]; excluding patients with prior admissions prohibits analysis of this variable. Another aspect is the capture of readmissions: readmissions outside of the index hospital were not included in most studies. In those that did include outside readmissions, the burden was sizeable: 17% in 1 single-center study and 23% in a multistate administrative database.[16,36] These outside readmissions must be included in future studies; they are as important as same-center readmissions both to patients and CMS.[3] Despite this heterogeneity, the studies scored relatively high on the Newcastle–Ottawa risk of bias scale, with the only common deficiency being an inadequate description of follow-up.

Building on the findings of this review, an important step will be the design of interventions to reduce readmissions. Such interventions require a full understanding of this population's characteristics and needs. Critically, we found a lack of data on social determinants of health. Impairments in these factors are well-established contributors to readmission risk in other populations,[4,40] and are highly prevalent in cirrhosis.[42] Indeed, CMS has focused resources toward social determinants of health in the effort to reduce utilization and improve outcomes. This lack of data on social determinants of health, as well as other understudied factors, represents an important opportunity for future research efforts to better define the modifiable features that could be targeted in the future to prevent readmissions. Such research is urgently needed and will likely require prospective studies to gather these important factors. Notably, most studies in this systematic review were retrospective and therefore unable to examine many of these understudied factors. Another important aspect that has received little attention is readmission preventability: only 2 studies assessed preventability, both through unstructured chart review. Preventability assessments in noncirrhotic populations have used wide-ranging methodologies, yielding inconsistent results.[43] This variability prompted recommendations that preventability should be assessed by multiple reviewers guided by explicit parameters.[43] Such detailed attention to preventability is urgently needed to better inform interventions.

In contrast to the lack of data on social factors, we found that the MELD score was examined in most studies and was frequently associated with readmission. Despite this consistent association, differences in the MELD scores between studies limit inferences into specific cutoff values that could identify the highest risk patients. Because of its existing widespread clinical use, the MELD score may prove to be important in readmission risk stratification. Efforts to develop a useful model including the MELD score are needed to target interventions to the highest risk patients.

This review has several limitations. Although we used a broad search strategy to capture studies, some may not have been included due to our selection criteria. For instance, 1 retrospective paper described factors associated with high admission density during 1 year but did not specifically report the frequency of early readmissions.[44] Similarly, a randomized trial of a disease management program did not specifically examine early readmissions.[45] Another quasi-experimental study of a quality improvement initiative was not included because a large proportion of their subjects was post liver transplant.[46] However, the inclusion of these papers is unlikely to change our conclusions; the retrospective study identified factors similar to those in the included studies, and the quasi-experimental study overlapped with the included study that assessed frailty.[27] Another potential limitation is the exclusion of studies published in abstract form only. Such studies may be important, as the field of cirrhosis readmissions is relatively young. However, including only full-paper publications ensures the inclusion of only higher quality studies scrutinized during the peer-review process. Similarly, newer published studies may have been missed due to the abundant interest in this topic and ongoing research. Lastly, the significant heterogeneity of the studies limits conclusions that can be made regarding the pooled readmission rates.

In summary, we found that patients with cirrhosis experience a high incidence of hospital readmissions. Several processes of care may be associated with readmissions, suggesting room for improvement in caring for this population and reducing readmissions. However, we identified several gaps in the literature, which does not adequately describe social factors and is lacking details on readmission preventability assessment. Future studies should attempt to address these issues so that interventions can be targeted to the highest risk patients and designed to best meet the needs of patients with cirrhosis.

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Things We Do For No Reason: Blood Cultures for Uncomplicated Skin and Soft Tissue Infections in Children

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Skin and soft tissue infections (SSTIs) are common pediatric diagnoses in both outpatient and inpatient settings. Blood cultures are frequently obtained for evaluation of SSTIs. Multiple studies have demonstrated that blood cultures rarely demonstrate true pathogenic bacterial growth, and even positive cultures do not change clinical management. Obtaining blood cultures has been associated with increased length of hospital stay. In addition, false-positive blood cultures may occur and result in repeat blood cultures and increased hospital charges. Clinicians should avoid obtaining blood cultures in pediatric patients with uncomplicated SSTIs but instead should focus on obtaining wound cultures when possible. *Journal of Hospital Medicine* 2018;13:496-499. © 2018 Society of Hospital Medicine

The "Things We Do for No Reason" (TWDFNR) series reviews practices that have become common parts of hospital care but 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.

CLINICAL SCENARIO

An 8-year-old previously healthy girl presented to the emergency department (ED) with 2 days of warmth, swelling, and pain over her right upper thigh. Three days prior before presentation, a "pimple" appeared on her leg and drained a small amount of pus. Over the next 24 hours, the lesion became swollen, red, and painful. Her pediatrician prescribed trimethoprim-sulfamethoxazole. The patient took 3 doses of this medication but still experienced worsening pain and swelling.

In the ED, she had normal vital signs for her age except for temperature of 100.8 °F. A 2 cm × 3 cm area of fluctuance, erythema, and warmth was noted, and bedside ultrasound demonstrated a simple fluid collection. Incision and drainage was performed with expression of several milliliters of pus. The patient was referred for admission due to worsening symptoms despite outpatient antibiotic therapy. The ED providers ordered a blood culture at the time of admission.

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BACKGROUND

Skin and soft tissue infections (SSTIs) are common pediatric diagnoses, which account for an estimated 390,000 ED visits annually[1] and represent the 7th most common reason for pediatric hospital admission in the United States.[2] The rates of SSTIs have increased over the past several decades partly due to the rise of methicillin-resistant *Staphylococcus aureus* (MRSA).[3]

WHY YOU MIGHT THINK BLOOD CULTURES ARE HELPFUL IN CHILDREN WITH SSTIS?

Prior to the introduction of the *Haemophilus influenzae* vaccine, the rates of SSTI-associated bacteremia ranged from 8% to 20%.[4,5] Although the rate of bacteremia has declined significantly, blood cultures are still commonly performed as part of the evaluation of uncomplicated SSTIs in children; studies have shown that blood culture rates are 46% in the combined outpatient/inpatient setting,[6] 34% in the ED setting,[7] and 47%-94% in the inpatient setting.[7-11] Clinicians still feel that bacteremia detection is important to guide the selection of antibiotics and treatment duration. Providers may also underestimate the risk of obtaining a contaminant result and associated charges. Lastly, clinicians may perform blood cultures due to cultural norms at their institution.

WHY BLOOD CULTURES ARE UNNECESSARY IN CHILDREN WITH UNCOMPLICATED SSTIS

Several decades into the post vaccine era, the current guidelines from the Infectious Diseases Society of America (IDSA) do not recommend blood cultures as part of the routine evaluation of uncomplicated SSTIs.[12] Multiple single-center studies have failed to demonstrate the benefits of obtaining blood cultures in pediatric patients with uncomplicated SSTIs in the post-*H. influenzae* vaccine era.[6–11]

Sadow et al[11] performed a retrospective case series of 381 children hospitalized with cellulitis to determine the rate and yield of blood cultures. Of the 266 (70%) patients who had a

blood culture performed, 5 (1.9%) were true positives and 13 (5.4%) were contaminants. Notably, the true positive results included 3 children with active varicella infection and 2 children with septic joints; the latter would qualify as a complicated SSTI or as a separate infectious process altogether. No significant change in management resulted the positive blood cultures.

Wathen et al[7] conducted a similar retrospective case series of 385 children with cellulitis who presented to the ED of a single tertiary-care children's hospital to determine the rate and yield of blood cultures. Of the 129 (33.5%) blood cultures performed, there were no true positives and 4 (3.1%) contaminants. Obtaining a blood culture was also associated with high rates of ordering complete blood count and hospitalization.

Malone et al[8] performed a retrospective case series of 580 children hospitalized with an SSTI at a single children's hospital to determine the yield of blood cultures for uncomplicated versus complicated SSTIs. Of the 482 patients with uncomplicated SSTIs, 455 (94.4%) had a blood culture, with no true positive cultures and 3 (0.7%) contaminants. Obtaining a blood culture in this study was associated with an almost 1 day increase in length of stay (LOS; mean LOS 3.24 vs 2.33 days, $P = .04$).

Parikh et al[6] conducted a retrospective cohort study of 304 children with SSTIs in both inpatient and outpatient settings to determine the yield and rate of blood cultures. Of this group, 140 (46.1%) patients had a blood culture performed, of which there were 3 (2.9%) true positives and 1 (0.7%) contaminant. True-positive bacteria included MRSA and *Streptococcus pyogenes*, neither of which was associated with a change in antibiotic regimen or increase in hospital LOS. The total charges associated with the original 140 blood cultures were estimated to be $42,450 annually in the authors' institution.

Lastly, Trenchs et al[9] performed a retrospective case series of 445 children hospitalized with SSTI in a Spanish children's hospital and found 353 (79.3%) blood cultures with 2 (0.6%) true positives and 10 (2.8%) contaminants. Methicillin-sensitive *Staphylococcus aureus* (MSSA) and *S. pyogenes* were the sole true-positive bacteria, and no change in management was reported. Obtaining blood cultures was associated with an increased hospital LOS (median LOS 4 vs. 3 days, $P < .001$).

Across these studies, the reported rates of true-positive blood cultures ranged from 0%-2.9%. Of the 1997 patients included in the studies, only 10 (0.5%) had true-positive blood cultures. This rate decreased to 0.4% if the 2 patients with septic arthritis from the study of Sadow et al were excluded. Isolated organisms included MRSA, MSSA, *S. pyogenes*, and *Streptococcus pneumoniae*. No unusual organisms were isolated in uncomplicated SSTIs, and the true-positive results were not associated with any reported change in antibiotic management.[6–9,11] False-positive blood culture results were found in 0%-5.4% of patients,[6–9,11] accounting for 30 patients or 1.5% of the total patients.

HARMS ASSOCIATED WITH UNNECESSARY BLOOD CULTURES IN SSTIS

Blood cultures necessitate venipunctures, which are painful for children and families. The inevitable false-positive contaminants also lead to repeat venipunctures and, potentially, unnecessary antibiotic exposure. From a high-value care perspective, Parikh et al reported hospital charges of $300 per blood culture and $250 for identification and sensitivity of positives.[6] Assuming that these single-center charges are representative of national charges and using 0.5% true positivity and 1.5% false positivity rates, subjecting all children with uncomplicated SSTIs to blood culture would result in $60,250 charges to find one true positive blood culture, with no resultant changes in management. Additionally, among the 200 children cultured to find one true positive, there would be 3 false positives, necessitating another $1650 in charges for identification, sensitivity analysis, and repeat culture. These amounts do not factor in the significant expenditures associated with increased LOS. The potential savings associated with forgoing blood cultures in children with SSTIs should be an incentive for institutional change.

WHEN BLOOD CULTURES MAY BE REASONABLE

The current IDSA guidelines recommend blood cultures for SSTIs in patients with immunodeficiency, animal bites, and immersion injuries (soft tissue injuries occurring in fresh or saltwater).[12] Previous studies also delineated criteria for "complicated" SSTIs, typically defined as surgical or traumatic wounds, infections requiring surgical intervention (not including simple incision and drainage), or infected ulcers or burns.[8,9] In the study of Malone et al, 10 (12.5%) positives were found among 80 patients with complicated SSTIs who had blood cultures performed.[8] Although this work had a single-center study design with a relatively small sample size, no unusual organisms were found; the grown cultures included MRSA, MSSA, and *S. pneumoniae*. In addition to patients with complicated SSTIs, immunocompromised children, such as those receiving chemotherapy or other immunosuppressive agents, were excluded from the studies of blood culture yield in SSTIs and may warrant blood cultures given the risk of overwhelming infection and susceptibility to rare or invasive organisms.[12] In a study of 57 pediatric patients with leukemia and no central catheters who experienced skin or soft tissue complications, Demircioglu et al[13] reported 6 positive blood cultures, including *Klebsiella oxytoca*, *Pseudomonas aeruginosa*, and *Escherichia coli*. These organisms would not be covered by typical SSTI antibiotic regimens, illustrating the value of blood cultures in this selected group of patients. Lastly, although the above studies included some infants, the data on utility of blood cultures in neonates are limited. Blood cultures may be reasonable in this group given the relative immunocompromised state of neonates compared with older children. Additionally, any infants aged <90 days with SSTI and fever should be evaluated separately under existing febrile infant protocols.

WHAT YOU SHOULD DO INSTEAD OF BLOOD CULTURES FOR UNCOMPLICATED SSTIS

Gram stain and wound culture of any purulent material may assist with choice of empiric antibiotic therapy and appropriate narrowing of regimen for antibiotic stewardship. Wound cul-

TABLE 1. **Studies Reporting Blood Culture Yield in Children with Skin and Soft Tissue Infections**

Lead Author	Year	Study Design	Population	Setting	Outcome Measures	Results
Sadow[11]	1998	Retrospective case series	Children aged 2 days to 22 years hospitalized with cellulitis.	Single urban university-affiliated hospital in Washington, D.C.	Rate and yield of blood culture	266/381 (70%) had blood culture. 5 (1.9%) cultures were true positives. 13 (5.4%) were contaminants.
Wathen[7]	2013	Retrospective case series	Children aged 2 months to 18 years with ED diagnosis of cellulitis.	Single urban tertiary children's hospital ED in St. Louis	Rate and yield of blood culture	129/385 (33.5%) had blood culture. 0 were positive. 4 (3.1%) were contaminants.
Malone[8]	2013	Retrospective case series	Children aged 0 to 18 years hospitalized with SSTI.	Single urban tertiary children's hospital in Oklahoma	Yield of blood culture in uncomplicated vs. complicated SSTI	455/482 (94.4%) patients with uncomplicated SSTI had blood culture. 0 were positive. 3 (0.7%) were contaminants. 80/98 (81.6%) patients with complicated SSTI had blood culture. 10 (12.5%) were true positives. 1 (1.2%) was contaminant.
Parikh[6]	2014	Retrospective cohort	Children aged 6 months to 18 years with asthma, bronchiolitis, SSTI or pneumonia seen in clinic/ED or hospitalized.	Single urban, academic, quaternary children's hospital in Washington, D.C.	Rate and yield of blood culture	140/304 (46.1%) children hospitalized with SSTI had blood culture. 3 (2.9%) were true positives. 1 (0.7%) was contaminant.
Trenchs[9]	2015	Retrospective case series	Children aged 0 to 18 years hospitalized with SSTI.	Single urban, tertiary children's hospital in Barcelona, Spain	Rate and yield of blood culture	353/445 (79.3%) had blood culture. 2 (0.6%) were true positives. 10 (2.8%) were contaminants.

Abbreviations: ED, emergency department; IV, intravenous; SSTI, skin and soft tissue infection.

tures of purulent material can identify the causative organism in 58%-66% of the cases.[9,14] The rate of wound culture varies widely from 29% to 81% in studies across different healthcare systems.[9,10,15] The use of visually appealing posters advising clinicians to "culture pus, not blood" has been shown to significantly decreased the number of blood cultures performed at a single pediatric hospital.[10]

RECOMMENDATIONS

- Do not obtain blood cultures in pediatric patients with uncomplicated SSTIs.
- If purulent material is available spontaneously or after incision and drainage, then send it for Gram stain and bacterial culture.
- Blood cultures are reasonable in patients with complicated SSTIs and in immunocompromised patients with SSTIs.
- Despite limited data, blood cultures may be reasonable in neonates with SSTIs. Febrile infants with SSTIs aged less than 90 days should be managed under existing febrile infant guidelines.

CONCLUSIONS

Blood cultures in pediatric patients with uncomplicated SSTIs have no proven benefit and are associated with increased LOS, non-negligible false-positive rate, and associated increase in financial charges to the patient and healthcare system. The patient described in the clinical scenario would have an extremely low likelihood of having any meaningful clinical information provided by blood culture as part of her evaluation.

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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Tissue Isn't the Issue

The approach to clinical conundrums by an expert clinician is revealed through the presentation of an actual patient's case in an approach typical of a morning report. Similar to patient care, sequential pieces of information are provided to the clinician, who is unfamiliar with the case. The focus is on the thought processes of both the clinical team caring for the patient and the discussant.

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

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A 43-year-old man with a history of asplenia, hepatitis C, and nephrolithiasis reported right-flank pain. He described severe, sharp pain that came in waves and radiated to the right groin, associated with nausea and nonbloody emesis. He noted "pink urine" but no dysuria. He had 4prior similar episodes during which he had passed kidney stones, although stone analysis had never been performed. He denied having fevers or chills.

The patient had been involved in a remote motor vehicle accident complicated by splenic laceration, for which he underwent splenectomy. He was appropriately immunized. The patient also suffered from bipolar affective disorder and untreated chronic hepatitis C infection with no evidence of cirrhosis. He smoked one pack of tobacco per day for the last 10 years and reported distant alcohol and methamphetamine use.

Right-flank pain can arise from conditions affecting the lower thorax (effusion, pneumonia, pulmonary embolism), abdomen (hepatobiliary or intestinal disease), retroperitoneum (hemorrhage or infection), musculoskeletal system, peripheral nerves (herpes zoster), or the genitourinary system (pyelonephritis). Pain radiating to the groin, discolored urine (suggesting hematuria), and history of kidney stones increase the likelihood of renal colic from nephrolithiasis.

Less commonly, flank pain and hematuria may present as initial symptoms of renal cell carcinoma, renal infarction, or aortic dissection. The patient's immunosuppression from asplenia and active injection drug use could predispose him to septic emboli to his kidneys. Prior trauma causing aortic injury could predispose himto subsequent dissection.

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The patient appeared well with a heart rate of 100 beats per minute, blood pressure 122/76 mmHg, temperature 36.8°C, respiratory rate 16 breaths per minute, and oxygen saturation 96% on room air. His cardiopulmonary and abdominal examinations were normal, and he had no costovertebral angle tenderness. His skin was warm and dry without rashes. His white blood cell (WBC) count was 26,000/μL; absolute neutrophil count was 22,000/μL. Serum chemistries were normal, including creatinine 0.63 mg/dL, calcium 8.8 mg/dL, and phosphorus 3.1 mg/dL. Lactate was 0.8 mmol/L (reference range: 0-2.0 mmol/L). Urinalysis revealed large ketones, >50 red blood cells (RBC) per high power field (HPF), <5 WBC per HPF, 1+ calcium oxalate crystals and pH 6.0. A bedside ultrasound showed mild right hydronephrosis. Computed tomography (CT) with intravenous contrast of his abdomen and pelvis demonstrated diffuse, mildly prominent subcentimeter mesenteric lymphadenopathy and no kidney stones. He was treated with intravenous fluids and pain control, and was discharged with a presumptive diagnosis of a passed kidney stone.

A passed stone would not explain this degree of leukocytosis. The CT results reduce the likelihood of a renal neoplasm, renal infarction, or pyelonephritis. Mesenteric lymphadenopathy is nonspecific, but it may signal underlying infection or malignancy with spread to lymph nodes, or it may be part of a systemic disorder causing generalized lymphadenopathy. Malignant causes of mesenteric lymphadenopathy (with no apparent primary tumor) include testicular cancer, lymphoma, and primary urogenital neoplasms.

His flank pain resolved over the next few days. One week later, he presented with fevers, diffuse headache, painful oral ulcers, pain in the knees and ankles, and a rash involving the face, trunk, and extremities. He was febrile to 38.1°C, normotensive, with an oxygen saturation of 96% on room air. He had erythema and swelling of the right eyelid and upper orbit, 2 shallow oral ulcers on the lower buccal mucosa, and bilateral, firm, nontender, 1-cm cervical lymphadenopathy. His visual acuity was normal. His

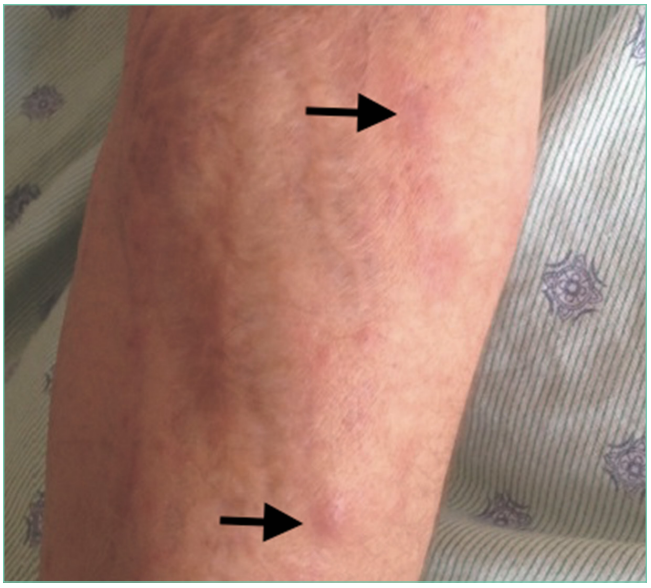

FIG 1. Erythematous papules and plaques

bilateral ankles and knees were warm and tender with small effusions but preserved range of motion. He had innumerable scattered erythematous papules with rare pustules, interspersed with large, erythematous plaques on his face, extremities, back, and buttocks with a predilection for previous scars and tattoos (Figure 1). He also had tender, erythematous nodules on his anterior lower extremities. His neurological exam was normal.

The lower extremity nodules are consistent with erythema nodosum, which may be observed in numerous infectious and noninfectious illnesses. The rapid tempo of this febrile illness mandates early consideration of infection. Splenectomized patients are at risk for overwhelming post-splenectomy infection from encapsulated organisms, although this risk is significantly mitigated with appropriate immunization. The patient is at risk of bacterial endocarditis, which could explain his fevers and polyarthritis, although plaques, pustules, and oral ulcers would be unusual. Disseminated gonococcal infection causes fevers, oral lesions, polyarthritis and pustular skin lesions, but plaques are uncommon. Disseminated mycobacterial and fungal infections may cause oral ulcers, but affected patients tend to be severely ill and have profound immunosuppression. Secondary syphilis may account for many of the findings; however, oral ulcers would be unusual, and the rash tends to be more widespread, with a predilection for the palms and soles. Human immunodeficiency virus (HIV) can cause oral ulcers and is the chief viral etiology to consider.

Noninfectious illnesses to consider include neoplasms and connective tissue diseases. Malignancy would be unlikely to manifest this abruptly or produce a paraneoplastic disorder with these features. Among the connective tissue diseases, sarcoidosis warrants consideration in this patient with adenopathy, erythema nodosum, arthritis, and a predilection for skin changes in prior scars. However, it is uncommon for sarcoidosis to present so explosively. Painful oral and genital ulcers, pustular rash, polyarthritis, and erythema nodosum occur in Behçet's disease, which is associated with pathergy (an exaggerated cutaneous response to minor trauma). Patients with Behçet's may have eye involvement, including uveitis and a hypopion, and may develop vascular aneurysms in the pulmonary, intracranial, or visceral arteries. Renal artery involvement could cause hematuria and flank pain.

The patient described severe fatigue and drenching night sweats for two months prior to admission. He denied dyspnea or cough. He was born in the southwestern United States and had lived in California for almost a decade. He had been incarcerated for a few years and released three years prior. He had intermittently lived in homeless shelters, but currently lived alone in downtown San Francisco. He had traveled remotely to the Caribbean, and more recently traveled frequently to the Central Valley in California. The patient formerly worked as a pipe-fitter and welder. He denied animal exposure or recent sick contacts. He was sexually active with women, and intermittently used barrier protection.

His years in the southwestern United States may have exposed the patient to blastomycosis or histoplasmosis; both can mimic mycobacterial disease. Blastomycosis demonstrates a slightly stronger predilection for spreading to the bones, genitourinary tract, and central nervous system, whereas histoplasmosis is a more frequent cause of polyarthrtitis and mesenteric adenopathy. The patient's travel to the Central Valley, California raises the possibility of coccidioidomycosis, which typically starts with pulmonary disease prior to dissemination to bones, skin, and other less common sites. Pipe-fitters are predisposed to asbestos-related illnesses, including lung cancer and mesothelioma, which would not explain this patient's presentation. Incarceration and high-risk sexual practices increase his risk for tuberculosis, HIV, and syphilis. Widespread skin involvement is more characteristic of syphilis or primary HIV infection than of disseminated fungal or mycobacterial infection.

WBC measured 29,000/uL with a neutrophilic predominance. His peripheral blood smear was unremarkable. A comprehensive metabolic panel was normal. Lactate dehydrogenase (LDH) was 317 U/L (reference range 140-280 U/L). Erythrocyte sedimentation rate (ESR) was 39 mm/hr (reference range < 20 mm/hr) and C-reactive protein (CRP) was 66 mg/L (reference range <6.3 mg/L). Blood, urine, and throat cultures were sent. Chest radiograph showed clear lungs without adenopathy. Ankle and knee radiographs identified small effusions bilaterally without bony abnormalities. CT of his brain showed a small, hypodense lesion in the right lacrimal gland. A lumbar puncture with cerebrospinal fluid (CSF) analysis showed absence of RBCs; WBC, 2/μL; protein, 35 mg/dL; glucose, 62 mg/dL; negative gram stain. CSF bacterial and fungal cultures, venereal disease research laboratory (VDRL), herpes simplex virus

polymerase chain reaction (HSV PCR), and cryptococcal antigen were sent for laboratory analysis. The patient was started on vancomycin and aztreonam.

Lesions of the lacrimal gland feature multiple causes, including autoimmune diseases (Sjögren's, Behçet's disease), granulomatous diseases (sarcoidosis, granulomatosis with polyangiitis), neoplasms (salivary gland tumors, lymphoma), and infections. Initiating broad-spectrum antibiotics is reasonable while awaiting additional information from blood and urine cultures, serologies for HIV and syphilis, and purified protein derivative or interferon-gamma release assay (IGRA).

If these tests fail to reveal a diagnosis, the search for atypical infections and noninfectious possibilities should expand. Histoplasmosis and blastomycosis would be the most likely fungal diseases to account for his arthritis and adenopathy. Coccidioidomycosis is less likely in light of the normal chest radiograph. Computed tomography of the chest would be reasonable to look for adenopathy, which would strengthen the case for lymphoma or sarcoidosis, and may also identify a potential site to biopsy to establish these diagnoses.

The patient continued to have intermittent fevers, sweats, and malaise over the next 3 days. All bacterial and fungal cultures remained negative, and antibiotics were discontinued. Rheumatoid factor, anticyclic citrullinated peptide, antinuclear antibody, and cryoglobulins were negative. Serum C3, C4, and angiotensin-converting enzyme (ACE) levels were normal. A rapid plasma reagin (RPR), HIV antibody, IGRA, and serum antibodies for Coccidioides, histoplasmosis, and West Nile virus were negative. Urine nucleic acid amplification testing for gonorrhea and chlamydia was negative. CSF VDRL, HSV PCR and cryptococcal antigen were negative. HSV culture from an oral ulcer showed no growth. The patient had a reactive hepatitis C antibody with a viral load of 3 million virus equivalents/mL.

The additional test results lower the likelihood of an acute infection. Uncontrolled hepatitis C increases the risk of several noninfectious manifestations. The normal results for serum complements and cryoglobulins effectively rule out cryoglobulinemia. Patients with hepatitis C have an increased risk of lymphoma, which could account for the subacute fevers, night sweats, adenopathy, elevated LDH, and the right orbital mass, but less likely for the oral ulcers, arthritis, and skin manifestations. Sarcoidosis is less likely given the lack of hilar adenopathy, relatively abrupt onset of multisystem disease, and the presence of oral ulcers. Behçet's disease could account for his oral ulcers, erythema nodosum, and distribution of papules, pustules, and plaques with the predilection for scars and tattoos. Behçet's could also explain the arthritis, the hematuria if the patient had renal artery involvement, and the orbital lesion. However, lymphadenopathy is not a prominent feature. At this point, tissue should be obtained for histopathology (to assess for vasculitis or granulomatous infiltration) and flow cytometry.

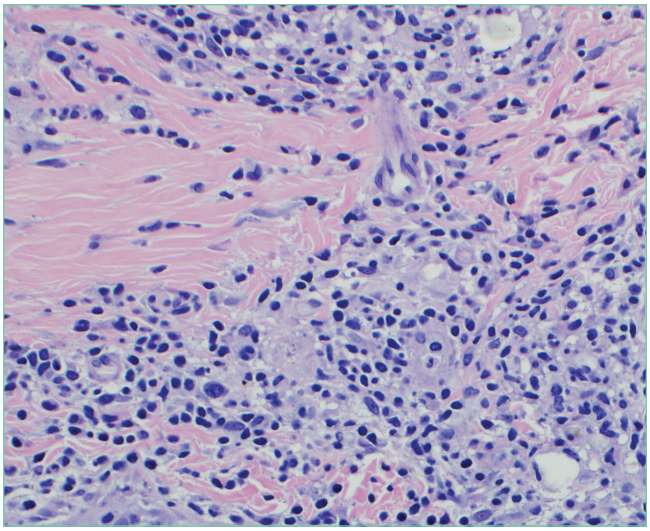

FIG 2. Inflammation at the interface of the dermis and the subcutis with neutrophils, histiocytes and fatty microcysts.

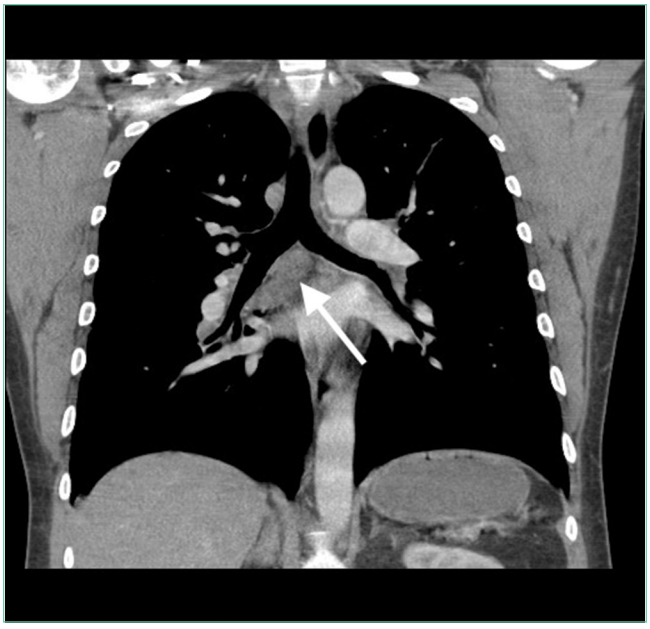

FIG 3. Noncontrast chest computed tomography (CT) showing subcarinal lymphadenopathy (arrow)

Biopsies of the skin plaques associated with old scars revealed granulomatous infiltrates. Fine-needle aspiration (FNA) of a submental lymph node showed benign lymphoid tissue; flow cytometry was negative for malignancy. Punch biopsy of the right anterior thigh nodule demonstrated superficial and deep perivascular infiltrate of lymphocytes in the dermis and superficial subcutis, and inflammation at the interface of the dermis and the subcutis with neutrophils, histiocytes, and fatty microcysts (Figure 2). All biopsies stained negative for fungi and mycobacteria. High-resolution CT scan of the chest demonstrated increased number and size of multiple lymph nodes of the mediastinum, hila, and upper abdomen (Figure 3).

Biopsy results and flow cytometry substantially lower the probability of lymphoma. The presence of granulomas on skin biopsy and the extensive lymphadenopathy are not characteristic of Behçet's. Biopsy from the leg describes erythema nodosum.

The most likely diagnosis is Löfgren's syndrome, a variant of sarcoidosis characterized by erythema nodosum, bilateral hilar lymphadenopathy, and polyarthralgias or polyarthritis. Löfgren's syndrome may include fevers, uveitis, widespread skin lesions and other systemic manifestations. Sarcoidosis could explain the lacrimal gland lesion, and could manifest with recurrent kidney stones. Oral lesions may occur in sarcoidosis. A normal serum ACE level may be observed in up to half of patients. The lack of visualized granulomas on the submental node FNA may reflect sampling error, lower likelihood of visualizing granulomas on FNA (compared with excisional biopsy), or biopsy location (hilar nodes are more likely to demonstrate sarcoid granulomas).

Although Löfgren's syndrome is often self-limited, treatment can ameliorate symptoms. Nonsteroidal anti-inflammatory medication can be tried first, with prednisone reserved for refractory cases.

The constellation of bilateral hilar adenopathy, arthritis, and erythema nodosum was consistent with Löfgren's syndrome, further supported by granulomatous infiltrates on biopsy. The patient's symptoms resolved with naproxen. He was scheduled for follow-up in dermatology and rheumatology clinics and was referred to hepatology for management of hepatitis C.

COMMENTARY

Sarcoidosis is a multisystem granulomatous disease of unclear etiology. The disease derives its name from Boeck's 1899 report describing benign cutaneous lesions that resembled sarcomas.[1] Sarcoidosis most commonly manifests as bilateral hilar adenopathy and pulmonary infiltrates, but may impact any tissue or organ, including the eyes, nonhilar lymph nodes, liver, spleen, joints, mucous membranes, and skin. Nephrolithiasis may result from hypercalcemia and/or hypercalciuria (related to granulomatous production of 1,25 vitamin D) and can be the presenting feature of sarcoidosis.[2] Less common presentations include neurologic sarcoidosis (which can present with seizures, aseptic meningitis, encephalopathy, neuroendocrine dysfunction, myelopathy and peripheral neuropathies), cardiac sarcoidosis (which may present with arrhythmias, valvular dysfunction, heart failure, ischemia, or pericardial disease), and Heerfordt syndrome (the constellation of parotid gland enlargement, facial palsy, anterior uveitis, and fever). Sarcoidosis may mimic other diseases, including malignancy, idiopathic pulmonary fibrosis, and infiltrative tuberculosis.[3] Sarcoidosis-like reactions have occurred in response to malignancy and medications.[4]

The patient's rash demonstrated a predilection for areas of prior scarring, which has a limited differential diagnosis. Keloids and hypertrophic scars occur at sites of former surgical wounds, lacerations, or areas of inflammation. Pruritic urticarial papules and plaques of pregnancy (PUPPP) is a benign inflammatory condition where papules cluster in areas of prior striae. Cutaneous lesions of Behçet's syndrome display pathergy, where pustular response is observed at sites of injury. Granulomatous infiltration in sarcoidosis may demonstrate a predilection for scars and tattoos (ie, scar or tattoo sarcoidosis).[5] Sarcoidosis can have other cutaneous manifestations, including psoriaform, ulcerative, or erythrodermic lesions; subcutaneous nodules; scarring or nonscarring alopecia; and lupus pernio – violaceous, nodular and plaque-like lesions on the nose, earlobes, cheeks, and digits.[5]

Löfgren's syndrome is a distinct variant of sarcoidosis. In 1952, Dr. Löfgren described a case series of patients with bilateral hilar lymphadenopathy and coexisting erythema nodosum and polyarthralgia.[6] The epidemiology favors young women.[7] Patients with Löfgren's syndrome present acutely (as in this case), which differs from the typical subacute course observed with sarcoidosis. In addition to the classic presentation described above, patients with Löfgren's syndrome may demonstrate additional manifestations of sarcoidosis, including fevers, peripheral adenopathy, arthritis, and granulomatous skin lesions. Painful symptoms may require short-term anti-inflammatory treatments. Most patients do not require systemic immunosuppression. Symptoms usually decrease over several months, and the majority of patients experience complete remission within years. Rare recurrences have been described up to several years.[8]

In confirming the diagnosis of sarcoidosis, current guidelines recommend exclusion of other diseases that present similarly, a work-up that generally includes compatible laboratory tests and imaging, and histologic demonstration of noncaseating granulomas.[9] However, Löfgren's syndrome is a notable exception. The constellation of fever, bilateral hilar adenopathy, polyarthralgia, and erythema nodosum suffices to diagnose Löfgren's syndrome as long as the disease remits rapidly and spontaneously.[9] Thus, in this case, although granulomatous infiltrates were confirmed on biopsy, the diagnosis of Löfgren's syndrome could have been based on clinical and radiologic features alone.

KEY LEARNING POINTS

- Sarcoidosis is a multisystem granulomatous disease that most commonly presents with bilateral hilar adenopathy and pulmonary infiltrates but can also present atypically, including with nephrolithiasis from hypercalcemia, neurologic syndromes, and cardiac involvement.
- Löfgren's syndrome, a variant of sarcoidosis, is characterized by relatively acute onset of fevers, erythema nodosum, bilateral hilar adenopathy, and polyarthralgia or polyarthritis. Most patients recover and manifest complete remission.
- A limited differential exists for rashes with a predilection for areas of tattoos and prior scarring, including keloids, PUPPP, Behçet's disease, and granulomatous infiltration.

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Value-Based Purchasing for Hospital-Acquired Venous Thromboembolism: Too Much, Too Soon

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As a hospital-acquired condition responsible for a significant share of preventable deaths in the United States,[1] venous thromboembolism (VTE) prevention should remain a high priority for healthcare organizations. Pursuant to the goal of reducing the frequency of this and other hospital-acquired conditions, several performance measures have been developed by third-party payers in the United States to provide incentives for inpatients to receive prophylaxis measures appropriate to their specific level of risk. Perhaps the best known of these is the Hospital Value-Based Purchasing Program, initiated by the Center for Medicare and Medicaid Studies (CMS) in 2013 as a provision of the Affordable Care Act.[2] The Joint Commission, as steward of the 6 VTE-related measures,[3] dictates the criteria for assessing performance. However, recent adjustments to one of these measures have been performed in such a way that neglects real-world considerations faced by providers and threatens to delegitimize the important role that value-based purchasing should have in reimbursement.

Effective in 2017, the guidelines pertaining to abstraction-based reporting added a new component to the VTE-6 measure, which applies to those inpatients not ordered to receive mechanical or pharmacologic prophylaxis who go on to suffer VTE. Specifically, it is concerned with how accurately hospitals stratify such patients as low risk before the decision is made to not order either method of prophylaxis. With the update, to satisfy the measure, a formal assessment confirming a patient's low-risk status must have been documented between arrival and the time the VTE diagnostic test was performed. The guidelines explicitly note that only 3 risk assessment models (RAMs) are accepted, including the Caprini DVT Prediction Score, Padua Prediction Score, and IMPROVE VTE Risk Score.[4] The rationale for this addition to the measure clearly is to protect patients from being incorrectly designated as low risk and subsequently receiving inadequate prophylaxis that could increase their likelihood of developing preventable VTE. Unfortunately, in its current form, it imposes a substantial burden on providers and healthcare organizations, without much promise of significantly reducing rates of this pervasive threat to patient safety.

LIMITATIONS

Although the aim of reducing the incidence of VTE is laudable, this updated requirement for VTE-6 is problematic on several levels. First, there is considerable uncertainty regarding how to implement the RAMs clinically in a user-friendly way that is conducive to their intended use. Due to limitations in most computerized physician order entry systems, it is not feasible to mandate the RAMs for only those patients not ordered for VTE prophylaxis (nor would it be sensible to restrict performing the assessment to low-risk patients, as the point of RAMs is to help risk stratify and not simply validate whatever determinations were already made by other means). As virtually every class of inpatient has some risk of VTE development, these factors effectively require that a score be tabulated on all admitted patients, giving the measure an enormous footprint on clinical operations. This is important because the permissible RAMs can sometimes be quite burdensome to complete faithfully. For instance, the Caprini Score necessitates the fairly prodigious collection and input of up to 26 data points. Some of the questions require exceedingly granular data, such as whether there is any "history of unexplained stillborn infant, recurrent spontaneous abortion (more than 3), premature birth with toxemia or growth restricted infant."[5] This clearly is far outside the scope of most focused admission assessments. Already deluged with the number of clicks inherent to the workflow of most electronic health records,[6] it seems likely that some providers default to selecting "no" for such prompts as a time-saving measure, potentially sabotaging the goal of linking patients with a risk-appropriate method of prophylaxis. Meanwhile, those who are diligent about completing the assessment honestly will find themselves rewarded with less time to dedicate to other critical aspects of patient care.[7]

The small number of RAMs accepted under the measure also fails to account for the breadth of clinical circumstances providers faced. Although the permitted models are validated in certain patient populations, they exclude some that might be better suited for many practice environments. The University of California San Diego "3 bucket" design, for instance, has been shown to result in high levels of risk-appropriate prophylaxis, has high inter-user agreement, and perhaps most importantly, is relatively quick and easy to use.[8] Also critical, it is easier to integrate into the admission workflow for under-resourced hospitals that might not have the ability to incorporate a point-based

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risk score calculator into their electronic health records.

Finally, the relative abruptness with which the changes were made complicated the task for institutions to integrate the RAMs into their applicable order sets in a user-friendly fashion. The new guidelines were released only 6 months before taking effect,[9] and the RAM requirement was not widely advertised. This left a fairly short window that does not seem to reflect an understanding by the Joint Commission of the process required by hospitals to make such a transition responsibly. This should involve obtaining inputs from multiple specialty stakeholders on which RAM to employ, working with information system specialists on how to restructure key order sets, and education of end-users on how to apply them correctly.[10]

RECOMMENDATIONS

For these reasons, the rollout of the VTE-6 update falls well short of its ambitions. Satisfying the measure necessitates a substantial investment of time and effort by providers and yet forcing the use of such decidedly imperfect RAMs could paradoxically worsen accurate risk stratification and appropriate use of prophylaxis. Also, while it represents only a small slice of pay-for-performance initiatives, its broader impact should not be underestimated. Unlike many of the more specific items, the VTE measures affect the workflow related to virtually all hospitalized patients. Therefore, it is imperative that regulators "get it right," as it might only take one poorly conceived mandate of this type to risk permanently souring providers and hospitals on the idea of value-based purchasing. The Joint Commission and CMS ought to seriously consider retracting the new provisions until the role of RAMs for VTE prevention is better understood. This would buy time to reconfigure the measure in a way that is compatible with actual clinical care and for hospitals to thoughtfully design how new requirements can best be implemented.

Disclosurses: The author has nothing to disclose.

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The Inpatient Blindside: Comorbid Mental Health Conditions and Readmissions among Hospitalized Children

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To ensure hospital quality, the Centers for Medicaid & Medicare Services have tied payments to performance measures, including readmissions.[1] One readmission metric, the Potentially Preventable Readmission measure (3M, PPR), was initially developed for Medicare and defined as readmissions related to an index admission, excluding those for treatment of cancer, related to trauma or burns, or following neonatal hospitalization. The PPR includes readmissions for both primary mental health conditions (MHCs) and for other hospitalizations with comorbid MHCs.[2] Although controversies surround equating a hospital's quality with its rate of readmissions, the PPR has been expanded to include numerous states. Since the PPR is also used for the Medicaid population in these states, it also measures pediatric readmissions. Hospitals in states adopting PPR calculations, including children's hospitals, must either meet these new quality metrics or risk financial penalties. In light of evidence of high readmission rates among adult patients with MHCs, several states have modified the PPR to exclude MHCs and claims for mental health services.[3–9]

In their study, "Mental Health Conditions and Unplanned Hospital Readmissions in Children," Doupnik et al. provided compelling evidence that MHCs in children (similar to adults) are closely associated with readmissions.[10] MHCs are possibly underappreciated risk factors for readmission penalties and therefore represent a necessary point for increased awareness. Doupnik et al. calculated 30-day unplanned hospital readmissions of children with versus without comorbid MHCs using another standard measure, the Pediatric All-Condition Readmission (PACR) measure. The PACR measure excludes index admissions with a MHC as primary diagnosis but includes children with comorbid MHCs.

Doupnik et al. used a nationally representative cohort of all index hospitalizations of children aged 3–21 years from the 2013 Nationwide Readmission Database that allowed for estimates of MHC prevalence in the study population.[11] A comorbid MHC was identified in almost 1 in 5 medical admissions and 1 in 7 procedural admissions. Comorbid substance abuse was identified in 5.4% of medical admissions and 4.7% of procedure admissions, making this diagnosis the most frequently coded stand-alone MHC. The authors' findings are particularly noteworthy given that diagnosis of MHCs is highly dependent upon coding and is therefore almost certainly underreported. In pediatric inpatient populations, the true prevalence of comorbid MHCs is probably higher.

Doupnik et al. observed that comorbid MHCs are a significant risk factor for readmission. After adjustment for demographic, clinical, and hospital characteristics, children with MHCs presented a nearly 25% higher chance of readmission for both medical and procedural hospitalizations. Children admitted with medical conditions and multiple MHCs yielded odds of readmission 50% higher than that of children without MHCs. Overall, the presence of MHCs was associated with more than 2,500 medical and 200 procedure readmissions.

Previous studies in adult populations have also found that comorbid MHCs are an important risk factor for readmissions.[12,13] Other research describes that children with MHCs have increased hospital resource use, including longer lengths of stay and higher hospitalization costs.[14-17] Further, children with MHCs as a primary diagnosis are more prone to readmission, with readmission rates approaching those observed in children with medical complexity in some cases.[18,19] MHCs are common among hospitalized children and have become an increasingly present comorbidity in primary medical or surgical admissions.[17]

One particular strength of this study lies in its description of the relationship between comorbid (not primary) MHCs and readmission following medical or surgical procedures in hospitalized children. This relationship has been examined in adult inpatient populations but less so in pediatric inpatient populations.[12,13] This study provides insights into the relationships between specific MHCs and unplanned readmissions for certain primary medical or surgical diagnoses, including those for attention deficit disorder and autism that are not well-recognized in adult populations.

High-quality inpatient pediatric practice depends not only upon recognition of concurrent MHCs during hospitalizations but also assurance of follow-up outside of such institutions. During the inpatient care of children, pediatric hospitalists often perform myopic inpatient care which fails to routinely address underlying MHCs.[20] For example, among children who are admitted with primary medical or procedure diagnoses, it is possible, or perhaps likely, that providers give little attention to an underlying MHC outside of continuation of a current

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medication. Comorbid MHCs are not accounted for within readmission calculations that directly affect hospital reimbursement. This study suggests that comorbid MHCs in hospitalized children may worsen readmission penalty status. In this manner, comorbid MHCs may represent a hospital's blindside.

We agree with Doupnik et al. that an integrated approach with medical and mental health professionals may improve the care of children with MHCs in hospitalized settings. This improvement in care may eventually affect hospital-level national quality metrics, such as readmissions. The findings of Doupnik et al. also provide a strong argument that pediatric inpatient providers should consider mental health consultations for patients with frequent admissions associated with chronic conditions, as comorbid MHCs are associated with worsened disease states and account for a disproportionate share of admissions for children with chronic conditions.[21,22] Recognition of comorbid MHCs may improve baseline chronic disease states for hospitalized children.

We assert that the current silos in inpatient pediatrics of medical and mental healthcare are outdated. Pediatric hospitalists need to assess for and access effective MHC treatment options in the inpatient setting. In addition to the provision of mental health care within hospital settings, providers should also ensure that appropriate follow-up is arranged at the time of discharge. From a health policy standpoint, providers should clarify how both primary and comorbid MHCs are included within readmission measures while considering the close association of these conditions with readmission. Although the care of children with MHCs requires a long-term and coordinated approach, identification and treatment during hospitalization offer unique opportunities to modify outcomes of MHCs and coexistent medical and surgical diagnoses.

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ERRATUM TO: Cardiac Troponins in Low-Risk Pulmonary Embolism Patients: A Systematic Review and Meta-Analysis

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The authors would like to make the following corrections to their manuscript, Cardiac Troponins in Low-Risk Pulmonary Embolism Patients: A Systematic Review and Meta-Analysis (doi: 10.12788/jhm.2961), published online first April 25, 2018 (all corrections in bold):

- The last sentence of the results section in the abstract should read: The pooled likelihood ratios (LRs) for all-cause mortality were positive LR 2.04 [95% CI, 1.53 to 2.72] and negative LR **0.72** [95% CI, 0.37 to 1.40].
- In the "All studies pooled" of the last row of Table 2, Tn+ is corrected to **463**. See revised table below.
- On page E5, the first paragraph in the "Outcomes of Studies with Corresponding Troponin+ and Troponin–" section beginning with the fifth sentence should read as follows):

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"In the pooled data, **463 (67%)** patients tested negative for troponin and 228 **(33%)** tested positive. The overall mortality (from sensitivity analysis) including in-hospital, 30-day, and 90-day mortalities was 1.2%. The NPVs for all individual studies and the overall NPV are 1 or approximately 1. The overall PPVs and by study were low, ranging from 0 to 0.60. The PLRs and NLRs were not estimated for an outcome within an individual study if none of the patients experienced the outcome. When outcomes were only observed among troponin-negative patients, such as in the study of Moore (2009) who used 30-day all-cause mortality, the PLR had a value of zero. When outcomes were only observed among troponin-positive patients, as for 30-day all-cause mortality in the Hakemi[9](2015), Lauque[10] (2014), and Lankeit[16] (2011) studies, the NLR had a value of zero. For zero cells, a continuity correction of 0.5 was applied. The pooled likelihood ratios (LRs) for all-cause mortality were positive LR 2.04 [95% CI, 1.53 to 2.72] and negative LR **0.72** [95% CI, 0.37 to 1.40]. The OR for all-cause mortality was 4.79 [95% CI 1.11 to 20.68, *P* = .0357].

TABLE 2. **Summary Measures of the Association between Troponin Classification and Overall 30-day All-cause Mortality and Stratified by Study**

Source	Low-risk PE Patients	Tn+	Tn-	PPV	NPV	PLR (95% CI)		NLR (95% CI) OR		Odds Ratio OR	Odds Ratio (95% CI)	Odds Ratio *P* Value
Ozsu et al.[8]	57	5	52									
90-day mortality	4	3	1	0.60	0.98	19.88	(4.56–86.66)	0.26	(0.05–1.42)	76.50	(5.31–1102.4)	.0014
Hakemi et al.[9]	173	84	89									
In-hospital mortality	4	4	0	0.05	1.00	1.90	(1.36–2.65)	0.19	(0.01–2.64)	10.01	(0.53–188.75)	.1243
Lauque et al.[10]	84	17	67									
30-day mortality	1	1	0	0.06	1.00	3.82	(1.54–9.48)	0.31	(0.03–3.44)	12.27	(0.48–315.11)	.1300
Ozsu et al.[13]	45	14	31									
30-day mortality	0	0	0	0.00	1.00	1.59	(0.21-11.79)	0.73	(0.10-5.23)	2.17	(0.04–114.99)	.7016
Sanchez et al.[14]	329	44	278									
30-day mortality	2	NS	NS	NS	NS	NS	—	NS	—	NS	—	—
Lankeit et al.[16]	198	71	127									
30-day mortality	1	1	0	0.01	1.00	2.11	(0.93–4.79)	0.39	(0.04-4.29)	5.43	(0.22–134.95)	.3024
Moores et al.[22]	191	42	149									
30-day mortality	1	0	1	0.00	0.99	1.12	(0.10–12.57)	0.97	(0.43-2.16)	1.16	(0.05–29.11)	.9260
All studies pooled[a]	691	228	**463**									
30-day mortality[b]	7	6	1	0.03	1.00	2.04	(1.53–2.72)	0.72	(0.37–1.40)	4.79	(1.11–20.68)	.0357
Sensitivity Analysis[c]						3.40	(1.81–6.37)	0.59	(0.33–1.08)	11.01	(3.38–35.92)	<.0001

[a]Total number of low risk PE patients, Tn+, Tn-

[b]Pooled estimates of PPV, NPV, PLR, NLR, and OR for 30-day all-cause mortality do not include data from the Ozsu[8] and Sanchez[14] studies.

[c]Includes the Ozsu 2015 study and assumes the 2 PE patients with mortalities in the Sanchez 2013 were from troponin positive

NOTE: Abbreviations: CI, confidence interval; NLR, negative likelihood ratio; NPV, negative predictive value; NS, data not supplied; PLR, positive likelihood ratio, PPV, positive predictive value.

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UHS Medical Group is a progressive multi-specialty group with a large primary care base, consisting of 200+ physicians providing care in over 20 medical and surgical specialties in multiple locations. The group is affiliated with United Health Services Hospitals, the regional leader in healthcare. We have an affiliation with Upstate Medical Center in Syracuse. The group has an opportunity for a residency trained Internal Medicine physician to practice as an Academic Hospitalist in a Regional Level II Trauma Center. Our team of physicians enjoy a work schedule of 7 on / 7 off for 10 hours each day. Primary role will be overseeing and teaching a resident service 12 months a year. A full compilation of subspecialty support is available including a closed ICU that is managed by the critical care team and we have a state of the art EMR. We offer a Competitive starting salary, Loan Forgiveness, Sign-On bonus, paid moving, CME, health and malpractice insurance provided and much more. UHS Hospitals are found in the tri-city area of Binghamton, NY which is home to Binghamton University. There are nearby locations for hiking, camping, fishing, and skiing as well as professional hockey and baseball.

Please contact
Lori Walling (607) 763-6392, lori_walling@uhs.org
to discuss this opportunity further.

Hospitalist Position in Picturesque Bridgton, Maine

Bridgton Hospital, part of the Central Maine Medical Family, seeks BE/BC Internist to join its well-established Hospitalist program. Candidates may choose part-time (7-8 shifts/month) to full-time (15 shifts/month) position. Located 45 miles west of Portland, Bridgton Hospital is located in the beautiful Lakes Region of Maine and boasts a wide array of outdoor activities including boating, kayaking, fishing, and skiing.

Benefits include medical student loan assistance, competitive salary, highly qualified colleagues and excellent quality of life. For more information visit our website at www.bridgtonhospital.org.

Interested candidates should contact Donna Lafean, CMMC Physician Recruitment, 300 Main Street, Lewiston, ME 04240; email: LafeanDo@cmhc.org; call: 800/445-7431; fax: 207/344-0658.

Bridgton Hospital
The Central Maine Medical Family

Dallas, Texas — Oncology and Hematologic Hospitalist Opportunities

The University of Texas Southwestern Medical Center, Department of Internal Medicine, Division of Hematology/Oncology, is seeking physicians to join a thriving oncology and hematologic malignancies program at the new William J Clements University Hospital. This state-of-the-art facility is the flagship of UT Southwestern's clinical and educational programs in dynamic and cosmopolitan Dallas, Texas. Applicants must have an M.D. degree, or equivalent, from an approved LCME medical school and satisfactory completion of an Internal Medicine residency program from an ACGME accredited program; individuals who have completed training in hematology and/or oncology are preferred and encouraged to apply as well. Level of appointment will be commensurate with experience. Candidate must be eligible for Texas medical licensure and be board certified in Internal Medicine.

Onco-Hospitalists will play a vital role in managing internal medicine issues in oncology and hematologic malignancies patients, as part of a multidisciplinary team providing comprehensive, cutting-edge therapy. Our goal is to grow the onco-hospitalist program into a true academic program, with meaningful collaborative clinical research between our Cancer Center physicians, fellows, and hospitalist team, and education of housestaff, students, and APPs.

Highlights of the position include:

- Salaries which are competitive with private oncology groups in Dallas and exceed academic programs elsewhere
- Faculty appointment at a top 20 medical school and research center that is home to 5 Nobel Prize winners
- Relocation allowance
- 403 (b), 457 and state-matched retirement accounts
- Incentive bonus payments
- Team based approach with individual dedicated support
- Dedicated advanced practice providers, pharmacists and discharge planners

Qualified applicants should submit a cover letter, curriculum vitae, three (3) references, and a summary of professional goals to:

Thomas Froehlich, M.D.
C/O Shawn Balusek, Division Administrator
UT Southwestern Medical Center
5323 Harry Hines Blvd.
Dallas, TX 75390-8852
or email **Shawn.Balusek@UTSouthwestern.edu**

UTSW is an Affirmative Action/Equal Opportunity Employer. Women, minorities, veterans and individuals with disabilities are encouraged to apply.

UTSouthwestern Medical Center

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- Excellence in Management in Hospital Medicine
- Outstanding Service in Hospital Medicine
- Clinical Leadership for Physicians
- Clinical Leadership for Nurse Practitioners and Physician Assistants
- Excellence in Humanitarian Services
- Excellence in Teamwork in Quality Improvement

Deadline for submissions is October 5, 2018.

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