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Numeracy, Health Literacy, Cognition, and 30-Day Readmissions among Patients with Heart Failure

Madeline R. Sterling, MD, MPH[1,2]*, Monika M. Safford, MD[1,2], Kathryn Goggins, MPH[3,4,5], Sam K. Nwosu, MS[6], Jonathan S. Schildcrout, PhD[6], Kenneth A. Wallston, PhD[7], Amanda S. Mixon, MD, MS, MSPH, FHM[3,8,9], Russell L. Rothman, MD, MPP[3,8], Sunil Kripalani, MD, MSc, SFHM[3,4,5,8] for the Vanderbilt Inpatient Cohort Study (VICS)

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BACKGROUND: Numeracy, health literacy, and cognition are important for chronic disease management. Prior studies have found them to be associated with poorer self-care and worse clinical outcomes, but limited data exists in the context of heart failure (HF), a condition that requires patients to monitor their weight, fluid intake, and dietary salt, especially in the posthospitalization period.

OBJECTIVE: To examine the relationship between numeracy, health literacy, and cognition with 30-day readmissions among patients hospitalized for acute decompensated HF (ADHF).

DESIGN/SETTING/PATIENTS: The Vanderbilt Inpatient Cohort Study is a prospective longitudinal study of adults hospitalized with acute coronary syndromes and/or ADHF. We studied 883 adults hospitalized with ADHF.

MEASUREMENTS: During their hospitalization, a baseline interview was performed in which demographic characteristics, numeracy, health literacy, and cognition were assessed. Through chart review, clinical characteristics were determined. The outcome of interest was 30-day readmission to any acute care hospital. To examine the association between numeracy, health literacy, cognition, and 30-day readmissions, multivariable Poisson (log-linear) regression was used.

RESULTS: Of the 883 patients admitted for ADHF, 23.8% (n = 210) were readmitted within 30 days; 33.9% of the study population had inadequate numeracy skills, 24.6% had inadequate/marginal literacy skills, and 53% had any cognitive impairment. Numeracy and cognition were not associated with 30-day readmissions. Though (objective) health literacy was associated with 30-day readmissions in unadjusted analyses, it was not in adjusted analyses.

CONCLUSIONS: Numeracy, health literacy, and cognition were not associated with 30-day readmission among this sample of patients hospitalized with ADHF. *Journal of Hospital Medicine* 2018;13:145-151. Published online first February 12, 2018. © 2018 Society of Hospital Medicine

Most studies to identify risk factors for readmission among patients with heart failure (HF) have focused on demographic and clinical characteristics.[1,2] Although easy to extract from administrative databases, this approach fails to capture the complex psychosocial and cognitive factors that influence the ability of HF patients to manage their disease in the postdischarge period, as depicted in the framework by Meyers et al.[3] (2014). To date, studies have found low health literacy, decreased social support, and cognitive impairment to be associated with health behaviors and outcomes among HF patients, including decreased self-care,[4] low HF-specific knowledge,[5] medication nonadherence,[6] hospitalizations,[7] and mortality.[8-10] Less, however, is known about the effect of numeracy on HF outcomes, such as 30-day readmission.

Numeracy, or quantitative literacy, refers to the ability to access, understand, and apply numerical data to health-related decisions.[11] It is estimated that 110 million people in the United States have limited numeracy skills.[12] Low numeracy is a risk factor for poor glycemic control among patients with diabetes,[13] medication adherence in HIV/AIDS,[14] and worse blood pressure control in hypertensives.[15] Much like these conditions, HF requires that patients understand, use, and act on numerical information. Maintaining a low-salt diet, monitoring

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weight, adjusting diuretic doses, and measuring blood pressure are tasks that HF patients are asked to perform on a daily or near-daily basis. These tasks are particularly important in the posthospitalization period and could be complicated by medication changes, which might create additional challenges for patients with inadequate numeracy. Additionally, cognitive impairment, which is a highly prevalent comorbid condition among adults with HF,[16,17] might impose additional barriers for those with inadequate numeracy who do not have adequate social support. However, to date, numeracy in the context of HF has not been well described.

Herein, we examined the effects of numeracy, alongside health literacy and cognition, on 30-day readmission risk among patients hospitalized for acute decompensated HF (ADHF).

METHODS

Study Design

The Vanderbilt Inpatient Cohort Study (VICS) is a prospective observational study of patients admitted with cardiovascular disease to Vanderbilt University Medical Center (VUMC), an academic tertiary care hospital. VICS was designed to investigate the impact of social determinants of health on postdischarge health outcomes. A detailed description of the study rationale, design, and methods is described elsewhere.[3]

Briefly, participants completed a baseline interview while hospitalized, and follow-up phone calls were conducted within 1 week of discharge, at 30 days, and at 90 days. At 30 and 90 days postdischarge, healthcare utilization was ascertained by review of medical records and patient report. Clinical data about the index hospitalization were also abstracted. The Vanderbilt University Institutional Review Board approved the study.

Study Population

Patients hospitalized from 2011 to 2015 with a likely diagnosis of acute coronary syndrome and/or ADHF, as determined by a physician's review of the medical record, were identified as potentially eligible. Research assistants assessed these patients for the presence of the following exclusion criteria: less than 18 years of age, non-English speaking, unstable psychiatric illness, a low likelihood of follow-up (eg, no reliable telephone number), on hospice, or otherwise too ill to complete an interview. Additionally, those with severe cognitive impairment, as assessed from the medical record (such as seeing a note describing dementia), and those with delirium, as assessed by the brief confusion assessment method, were excluded from enrollment in the study.[18,19] Those who died before discharge or during the 30-day follow-up period were excluded. For this analysis, we restricted our sample to only include participants who were hospitalized for ADHF.

Outcome Measure: 30-Day Readmission

The main outcome was all-cause readmission to any hospital within 30 days of discharge, as determined by patient interview, review of electronic medical records from VUMC, and review of outside hospital records.

Main Exposures: Numeracy, Health Literacy, and Cognitive Impairment

Numeracy was assessed with a 3-item version of the Subjective Numeracy Scale (SNS-3), which quantifies the patients perceived quantitative abilities.[20] Other authors have shown that the SNS-3 has a correlation coefficient of 0.88 with the full-length SNS-8 and a Cronbach's alpha of 0.78.[20-22] The SNS-3 is reported as the mean on a scale from 1 to 6, with higher scores reflecting higher numeracy.

Subjective health literacy was assessed by using the 3-item Brief Health Literacy Screen (BHLS).[23] Scores range from 3 to 15, with higher scores reflecting higher literacy. Objective health literacy was assessed with the short form of the Test of Functional Health Literacy in Adults (sTOFHLA).[24,25] Scores may be categorized as inadequate (0-16), marginal (17-22), or adequate (23-36).

We assessed cognition by using the 10-item Short Portable Mental Status Questionnaire (SPMSQ).[26] The SPMSQ, which describes a person's capacity for memory, structured thought, and orientation, has been validated and has demonstrated good reliability and validity.[27] Scores of 0 were considered to reflect intact cognition, and scores of 1 or more were considered to reflect any cognitive impairment, a scoring approach employed by other authors.[28] We used this approach, rather than the traditional scoring system developed by Pfeiffer et al.[26] (1975), because it would be the most sensitive to detect any cognitive impairment in the VICS cohort, which excluded those with severe cognition impairment, dementia, and delirium.

Covariates

During the hospitalization, participants completed an in-person interviewer-administered baseline assessment composed of demographic information, including age, self-reported race (white and nonwhite), educational attainment, home status (married, not married and living with someone, not married and living alone), and household income.

Clinical and diagnostic characteristics abstracted from the medical record included a medical history of HF, HF subtype (classified by left ventricular ejection fraction [LVEF]), coronary artery disease, chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM), and comorbidity burden as summarized by the van Walraven-Elixhauser score.[29,30] Depressive symptoms were assessed during the 2 weeks prior to the hospitalization by using the first 8 items of the Patient Health Questionnaire.[31] Scores ranged from 0 to 24, with higher scores reflecting more severe depressive symptoms. Laboratory values included estimated glomerular filtration rate (eGFR), hemoglobin (g/dl), sodium (mg/L), and brain natriuretic peptide (BNP) (pg/ml) from the last laboratory draw before discharge. Smoking status was also assessed (current and former/nonsmokers).

Hospitalization characteristics included length of stay in days, number of prior admissions in the last year, and transfer to the intensive care unit during the index admission.

Statistical Analysis

Descriptive statistics were used to summarize patient characteristics. The Kruskal-Wallis test and the Pearson χ^2 test were

used to determine the association between patient characteristics and levels of numeracy, literacy, and cognition separately. The unadjusted relationship between patient characteristics and 30-day readmission was assessed by using Wilcoxon rank sums tests for continuous variables and Pearson χ^2 tests for categorical variables. In addition, a correlation matrix was performed to assess the correlations between numeracy, health literacy, and cognition (supplementary Figure 1).

To examine the association between numeracy, health literacy, and cognition and 30-day readmissions, a series of multivariable Poisson (log-linear) regression models were fit.[32] Like other studies, numeracy, health literacy, and cognition were examined as categorical and continuous measures in models.[33] Each model was modified with a sandwich estimator for robust standard errors. Log-linear models were chosen over logistic regression models for ease of interpretation because (exponentiated) parameters correspond to risk ratios (RRs) as opposed to odds ratios. Furthermore, the fitting challenges associated with log-linear models when predicted probabilities are near 0 or 1 were not present in these analyses. Redundancy analyses were conducted to ensure that independent variables were not highly correlated with a linear combination of the other independent variables. To avoid case-wise deletion of records with missing covariates, we employed multiple imputation with 10 imputation samples by using predictive mean matching.[34,35] All analyses were conducted in R version 3.1.2 (The R Foundation, Vienna, Austria).[36]

RESULTS

Overall, 883 patients were included in this analysis (supplementary Figure 2). Of the 883 participants, 46% were female and 76% were white (Table 1). Their median age was 60 years (interdecile range [IDR] 39-78) and the median educational attainment was 13.5 years (IDR 11-18).

Characteristics of the study sample by levels of subjective numeracy, objective health literacy, and cognition are shown in Table 1. A total of 33.9% had inadequate health numeracy (SNS scores 1-3 on a scale of 1-6) with an overall mean subjective numeracy score of 4.3 (standard deviation ± 1.3). Patients with inadequate numeracy were more likely to be women, nonwhite, and have lower education and income. Overall, 24.6% of the study population had inadequate/marginal objective health literacy, which is similar to the 26.1% with inadequate health literacy by the subjective literacy scale (BHLS scores 3-9 on a scale of 3-15) (supplementary Table 1). Patients with inadequate objective health literacy were more likely to be older, nonwhite, have less education and income, and more comorbidities compared with those with marginal/adequate health literacy. Overall, 53% of participants had any cognitive impairment (SPMSQ score = 1 or greater). They were more likely to be older, female, have less education and income, a greater number of comorbidities, and a higher severity of HF during the index admission compared with those with intact cognition.

A total of 23.8% (n = 210) of patients were readmitted within 30 days of discharge (Table 2). There was no statistically significant difference in readmission by numeracy level ($P = .66$). Readmitted patients were more likely to have lower objective health literacy compared with those who were not readmitted (27.1 vs 28.3; $P = .04$). A higher percentage of readmitted patients were cognitively impaired (57%) compared with those not readmitted (51%); however, this difference was not statistically significant ($P = .11$). Readmitted patients did not differ from nonreadmitted patients by demographic factors (supplementary Table 2). They were, however, more likely to have a history of HF, COPD, diabetes, CKD, higher Elixhauser scores, lower eGFR and lower sodium prior to discharge, and a greater number of prior readmissions in the last 12 months compared with those who were not readmitted (all $P < .05$).

In unadjusted and adjusted analyses, no statistically significant associations were seen between numeracy and the risk of 30-day readmission (Table 3). Additionally, in the adjusted analyses, there was no statistically significant association between objective health literacy or cognition and 30-day readmission. (supplementary Table 3). In a fully adjusted model, a history of diabetes was associated with a 30% greater risk of 30-day readmission compared with patients without a history of diabetes (RR = 1.30; $P = .04$) (supplementary Table 3). Per a 13-point increase in the Elixhauser score, the risk of readmission within 30 days increased by approximately 21% (RR = 1.21; $P = .02$). Additionally, having 3 prior hospital admissions in the previous 12 months was associated with a 30% higher risk of readmission than having 2 or fewer prior hospital admissions (RR = 1.3; $P < .001$).

DISCUSSION

This is the first study to examine the effect of numeracy alongside literacy and cognition on 30-day readmission risk among patients hospitalized with ADHF. Overall, we found that 33.9% of participants had inadequate numeracy skills, and 24.6% had inadequate or marginal health literacy. In unadjusted and adjusted models, numeracy was not associated with 30-day readmission. Although (objective) low health literacy was associated with 30-day readmission in unadjusted models, it was not in adjusted models. Additionally, though 53% of participants had any cognitive impairment, readmission did not differ significantly by this factor. Taken together, these findings suggest that other factors may be greater determinants of 30-day readmissions among patients hospitalized for ADHF.

Only 1 other study has examined the effect of numeracy on readmission risk among patients hospitalized for HF. In this multicenter prospective study, McNaughton et al.[37] found low numeracy to be associated with higher odds of recidivism to the emergency department (ED) or hospital within 30 days. Our findings may differ from theirs for a few reasons. First, their study had a significantly higher percentage of individuals with low numeracy (55%) compared with ours (33.9%). This may be because they did not exclude individuals with severe cognitive impairment, and their patient population was of lower socioeconomic status (SES) than ours. Low SES is associated with higher 30-day readmissions among HF patients[1,10] throughout the literature, and low numeracy is associated with low SES in other diseas-

TABLE 1. **Characteristics of Study Participants Hospitalized for Acute Decompensated Heart Failure (ADHF) by Subjective Numeracy, Objective Health Literacy, and Cognition in the Vanderbilt Inpatient Cohort Study (VICS)**

			Numeracy (n = 881)			Health Literacy (n = 825)			Cognition (n =878)		
			Inadequate	Adequate	*P* Value	Inadequate/ Marginal	Adequate	*P* Value	Any Impairment	Intact Cognition	*P* Value
Patient Characteristics	**N**	**Overall**	**n = 299**	**n = 582**		**n = 203**	**n = 622**		**n = 462**	**n = 416**	
Socio-Demographic Characteristics											
Age, median (IDR)	883	60 (39, 78)	63 (43, 81)	60 (38, 77)	<.001	63 (43, 81)	60 (38, 77)	<.001	61 (42, 80)	60 (38, 76)	.04
Female, n (%)	883	410 (46%)	104 (45%)	304 (47%)	.69	104 (45%)	304 (47%)	.69	239 (52%)	168 (40%)	<.001
Race:Non-White, n (%)	882	212 (24%)	44 (19%)	166 (26%)	.05	44 (19%)	166 (26%)	.05	126 (27%)	84 (20%)	.01
Education, median (IDR)	882	13 (11, 18)	12 (9, 14)	14 (12, 18)	<.001	12 (9, 14)	14 (12, 18)	<.001	12 (10, 16)	14 (12, 18)	<.001
Income, median (IDR)	839	5 (2, 8)	4 (2, 7)	5 (2, 8)	<.001	4 (2, 7)	5 (2, 8)	<.001	5 (1, 7)	6 (2, 9)	<.001
Home Status, n (%)	881				.18			.18			.08
Married		475 (54%)	136 (59%)	339 (52%)		136 (59%)	339 (52%)		233 (51%)	241 (58%)	
Not Married, Living with Someone		209 (24%)	50 (22%)	157 (24%)		50 (22%)	157 (24%)		120 (26%)	88 (21%)	
Not Married, Living Alone		197 (22%)	44 (19%)	153 (24%)		44 (19%)	153 (24%)		108 (23%)	87 (21%)	
Clinical and Diagnostic Characteristics											
History of HF, n (%)	864	688 (80%)	182 (81%)	503 (79%)	.57	182 (81%)	503 (79%)	.57	363 (80%)	320 (79%)	.73
History of COPD, n (%)	883	242 (27%)	78 (34%)	164 (25%)	.01	78 (34%)	164 (25%)	.011	144 (31%)	97 (23%)	.01
History of CAD, n (%)	863	375 (43%)	113 (50%)	262 (41%)	.02	113 (50%)	262 (41%)	.02	202 (44%)	171 (42%)	.52
History of Diabetes, n (%)	864	377 (44%)	114 (51%)	261 (41%)	.01	114 (51%)	261 (41%)	.01	210 (46%)	163 (40%)	.08
Depression, median (IDR)	865	9 (3, 17)	10 (4, 19)	8 (3, 16)	<.001	10 (4, 19)	8 (3, 16)	<.001	9 (3, 17)	8 (3, 16)	.43
Elixhauser Score, median (IDR)	867	20 (10, 34)	22 (12, 34)	21 (10, 35)	.11	21 (11, 33)	20 (9, 34)	.34	22 (11, 34)	20 (10, 35)	.09
Ejection Fraction (%), median (IDR)	868	40 (15, 60)	45 (15, 60)	38 (15, 60)	.05	45 (15, 60)	38 (15, 60)	.05	42 (15, 60)	35 (15, 60)	.08
EGFR, median (IQR)	865	57 (25, 97)	49 (23, 92)	60 (26, 97)	<.001	49 (23, 92)	60 (26, 97)	.001	57 (26, 97)	58 (25, 97)	.76
Hemoglobin (g/dL), median (IDR)	862	12 (9, 15)	11 (9, 15)	12 (9, 15)	.07	11 (9, 15)	12 (9, 15)	.07	11 (9, 15)	12 (9, 15)	.01
Sodium(mg/L), median (IDR)	865	137 (132, 141)	137 (132, 142)	137 (132, 141)	.81	137 (132, 142)	137 (132, 141)	.81	137 (133, 141)	137 (132, 141)	.6
BNP(pg/mL), median (IDR)	791	620 (110, 2374)	669 (107, 2502)	611 (116, 2242)	.59	669 (107, 2502)	611 (116, 2242)	.59	616 (114, 2505)	620 (106, 2219)	.48
Current smoker, n (%)	858	110 (13%)	17% (80/290)	11% (60/568)	<.001	38 (17%)	72 (11%)	.03	43 (15%)	67 (11%)	.06
Hospitalization Characteristics											
Length of Stay (days), median (IDR)	883	4 (2, 13)	5 (2, 11)	4 (2, 13)	.31	5 (2, 11)	4 (2, 13)	.31	5 (2, 13)	4 (2, 12)	.16
Transfer to ICU, n (%)	864	198 (23%)	47 (21%)	150 (24%)	.41	47 (21%)	150 (24%)	.41	106 (23%)	92 (23%)	.83
Number Admissions Past 12 Months	877	1 (0, 5)	2 (0, 5)	1 (0, 5)	.06	2 (0, 5)	1 (0, 5)	.06	2 (0, 5)	1 (0, 5)	.23

NOTE: Continuous variables are summarized with the median and interdecile range: median (IDR). Categorical variables are summarized with the n and percentage: n (%). N is the number of nonmissing values. Income was considered a continuous variable, but the numbers represent ordinal categories: 1 = <$10,000; 2 = $10,000 to $14,999; 3 = $15,000 to $19,999; 4 = $20,000 to $24,999; 5 = $25,000 to $34,999; 6 = $35,000 to $49,999; 7 = $50,000 to $74,999; 8 = $75,000 to $99,999; 9 = $100,00. Educational attainment ranges from 1 year to 25 years. For associations with categorical variables, the Pearson χ^2 test was used. For associations with continuous variables, the Kruskal-Wallis test was used. Abbreviations: ADHF, acute decompensated heart failure; BNP, brain natriuretic peptide; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; eGFR, estimated glomerular filtration rate; HF, heart failure; ICU, intensive care unit; IDR, interdecile range; IQR, interquartile range; VICS, Vanderbilt Inpatient Cohort Study.

es.[13,38,39] Finally, they studied recidivism, which was defined as any unplanned return to the ED or hospital within 30 days of the index ED visit for acute HF. We only focused on 30-day readmissions, which also may explain why our results differed.

We found that health literacy was not associated with 30-day readmissions, which is consistent with the literature. Although an association between health literacy and mortality exists among adults with HF, several studies have not found an association between health literacy and 30- and 90-day readmission among adults hospitalized for HF.[8,9,40] Although we found an association between objective health literacy and 30-day readmission in unadjusted analyses, we did not find one in the multivariable model. This, along with our numeracy finding, suggests that numeracy and literacy may not be driving the 30-day readmission risk among patients hospitalized with ADHF.

We examined cognition alongside numeracy and literacy because it is a prevalent condition among HF patients and because it is associated with adverse outcomes among patients with HF, including readmission.[41,42] Studies have shown that HF preferentially affects certain cognitive domains,[43] some of which are vital to HF self-care activities. We found that 53% of patients had any cognitive impairment, which is consistent with the literature of adults hospitalized for ADHF.[44,45] Cognitive impairment was not, however, associated with 30-day readmissions. There

may be a couple reasons for this. First, we measured cognitive impairment with the SPMSQ, which, although widely used and well-validated, does not assess executive function, the domain most commonly affected in HF patients with cognitive impairment.[46] Second, patients with severe cognitive impairment and those with delirium were excluded from this study, which may have limited our ability to detect differences in readmission by this factor.

As in prior studies, we found that a history of DM and more hospitalizations in the prior year were independently associated with 30-day readmissions in fully adjusted models. Like other studies, in adjusted models, we found that LVEF and a history of HF were not independently associated with 30-day readmission.[47-49] This, however, is not surprising because recent studies have shown that, although HF patients are at risk for multiple hospitalizations, early readmission after a hospitalization for ADHF specifically is often because of reasons unrelated to HF or a non-cardiovascular cause in general.[50,51]

Although a negative study, several important themes emerged. First, while we were able to assess numeracy, health literacy, and cognition, none of these measures were HF-specific. It is possible that we did not see an effect on readmission because our instruments failed to assess domains specific to HF, such as monitoring weight changes, following a low-salt diet, and interpreting blood pressure. Currently, however, no HF-specific objective numeracy measure exists. With respect to health literacy, only 1 HF-specific measure exists,[52] although it was only recently developed and validated. Second, while numeracy may not be a driving influence of all-cause 30-day readmissions, it may be associated with other health behaviors and quality metrics that we did not examine here, such as self-care, medication adherence, and HF-specific readmissions. Third, it is likely that the progression of HF itself, as well as the clinical management of patients following discharge, contribute significantly to 30-day readmissions. Increased attention to predischarge processes for HF patients occurred at VUMC during the study period; close follow-up and evidence-directed therapies may have mitigated some of the expected associations. Finally, we were not able to assess numeracy of participants' primary caregivers who may help patients at home, especially postdischarge. Though a number of studies have examined the role of family caregivers in the management of HF,[53,54] none have examined numeracy levels of caregivers in the context of HF, and this may be worth doing in future studies.

TABLE 2. **30-Day Readmissions by Numeracy, Health Literacy, and Cognition among Participants Hospitalized for ADHF in the VICS**

		Overall	No Readmission	Readmission	
	N	N = 883	N = 673	N = 210	*P* Value
Numeracy					
Numeracy category	881				.75
Inadequate		299 (34%)	230 (34%)	69 (33%)	
Adequate		582 (66%)	442 (66%)	140 (67%)	
Numeracy score	881	4 (2-6)	4 (2-6)	5 (2-6)	.66
Health literacy					
Subjective literacy category (BHLS)	880				.67
Inadequate		230 (26%)	178 (26%)	52 (25%)	
Adequate		650 (74%)	494 (74%)	156 (75%)	
BHLS	881	12 (7-15)	12 (7-15)	12 (6-15)	.52
Objective literacy category (sTOFHLA)	825				.11
Inadequate		127 (15%)	89 (14%)	38 (19%)	
Marginal		76 (9%)	63 (10%)	13 (7%)	
Adequate		622 (75%)	475 (76%)	147 (74%)	
sTOFHLA	825	32 (14-36)	33 (15-36)	31 (12-35)	.04
Cognition					
Cognition category	878				.11
Cognitive impairment		462 (53%)	342 (51%)	120 (57%)	
Intact cognition		416 (47%)	327 (49%)	89 (43%)	
Cognition score	878	0 (0-1)	0 (0-1)	0 (0-2)	.09

NOTE: N is the number of nonmissing values. For associations with categorical variables, the Pearson χ^2 test was used. For associations with continuous variables, the Wilcoxon test was used. Abbreviations: ADHF, acute decompensated heart failure; BHLS, Brief Health Literacy Screen; sTOFHLA, Short Test of Functional Health Literacy in Adults; VICS, Vanderbilt Inpatient Cohort Study.

Overall, our study has several strengths. The size of the cohort is large and there were high response rates during the follow-up period. Unlike other HF readmission studies, VICS accounts for readmissions to outside hospitals. Approximately 35% of all hospitalizations in VICS are to outside facilities. Thus, the ascertainment of readmissions to hospitals other than Vanderbilt is more comprehensive than if readmissions to VUMC were only considered. We were able to include a number of clinical comorbidities, laboratory and diagnostic tests from the index admission, and hospitalization characteristics in our analyses. Finally, we performed additional analyses to investigate the correlation between numeracy, literacy, and cognition; ultimately, we found that the majority of these correlations were weak, which supports our ability to study them simultaneously among VICS participants.

Nonetheless, we note some limitations. Although we cap-

TABLE 3. **The Effect of Numeracy on 30-Day Readmissions among Those Hospitalized for ADHF in the VICS**

	Model 1			Model 2			Model 3			Model 4			Model 5		
Numeracy	**RR**	**95% CI**	***P* Value**	**RR**	**95% CI**	***P* Value**	**RR**	**95% CI**	***P* Value**	**RR**	**95% CI**	***P* Value**	**RR**	**95% CI**	***P* Value**
Numeracy score (per 2 point change)	1.02	0.86-1.23	.79	1.09	0.89-1.33	.39	1.04	0.83-1.29	.75	1.06	0.85-1.33	.57	1.04	0.83-1.30	.72

NOTE: Poisson Model Estimates: Model 1 adjusts for numeracy alone; Model 2 adjusts for the Model 1 variable and adjusts for health literacy and cognition; Model 3 adjusts for the Model 2 variables and demographics; Model 4 adjusts for Model 3 variables and clinical and diagnostic characteristics; and Model 5 adjusts for Model 4 variables and hospitalization characteristics.
Abbreviations: ADHF, acute decompensated heart failure; CI, confidence interval; RR, risk ratio; VICS, Vanderbilt Inpatient Cohort Study.

tured readmissions to outside hospitals, the study took place at a single referral center in Tennessee. Though patients were diverse in age and comorbidities, they were mostly white and of higher SES. Finally, we used home status as a proxy for social support, which may underestimate the support that home care workers provide.

In conclusion, in this prospective longitudinal study of adults hospitalized with ADHF, inadequate numeracy was present in more than a third of patients, and low health literacy was present in roughly a quarter of patients. Neither numeracy nor health literacy, however, were associated with 30-day readmissions in adjusted analyses. Any cognitive impairment, although present in roughly one-half of patients, was not associated with 30-day readmission either. Our findings suggest that other influences may play a more dominant role in determining 30-day readmission rates in patients hospitalized for ADHF than inadequate numeracy, low health literacy, or cognitive impairment as assessed here.

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Do Combined Pharmacist and Prescriber Efforts on Medication Reconciliation Reduce Postdischarge Patient Emergency Department Visits and Hospital Readmissions?

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BACKGROUND: Although medication reconciliation (Med Rec) has demonstrated a reduction in potential adverse drug events, its effect on hospital readmissions remains inconclusive.

OBJECTIVE: To evaluate the impact of an interprofessional Med Rec bundle from admission to discharge on patient emergency department visits and hospital readmissions (hospital visits).

METHODS: The design was a retrospective, cohort study. Patients discharged from general internal medicine over a 57-month interval were identified through administrative databases. Patients who received an enhanced, Gold level, Med Rec bundle (including both admission Med Rec and interprofessional pharmacist-prescriber collaboration on discharge Med Rec) were assigned to the intervention group. Patients who received partial Med Rec services, Silver and Bronze level, comprised the control group. The primary outcome was hospital visits within 30 days of discharge.

RESULTS: Over a 57-month period, 9931 unique patient visits (n = 8678 patients) met the study criteria. The main analysis did not detect a difference in 30-day hospital visits between the intervention (Gold level bundle) and control (21.25% vs 19.26%; adjusted odds ratio, 1.06; 95% confidence interval [CI], 0.95-1.19). Propensity score adjustment also did not detect an effect (16.7% vs18.9%; relative risk of readmission, 0.88; 95% CI, 0.59-1.32).

CONCLUSION: A long-term, observational evaluation of interprofessional Med Rec did not detect a difference in 30-day postdischarge patient hospital visits between patients who received enhanced versus partial Med Rec patient care bundles. In future prospective studies, researchers could focus on evaluating high-risk populations and specific elements of Med Rec services on avoidable, medication-related hospital admissions and postdischarge adverse drug events. *Journal of Hospital Medicine* 2018;13:152-157. Published online first October 4, 2017.

Healthcare systems are targeting effective strategies to improve patient safety and reduce hospital readmissions. Hospital readmissions can be detrimental to patients' health, a source of avoidable healthcare costs, and are frequently a reflection of the quality of patient care during transitions of care. Medication reconciliation (Med Rec) was identified as 1 of 12 interventions that may reduce 30-day readmissions; however, rigorously designed studies are scarce.[1,2] Published systematic reviews and meta-analyses have produced mixed conclusions regarding the impact of Med Rec on unplanned 30-day readmissions.[2-4]

In several studies, researchers have established the positive impact of Med Rec on reducing patient medication discrepancies and potential adverse drug events.[4-8] Pharmacy-led Med Rec interventions have been shown to easily identify more clinically relevant and higher impact medication discrepancies when compared to usual care.[8] In a systematic review, Mueller et al.[2] suggest that there are several interrelated elements that determine if a Med Rec intervention will influence hospital readmissions. These elements form a multicomponent "bundle" of interventions, including a systematic medication history process, admission reconciliation, patient education on discharge, discharge reconciliation, and communication to outpatient providers.[9] Several prospective randomized controlled studies have demonstrated lower readmission rates and fewer visits to the emergency department (ED) after implementing a comprehensive, interprofessional, bundled intervention (including Med Rec) from admission to discharge.[10-13] A 2016 systematic

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TABLE 1. **Varying Levels of Intensity (Taxonomy) of Med Rec Care Integrated With Interprofessional Medication Management**

Care Bundle Category	Care Level of Intensity	Key Components	Published Examples
Partial	Bronze	BPMH with admission reconciliation Med Rec informatics platform to support the healthcare team	Cornish et al. 2005[16]; Kwan et al. 2007[17]
	Silver	Bronze plus Prescriber-only discharge Med Rec	Wong et al. 2008[6]; Schnipper et al. 2009[7]
Enhanced	Gold	Silver plus Interprofessional (prescriber and pharmacist collaboration) discharge Med Rec Varying degrees of medication management and pharmaceutical care	Schnipper et al. 2009[7]; Cesta et al. 2006[15]; Dedhia et al. 2009[18]
Intensive	Platinum	Gold plus Patient medication education prior to discharge (including discussion of medication changes) Provision of patient-friendly reconciled medication schedules upon discharge Broader attention to medication management and pharmaceutical care with pharmacist inpatient rounding	Makowsky et al 2009[13]; Dedhia et al. 2009[18]; Murphy et al. 2009[19]; Nazareth et al. 2001[20]; Al-Rashed et al. 2002[21]
	Diamond	Platinum plus Postdischarge follow-up phone call to patient by hospital clinician (eg, nurse or pharmacist) Communication of medication changes with rationale directly to community pharmacy and primary care physician	Karapinar-Çarkit et al. 2009[5]; Jack et al 2009[11]; Gillespie et al. 2009[12] ; Schnipper et al. 2006[22]; Walker et al. 2009[23]

NOTE: Table 1 outlines a proposed continuum of degrees of Med Rec care bundles varying from Bronze to Silver, Gold, Platinum, and Diamond. The key being that more advanced levels of care and higher intensities have a progression in the care elements in the multicomponent bundle: true interprofessional collaboration, active patient and family participation in all stages, and the comprehensive nature of transition communication personalized for more providers. Of note, for a given ward and interprofessional team, different proportions of patients may receive levels from Bronze to Platinum and the quality and accuracy of each stage may also vary. The degree on the care level intensity continuum has a meaningful differential impact on patient outcomes (such as hospital readmissions) as demonstrated in published studies. Adapted with permission from Healthcare Quarterly 2012;15(Special Issue):44.

Abbreviations: BPMH, best possible medical history; Med Rec, medical reconciliation.

review and meta-analysis specifically evaluated pharmacy-led Med Rec programs (the majority of which included interventions involving multicomponent bundles) and demonstrated a significant reduction in posthospital healthcare utilization.[14]

Although comprehensive, interprofessional, bundled interventions have been shown to reduce readmission rates and ED visits in randomized controlled trials (RCTs), limited resources often prevent hospitals from consistently implementing all aspects of these multicomponent interventions. In practice, clinicians may provide varying components of the bundle, such as the combination of admission medication history by the pharmacist and discharge Med Rec completed by the physician alone. The unique impact of combined pharmacist and prescriber Med Rec interventions from admission to discharge on readmissions remains inconclusive. Further, it is unclear which high-risk patient groups will benefit the most from these interventions. We set out to evaluate the impact of an enhanced, interprofessional Med Rec process from admission to discharge (characterized within the context of a novel taxonomy continuum that specifies clinician involvement and intensity of services) on readmissions to hospital and ED visits within 30 days of discharge.

METHODS

We conducted a retrospective, observational, analytical cohort study using QuadraMed's Computerized Patient Record and the EMITT (Electronic Medication Information Transfer Tool)[15] to collect data from 2007 to 2011.

Setting

The study was conducted at a 417-bed tertiary care teaching hospital in Toronto, Ontario, Canada.

Med Rec Process and Description of Exposure (Intervention)

The targeted clinical areas had sustained interprofessional models of patient care in place from admission to discharge. They also were actively using an in-house EMITT to facilitate the documentation and tracking of Med Rec efforts throughout patient admission, transfer, and discharge.[15] On admission, the pharmacist conducted a best possible medication history (BPMH). A BPMH provides the cornerstone for Med Rec. It differs from a routine medication history in that it involves (1) a systematic process for interviewing the patient (or family) and (2) a review of at least one other reliable source of information (eg, a provincial medication database, an inspection of medication vials, or contact with the community pharmacy) to obtain and verify patient medications (prescribed and nonprescribed). The pharmacist recorded the BPMH in the electronic patient record. The application supported admission and discharge Med Rec. On discharge, there were 2 options: (1) the prescriber alone would review and complete the discharge Med Rec and generate electronic prescriptions (Table 1, Silver level care) or (2) the pharmacist would collaborate with the prescriber to complete the discharge reconciliation and the prescriber would electronically generate prescriptions (Table 1, Gold level care). All clinical areas had a combined pharmacist and prescriber Med Rec model in place at admission, but the proportion of patients receiving discharge reconciliation completed by pharmacist and prescriber versus the prescriber-alone varied based on the individual clinician's practices.

Patient Selection

All consecutive hospitalized patients admitted and discharged by the general internal medicine [GIM] service from March

2007 to December 2011 were included. The GIM service was chosen for the main analysis because they had been performing the intervention for the longest period of time and had the largest population of patients. Patients were identified via their hospital-specific medical record identification number and specific hospital-visit number. Patients were excluded if any of the following occurred: (1) the length of stay of their index admission was less than 24 hours; (2) they died during the visit; (3) they were transferred to a separate acute care inpatient facility; or (4) they left hospital against medical advice. Patient visits were excluded as index cases from the analysis if they were returning within 90 days of a previous discharge.

Outcomes

The primary study outcome was the occurrence of an inpatient readmission or ED visit within 30 days of discharge. In our secondary analyses, we examined the impact of the intervention on high-risk patient populations, such as those ≥65 years of age, with a length of stay, acuity of admission, Charlson comorbidity index, and emergency department visits in past 6 months (LACE) index score ≥10 (see supplementary Appendix 1 for LACE score description), on high-alert medications (1 or more of warfarin, insulin, digoxin, and opioids), and on ≥10 medications.

Data Collection

Identification of Exposure of Interest

We used the electronic database to capture all patients who received pharmacist and prescriber supported admission-to-discharge reconciliation. We explicitly defined increasing intensity of Med Rec care in categories of Bronze, Silver, and Gold care levels (Table 1). The exposed (intervention) group received an enhanced Med Rec bundle (patients receiving Gold level care). The control group was made of patients receiving a partial Med Rec Bundle (patients receiving Silver or Bronze level of care or below).

Determination of Hospital Visits

A search of administrative databases was used to determine if patients admitted to the targeted services had an ED visit or urgent inpatient admission to the study hospital within 30 days.

Statistical Analysis

A logistic regression for outcomes was performed. This yielded an adjusted odds ratio with a 95% confidence interval (CI) between the intervention and control groups. Statistical significance was determined with a 2-sided α level of 0.05. In the analysis, we used Statistical Analysis Software version 9.2.

In our multivariate logistic regression model, we adjusted for confounding factors that might influence the patients' risk of readmission or the type of Med Rec they received upon discharge. By using administrative databases, patient level demographics, and the Charlson comorbidity index, the most responsible diagnosis and disease burden were collected. Medication-related factors collected included the number of medications on discharge and the presence of predefined high-alert medications. The number of medications on the medication discharge list was determined by using the electronic database. The final adjustment model included age, gender, the number of medications on discharge, and the LACE index score (supplementary Appendix 1). The LACE index score has been validated in Ontario, Canada, populations to quantify the risk of death or unplanned readmission within 30 days of discharge.[24]

Propensity Score Adjustment

Propensity scoring (probability of treatment assignment conditional on observed baseline characteristics) was planned a priori to account for possible factors that would impact whether a patient received the intervention or control care levels. The propensity score for receiving Med Rec was computed from a logistic model using Med Rec as the outcome. A structured iterative approach was used to refine this model to achieve covariate balance within the matched pairs. Covariate balance was measured by the standardized difference, in which an absolute standardized difference >10% represents meaningful imbalance.[25] From the original cohort, we attempted to match patients who had the intervention to patients from the control by means of a matching algorithm using the logit of the propensity score for receiving the intervention.[26]

Subgroup Analysis

We also examined the impact of the intervention on high-risk patient populations such as those ≥65 years of age, with a LACE index score ≥10, on high-alert medications, and on ≥10 medications. A univariate analysis was conducted to identify patient-related risk predictors that may be independently correlated with a higher risk of hospital visits.

RESULTS

Baseline Characteristics

A total of 8678 patients representing 9931 unique visits met the inclusion criteria for analysis. There were 2541 unique visits (approximately 26% of visits) in the intervention group that received Gold level care and 7390 unique visits in the control group. The patients in the control group were largely patients who received the original standard of care at the institution, Silver level care (67% of the control group). Patients who received Bronze level care or less comprised 33% of the control group.

Patients in the intervention group were significantly older (average of 68 years old versus 64 years old) and on more medications. They also notably had a longer duration of stay in hospital, an increased percentage of visits with a LACE index score ≥10, and were more likely to be discharged home on a high-alert medication and with supports (Table 2).

Main Analysis

The main unadjusted analysis of GIM patients (n = 9931 visits) did not detect a difference in 30-day ED visits and readmissions between the intervention group (540 out of 2541; 21.2%) and control (1423 out of 7390; 19.3%; Table 3). By using a multivariate logistic regression model to account for age, sex, LACE index,

TABLE 2. **Baseline Characteristics of Visits: General Internal Medicine**

Baseline Demographics Total Visits N = 9931	Interprofessional Discharge Reconciliation N = 2541	Did Not Receive Interprofessional Discharge Reconciliation N = 7390
Age in years at index visit, mean (SD)	68 (17.91)	64.66 (19.36)
Female, no. (%)	1200 (47)	3540 (48)
Mean LOS [acute + awaiting long-term care], days (SD)	11.47 (27.19)	8.70 (14.87)
Mean Charlson comorbidity score, no. (SD)	0.57 (1.16)	0.52 (1.18)
Mean LACE index, no. (SD)	8.59 (2.45)	8.06 (2.47)
LACE index score ≥10, no. (%)	852 (34)	1964 (27)
Mean number of medications on discharge, no. (SD)	10.17 (5.10)	8.72 (5.63)
Greater than or equal to 10 discharge medications, no. (%)	1303 (51)	3070 (41)
Discharge code: home with supports, no. (%)	778 (31)	1647 (22)
Predefined high alert medication, no. (%)	604 (24)	1317 (18)

NOTE: Abbreviations: LACE, length of stay ("L"), acuity of the admission ("A"), comorbidity of the patient (measured with the Charlson comorbidity index score) ("C"), and emergency department use of patients ("E"), LOS, length of stay; SD, standard deviation.

TABLE 3. **Main Analysis of 30-Day Hospital Visits for General Internal Medicine**

	Control Total Visits N = 7390		Intervention Total Visits N = 2541		Total	
Type of Hospital Visit	n	%	n	%	N	AOR[a] (95% CI)
ED Visit	1352	18.29	523	20.58	1875	1.08 (0.96-1.21), *P* = .18
IP admission	904	12.23	365	14.36	1269	1.20 (1.06-1.37), *P* = .18
ED or IP	1423	19.26	540	21.25	1963	1.06 (0.945-1.19), *P* = .33

[a]AOR is the adjusted odds ratio *P* value determined by using a multivariate logistic regression model to account for age, sex, LACE index, and number of medications on discharge.

NOTE: Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; ED, emergency department; IP, inpatient; LACE, length of stay ("L"), acuity of the admission ("A"), comorbidity of the patient (measured with the Charlson comorbidity index score) ("C"), and emergency department use of patients ("E")

and number of medications on discharge, the adjusted odds ratio was 1.06 (95% CI, 0.95-1.19; *P* = .33). After propensity score adjustment, the relative risk of readmission was 0.88 (16.7% vs 18.9%; 95% CI, 0.59-1.32; *P* = .54).

Secondary Analyses

In each predefined high-risk patient subgroup (age ≥65, LACE index score ≥10, number of discharge medications ≥10, and the presence of high-alert medications), analyses of our primary endpoint did not detect significant adjusted odds ratios (Table 4). In our univariate analysis, increasing number of medications, LACE index score, and male gender were independently correlated with a higher risk of hospital visits (supplementary Appendix 2).

DISCUSSION

Med Rec is widely recommended as a patient safety strategy to prevent clinically significant medication discrepancies at transitions in care.[4-9] However, Med Rec varies widely in terms of what it entails and who delivers it, with the preponderance of evidence suggesting an impact on clinically significant medication discrepancies only when interprofessional care delivered includes a central role for pharmacists.[27] Furthermore, Med Rec appears to impact short term readmissions only when embedded in a broader, multifaceted, bundled intervention in which pharmacists or other team members educate patients about their medications and deliver postdischarge follow-up phone calls.[10-13]

As very few hospitals have the resources to sustainably deliver intensive care bundles that are represented in RCTs (characterized by Platinum and Diamond levels of care in Table 1), in our observational study, we sought to explore whether a resource-attainable, enhanced Med Rec care bundle (Gold level) had an impact on hospital utilization compared to partial Med Rec care bundles (Bronze and Silver levels). In our findings, we did not detect a significant difference on ED visits and readmissions within 30 days between enhanced and partial care bundles. In a secondary analysis of the influence of the intervention on prespecified high-risk patient subgroups, we also did not detect a difference.

As far as we are aware, our long-term, observational study is the largest to date to explore a real-life, enhanced Med Rec intervention and examine its impact on meaningful patient outcomes. We extrapolated that our intervention group received several critical attributes of a successful bundle as discussed by Mueller in a systematic review.[2] Our intervention included the following: (1) a systematic BPMH process on admission; (2) integrated admission-to-discharge reconciliation processes; (3) discharge delineation of medication changes since admission;

TABLE 4. **ED or IP Admissions in High Risk Patient Subgroups-General Internal Medicine**

High-risk Group	Total No. of Visits	ED Visits or Inpatient Admissions				AOR (95% CI)
		No. of control visits	ED or IP admissions (% of total control visits)	No. of intervention visits	ED or IP admissions (% of total intervention visits)	
Age ≥65	5667	4087	787 (19.26)	1580	347 (21.96)	1.41 (0.99-1.32)
LACE index score ≥10	2816	1964	481 (24.49)	852	235 (27.58)	1.17 (0.97-1.41)
No. of medications ≥10	4373	3070	659 (21.47)	1303	285 (21.87)	1.00 (0.85-1.17)
On high-alert medication	8010	6073	1166 (19.20)	1937	407 (21.01)	1.05 (0.92-1.19)

NOTE: Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; ED, emergency department; IP, inpatient; LACE, length of stay ("L"), acuity of the admission ("A"), comorbidity of the patient (measured with the Charlson comorbidity index score) ("C"), and emergency department use of patients ("E")

(4) pharmacist involvement in reconciliation from admission to discharge; (5) an electronic platform; and (6) formal discharge reconciliation with interprofessional collaboration. Additional components in the bundle described by Mueller included the following: patient education at discharge, postdischarge communication with the patient, and communication with outpatient providers and medication management.

In our results, we did not find a difference in outcomes between the intervention and control groups. Therefore, it is possible that the enhanced bundle's focus on interprofessional involvement in discharge reconciliation (Gold care level) has no impact on hospital utilization compared to partial care bundles (Silver and Bronze levels). Kwan et al.[3] describe similar findings in their systematic review, in which they evaluated the effects of hospital-based Med Rec on unintentional discrepancies with nontrivial risks for harm to patients on 30-day postdischarge hospital visits. Kwan et al.[3] concluded that larger well-designed studies are required to further evaluate this outcome, but authors of current published studies suggest that Med Rec alone probably does not reduce postdischarge hospital utilization within 30 days. Med Rec may have a more significant impact on utilization when bundled with other interventions that improve discharge coordination.[3]

There may be several reasons why we were unable to detect a significant difference between the intervention and control groups. One limitation is that our nonrandomized, retrospective design may have led to unmeasured confounders that impacted allocation into the intervention group versus the control group. It was notable that patients in the intervention group had an increased age, longer duration of hospital stay, more medications, and high-alert medications on discharge compared to the control group and that may have biased our results towards the null hypothesis. Although the propensity score analysis attempted to adjust for this, it also did not detect a significant difference between groups.

In addition, the existing standard of care during the study period allowed for patients in the control group to receive varying levels of Med Rec. Ideally, we would have compared the intervention to a placebo group that did not receive any Med Rec-related care elements. However, as this was a real-life observational study, the majority of patients received some Med Rec services as a part of the standard of care. As a result, 67% of patients in the control group received Silver level Med Rec with a BPMH, admission reconciliation, and prescriber-only discharge reconciliation. This may have made it more difficult to show an incremental benefit on readmissions between the intervention and control.

Also, our primary outcome of all-cause ED or hospital readmissions within 30 days may not have been sensitive enough to detect the effect of Med Rec interventions alone. Only a small proportion of readmissions within 30 days of discharge are preventable and many patient and community level factors responsible for readmissions cannot be controlled by the hospital's actions.[28] Comprehensive pharmacy interventions have demonstrated decreased hospitalizations and emergency visits at 12 months; however, the largest impact was seen on the more specific outcome of medication-related hospitalizations (80% reduction).[29] Lastly, another limitation was that we were unable to capture hospital visits to other centres. However, in our region, almost 75% of readmissions are to the same site as the initial hospitalization.[30]

Overall, our findings in this study and novel characterization of Med Rec services are relevant to many hospital sites that are striving to implement integrated Med Rec with limited healthcare resources. Although interprofessional Med Rec likely reduces clinically significant medication discrepancies, enhanced interprofessional Med Rec on discharge (Gold Med Rec) alone may not be enough to impact hospital utilization compared to partial Med Rec services (Silver and Bronze Med Rec). Further research into practical, targeted Med Rec bundles on more specific outcomes (such as preventable postdischarge adverse events, "avoidable" hospital readmissions, and medication-related readmissions) may detect a significant benefit.

CONCLUSION

A long-term observational evaluation of interprofessional Med Rec did not detect a difference in 30-day postdischarge patient hospital visits between patients who received enhanced versus partial Med Rec patient care bundles. Researchers of future prospective studies could focus on evaluating high-risk populations or specific elements of Med Rec services on avoidable medication-related hospital admissions and postdischarge adverse drug events.

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The TEND (Tomorrow's Expected Number of Discharges) Model Accurately Predicted the Number of Patients Who Were Discharged from the Hospital the Next Day

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BACKGROUND: Knowing the number of discharges that will occur is important for administrators when hospital occupancy is close to or exceeds 100%. This information will facilitate decision making such as whether to bring in extra staff, cancel planned surgery, or implement measures to increase the number of discharges. We derived and internally validated the TEND (Tomorrow's Expected Number of Discharges) model to predict the number of discharges from hospital in the next day.

METHODS: We identified all patients greater than 1 year of age admitted to a multisite academic hospital between 2013 and 2015. In derivation patients we applied survival-tree methods to patient-day covariates (patient age, sex, comorbidities, location, admission urgency, service, campus, and weekday) and identified risk strata having unique discharge patterns. Discharge probability in each risk strata for the previous 6 months was summed to calculate each day's expected number of discharges.

RESULTS: Our study included 192,859 admissions. The daily number of discharges varied extensively (median 139; interquartile range [IQR] 95-160; range 39-214). We identified 142 discharge risk strata. In the validation patients, the expected number of daily discharges strongly predicted the observed number of discharges (adjusted R2 = 89.2%; $P < .0001$). The relative difference between observed and expected number of discharges was small (median 1.4%; IQR −5.5% to 7.1%).

CONCLUSION: The TEND model accurately predicted the daily number of discharges using information typically available within hospital data warehouses. Further study is necessary to determine if this information improves hospital bed management. *Journal of Hospital Medicine* 2018;13:158-163. Published online first August 17, 2017.

Hospitals typically allocate beds based on historical patient volumes. If funding decreases, hospitals will usually try to maximize resource utilization by allocating beds to attain occupancies close to 100% for significant periods of time. This will invariably cause days in which hospital occupancy exceeds capacity, at which time critical entry points (such as the emergency department and operating room) will become blocked. This creates significant concerns over the patient quality of care.

Hospital administrators have very few options when hospital occupancy exceeds 100%. They could postpone admissions for "planned" cases, bring in additional staff to increase capacity, or instigate additional methods to increase hospital discharges such as expanding care resources in the community. All options are costly, bothersome, or cannot be actioned immediately. The need for these options could be minimized by enabling hospital administrators to make more informed decisions regarding hospital bed management by knowing the likely number of discharges in the next 24 hours.

Predicting the number of people who will be discharged in the next day can be approached in several ways. One approach would be to calculate each patient's expected length of stay and then use the variation around that estimate to calculate each day's discharge probability. Several studies have attempted to model hospital length of stay using a broad assortment of methodologies, but a mechanism to accurately predict this outcome has been elusive[1,2] (with Verburg et al.[3] concluding in their study's abstract that "…it is difficult to predict length of stay…"). A second approach would be to use survival analysis methods to generate each patient's hazard of discharge over time, which could be directly converted to an expected daily risk of discharge. However, this approach is complicated by the concurrent need to include time-dependent covariates and consider the competing risk of death in hospital, which can complicate survival modeling.[4,5] A third approach would be the implementation of a longitudinal analysis using marginal models to predict the daily probability of discharge,[6] but this

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method quickly overwhelms computer resources when large datasets are present.

In this study, we decided to use nonparametric models to predict the daily number of hospital discharges. We first identified patient groups with distinct discharge patterns. We then calculated the conditional daily discharge probability of patients in each of these groups. Finally, these conditional daily discharge probabilities were then summed for each hospital day to generate the expected number of discharges in the next 24 hours. This paper details the methods we used to create our model and the accuracy of its predictions.

METHODS

Study Setting and Databases Used for Analysis

The study took place at The Ottawa Hospital, a 1000-bed teaching hospital with 3 campuses that is the primary referral center in our region. The study was approved by our local research ethics board.

The Patient Registry Database records the date and time of admission for each patient (defined as the moment that a patient's admission request is registered in the patient registration) and discharge (defined as the time when the patient's discharge from hospital was entered into the patient registration) for hospital encounters. Emergency department encounters were also identified in the Patient Registry Database along with admission service, patient age and sex, and patient location throughout the admission. The Laboratory Database records all laboratory studies and results on all patients at the hospital.

Study Cohort

We used the Patient Registry Database to identify all people aged 1 year or more who were admitted to the hospital between January 1, 2013, and December 31, 2015. This time frame was selected to (i) ensure that data were complete; and (ii) complete calendar years of data were available for both derivation (patient-days in 2013-2014) and validation (2015) cohorts. Patients who were observed in the emergency room without admission to hospital were not included.

Study Outcome

The study outcome was the number of patients discharged from the hospital each day. For the analysis, the reference point for each day was 1 second past midnight; therefore, values for time-dependent covariates up to and including midnight were used to predict the number of discharges in the next 24 hours.

Study Covariates

Baseline (ie, time-independent) covariates included patient age and sex, admission service, hospital campus, whether or not the patient was admitted from the emergency department (all determined from the Patient Registry Database), and the Laboratory-based Acute Physiological Score (LAPS). The latter, which was calculated with the Laboratory Database using results for 14 tests (arterial pH, PaCO2, PaO2, anion gap, hematocrit, total white blood cell count, serum albumin, total bilirubin, creatinine, urea nitrogen, glucose, sodium, bicarbonate, and troponin I) measured in the 24-hour time frame preceding hospitalization, was derived by Escobar and colleagues[7] to measure severity of illness and was subsequently validated in our hospital.[8] The independent association of each laboratory perturbation with risk of death in hospital is reflected by the number of points assigned to each lab value with the total LAPS being the sum of these values. Time-dependent covariates included weekday in hospital and whether or not patients were in the intensive care unit.

Analysis

We used 3 stages to create a model to predict the daily expected number of discharges: we identified discharge risk strata containing patients having similar discharge patterns using data from patients in the derivation cohort (first stage); then, we generated the preliminary probability of discharge by determining the daily discharge probability in each discharge risk strata (second stage); finally, we modified the probability from the second stage based on the weekday and admission service and summed these probabilities to create the expected number of discharges on a particular date (third stage).

The first stage identified discharge risk strata based on the covariates listed above. This was determined by using a survival tree approach[9] with proportional hazard regression models to generate the "splits." These models were offered all covariates listed in the Study Covariates section. Admission service was clustered within 4 departments (obstetrics/gynecology, psychiatry, surgery, and medicine) and day of week was "binarized" into weekday/weekend-holiday (because the use of categorical variables with large numbers of groups can "stunt" regression trees due to small numbers of patients—and, therefore, statistical power—in each subgroup). The proportional hazards model identified the covariate having the strongest association with time to discharge (based on the Wald X^2 value divided by the degrees of freedom). This variable was then used to split the cohort into subgroups (with continuous covariates being categorized into quartiles). The proportional hazards model was then repeated in each subgroup (with the previous splitting variable[s] excluded from the model). This process continued until no variable was associated with time to discharge with a *P* value less than .0001. This survival-tree was then used to cluster all patients into distinct discharge risk strata.

In the second stage, we generated the preliminary probability of discharge for a specific date. This was calculated by assigning all patients in hospital to their discharge risk strata (Appendix). We then measured the probability of discharge on each hospitalization day in all discharge risk strata using data from the previous 180 days (we only used the prior 180 days of data to account for temporal changes in hospital discharge patterns). For example, consider a 75-year-old patient on her third hospital day under obstetrics/gynecology on December 19, 2015 (a Saturday). This patient would be assigned to risk stratum #133 (Appendix A). We then measured the probability of discharge of all patients in this discharge risk stratum hospitalized in the previous 6 months (ie, between

June 22, 2015, and December 18, 2015) on each hospital day. For risk stratum #133, the probability of discharge on hospital day 3 was 0.1111; therefore, our sample patient's preliminary expected discharge probability was 0.1111.

To attain stable daily discharge probability estimates, a minimum of 50 patients per discharge risk stratum-hospitalization day combination was required. If there were less than 50 patients for a particular hospitalization day in a particular discharge risk stratum, we grouped hospitalization days in that risk stratum together until the minimum of 50 patients was collected.

The third (and final) stage accounted for the lack of granularity when we created the discharge risk strata in the first stage. As we mentioned above, admission service was clustered into 4 departments and the day of week was clustered into weekend/weekday. However, important variations in discharge probabilities could still exist within departments and between particular days of the week.[10] Therefore, we created a correction factor to adjust the preliminary expected number of discharges based on the admission division and day of week. This correction factor used data from the 180 days prior to the analysis date within which the expected daily number of discharges was calculated (using the methods above). The correction factor was the relative difference between the observed and expected number of discharges within each division-day of week grouping.

For example, to calculate the correction factor for our sample patient presented above (75-year-old patient on hospital day 3 under gynecology on Saturday, December 19, 2015), we measured the observed number of discharges from gynecology on Saturdays between June 22, 2015, and December 18, 2015, (n = 206) and the expected number of discharges (n = 195.255) resulting in a correction factor of (observed-expected)/expected = (195.255-206)/195.206 = 0.05503. Therefore, the final expected discharge probability for our sample patient was 0.1111+0.1111*0.05503=0.1172. The expected number of discharges on a particular date was the preliminary expected number of discharges on that date (generated in the second stage) multiplied by the correction factor for the corresponding division-day or week group.

RESULTS

There were 192,859 admissions involving patients more than 1 year of age that spent at least part of their hospitalization between January 1, 2013, and December 31, 2015 (Table). Patients were middle-aged and slightly female predominant, with about half being admitted from the emergency department. Approximately 80% of admissions were to surgical or medical services. More than 95% of admissions ended with a discharge from the hospital with the remainder ending in a death. Almost 30% of hospitalization days occurred on weekends or holidays. Hospitalizations in the derivation (2013-2014) and validation (2015) group were essentially the same, except there was a slight drop in hospital length of stay (from a median of 4 days to 3 days) between the 2 periods.

Patient and hospital covariates importantly influenced the daily conditional probability of discharge (Figure 1). Patients admitted to the obstetrics/gynecology department were notably more likely to be discharged from hospital with no influence from the day of week. In contrast, the probability of discharge decreased notably on the weekends in the other departments. Patients on the ward were much more likely to be discharged than those in the intensive care unit, with increasing age associated with a decreased discharge likelihood in the former but not the latter patients. Finally, discharge probabilities varied only slightly between campuses at our hospital with discharge risk decreasing as severity of illness (as measured by LAPS) increased.

TABLE. **Description of Study Cohort**

	Cohort	
	Derivation (2013–2014)	**Validation (2015)**
HOSPITALIZATIONS	**N = 143,894**	**N = 48,965**
BASELINE COVARIATES[a]		
Mean age (SD)		
Overall	57.0 ± 20.5	57.6 ± 20.5
Obs/Gyn	33.6 ± 9.5	33.9 ± 9.7
Psychiatry	41.9 ± 17.4	41.9 ± 17.6
Surgery	58.7 ± 18.4	59.0 ± 18.2
Medicine	66.3 ± 17.8	66.5 ± 17.9
Female	81,449 (56.6%)	27,503 (56.2%)
Median LAPS (IQR) [range]	11 (0-38) [0-183]	15 (0-39) [0-180]
Campus		
General	69,098 (48.0%)	23,714 (48.4%)
Civic	58,479 (40.6%)	20,024 (40.9%)
Heart Instititute	16,317 (11.3%)	5227 (10.7%)
Patient admitted from emergency department	73,145 (50.8%)	25,931 (53.0%)
Department		
Obs/Gyn	23,171 (16.1%)	7557 (15.4%)
Psychiatry	6370 (4.4%)	2171 (4.4%)
Surgery	56,084 (39.0%)	18,640 (38.1%)
Medicine	58,269 (40.5%)	20,597 (42.1%)
Median hosptial length of stay (IQR)	4 (2-8)	3 (2-8)
Outcome	138,456 (96.2%)	47,156 (96.3%)
Discharge	5438 (3.8%)	1809 (3.7%)
Death	Yes	No
HOSPITAL DAYS	**N = 1,284,226**	**N = 398,683**
TIME-DEPENDENT COVARIATES[b]		
Weekend or holiday	382,466 (29.8%)	116,905 (29.3%)
Patient in ICU	38,673 (3.0%)	10,244 (2.6%)

[a] Unit of analysis = hospitalization.

[b] Unit of analysis = hospital-day.

NOTE: Data from the derivation cohort were used to create the discharge risk strata (Appendix A). These were used to cluster patients in the validation cohort to predict the daily number of discharges. Abbreviations: ICU, intensive care unit; IQR, interquartile range; LAPS, Laboratory-based Acute Physiological Score; Obs/Gyn; obstetrics/gynecology; SD, standard deviation.

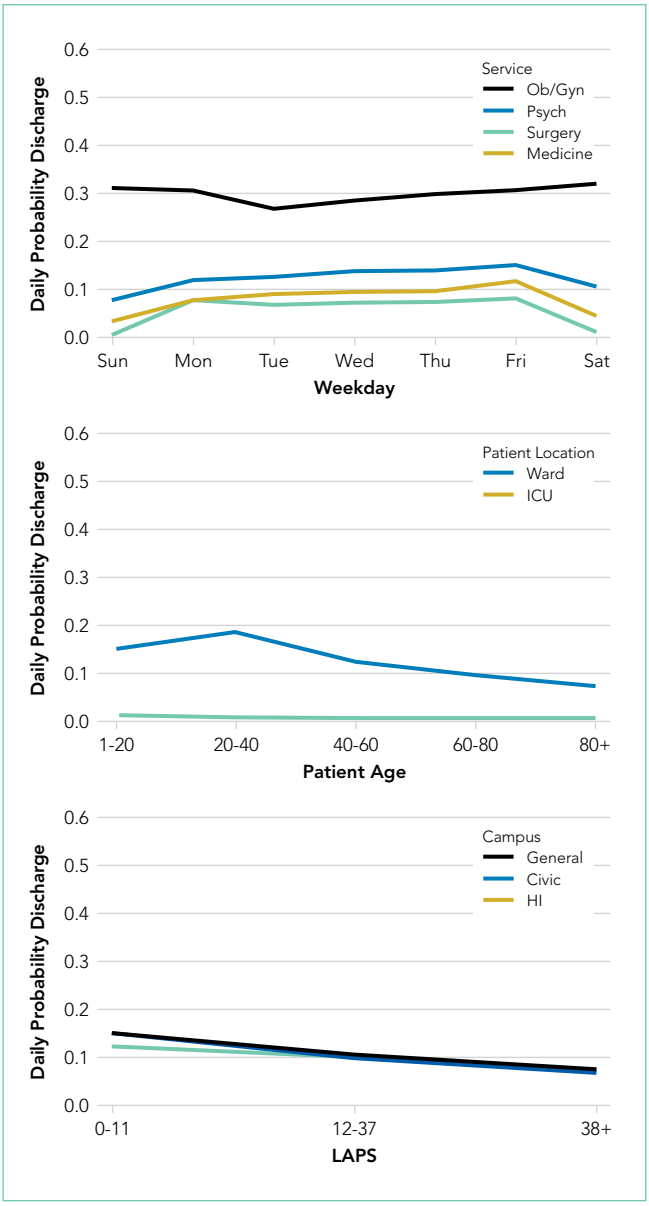

FIG 1. Influence of patient and hospital factors on the daily probability of hospital discharge. These 3 plots illustrate the influence of 6 factors (service, weekday, patient location, patient age, hospital campus, and LAPS) on the daily probability of discharge (conditional on the patient being alive and still in hospital on that day).

NOTE: Abbreviations: HI, heart institute; ICU, intensive care unit; LAPS, Laboratory-based Acute Physiological Score; Ob/Gyn; obstetrics-gynecology; Psych, psychiatry.

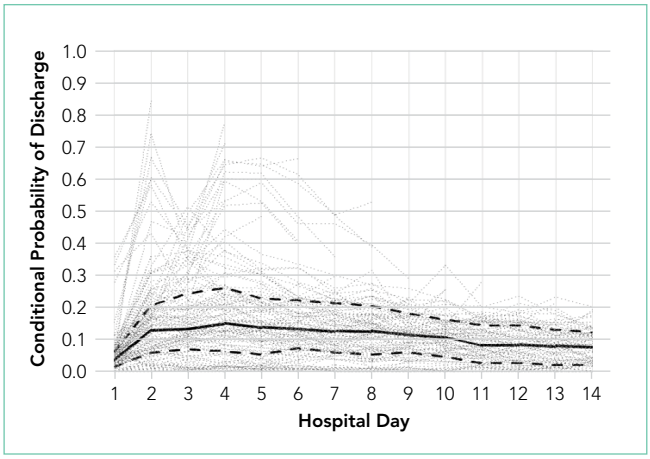

FIG 2. Daily conditional probability of discharge within discharge risk strata.

NOTE: The vertical axis presents the daily probability of discharge from hospital (conditional upon patients remaining alive in the hospital up to that day) in the first 14 days of hospitalization (horizontal axis) using all observations in the derivation population (2013-2014). Individual lines present results for the discharge risk strata defined in Appendix A. Probabilities in risk strata having less than 50 patients for a particular day are not presented. The heavy solid line presents the median value of all risk strata for that day flanked by its interquartile range (represented by the heavy dotted lines).

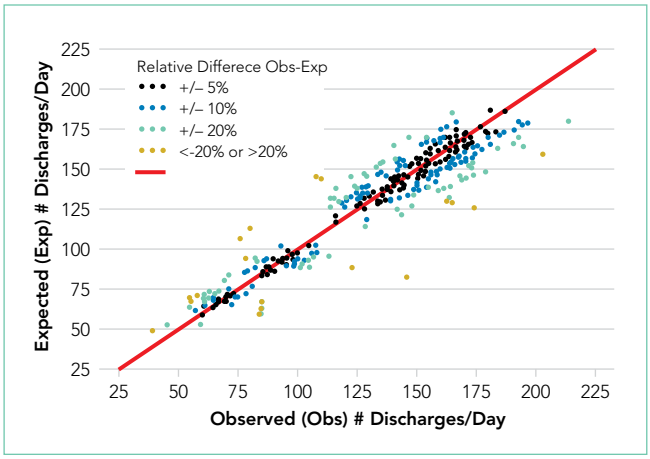

FIG 3. Expected versus observed daily number of discharges in the validation cohort. This figure presents the observed daily number of discharges (horizontal axis) against the expected daily number of discharged (vertical axis) for each day in the validation cohort (2015). The expected number of discharges was the sum of the expected discharge probabilities of each patient in the hospital on that day. Expected discharge probabilities were estimated by calculating the probability of discharge in all risk strata-hospital day combinations by using data from the previous 6 months. Perfect agreement is indicated by the red line. Relative differences between the observed and expected number of daily discharges are indicated by the color of the data point (Legend).

The TEND model contained 142 discharge risk strata (Appendix A). Weekend-holiday status had the strongest association with discharge probability (ie, it was the first splitting variable). The most complex discharge risk strata contained 6 covariates. The daily conditional probability of discharge during the first 2 weeks of hospitalization varied extensively between discharge risk strata (Figure 2). Overall, the conditional discharge probability increased from the first to the second day, remained relatively stable for several days, and then slowly decreased over time. However, this pattern and day-to-day variability differed extensively between risk strata.

The observed daily number of discharges in the validation cohort varied extensively (median 139; interquartile range [IQR] 95-160; range 39-214). The TEND model accurately predicted the daily number of discharges with the expected daily number being strongly associated with the observed number (adjusted R^2 = 89.2%; $P < .0001$; Figure 3). Calibration decreased but remained significant when we limited the analyses by hospital campus (General: R^2 = 46.3%; $P < .0001$; Civic: R^2 = 47.9%; $P < .0001$; Heart Institute: R^2 = 18.1%; $P < .0001$). The expected number of daily discharges was an unbiased estimator of the observed number of discharges (its parameter estimate in a lin-

ear regression model with the observed number of discharges as the outcome variable was 1.0005; 95% confidence interval, 0.9647-1.0363). The absolute difference in the observed and expected daily number of discharges was small (median 1.6; IQR −6.8 to 9.4; range −37 to 63.4) as was the relative difference (median 1.4%; IQR −5.5% to 7.1%; range −40.9% to 43.4%). The expected number of discharges was within 20% of the observed number of discharges in 95.1% of days in 2015.

DISCUSSION

Knowing how many patients will soon be discharged from the hospital should greatly facilitate hospital planning. This study showed that the TEND model used simple patient and hospitalization covariates to accurately predict the number of patients who will be discharged from hospital in the next day.

We believe that this study has several notable findings. First, we think that using a nonparametric approach to predicting the daily number of discharges importantly increased accuracy. This approach allowed us to generate expected likelihoods based on actual discharge probabilities at our hospital in the most recent 6 months of hospitalization-days within patients having discharge patterns that were very similar to the patient in question (ie, discharge risk strata, Appendix A). This ensured that trends in hospitalization habits were accounted for without the need of a period variable in our model. In addition, the lack of parameters in the model will make it easier to transplant it to other hospitals. Second, we think that the accuracy of the predictions were remarkable given the relative "crudeness" of our predictors. By using relatively simple factors, the TEND model was able to output accurate predictions for the number of daily discharges (Figure 3).

This study joins several others that have attempted to accomplish the difficult task of predicting the number of hospital discharges by using digitized data. Barnes et al.[11] created a model using regression random forest methods in a single medical service within a hospital to predict the daily number of discharges with impressive accuracy (mean daily number of discharges observed 8.29, expected 8.51). Interestingly, the model in this study was more accurate at predicting discharge likelihood than physicians. Levin et al.[12] derived a model using discrete time logistic regression to predict the likelihood of discharge from a pediatric intensive care unit, finding that physician orders (captured via electronic order entry) could be categorized and used to significantly increase the accuracy of discharge likelihood. This study demonstrates the potential opportunities within health-related data from hospital data warehouses to improve prediction. We believe that continued work in this field will result in the increased use of digital data to help hospital administrators manage patient beds more efficiently and effectively than currently used resource intensive manual methods.[13,14]

Several issues should be kept in mind when interpreting our findings. First, our analysis is limited to a single institution in Canada. It will be important to determine if the TEND model methodology generalizes to other hospitals in different jurisdictions. Such an external validation, especially in multiple hospitals, will be important to show that the TEND model methodology works in other facilities. Hospitals could implement the TEND model if they are able to record daily values for each of the variables required to assign patients to a discharge risk stratum (Appendix A) and calculate within each the daily probability of discharge. Hospitals could derive their own discharge risk strata to account for covariates, which we did not include in our study but could be influential, such as insurance status. These discharge risk estimates could also be incorporated into the electronic medical record or hospital dashboards (as long as the data required to generate the estimates are available). These interventions would permit the expected number of hospital discharges (and even the patient-level probability of discharge) to be calculated on a daily basis. Second, 2 potential biases could have influenced the identification of our discharge risk strata (Appendix A). In this process, we used survival tree methods to separate patient-days into clusters having progressively more homogenous discharge patterns. Each split was determined by using a proportional hazards model that ignored the competing risks of death in hospital. In addition, the model expressed age and LAPS as continuous variables, whereas these covariates had to be categorized to create our risk strata groupings. The strength of a covariate's association with an outcome will decrease when a continuous variable is categorized.[15] Both of these issues might have biased our final risk strata categorization (Appendix A). Third, we limited our model to include simple covariates whose values could be determined relatively easily within most hospital administrative data systems. While this increases the generalizability to other hospital information systems, we believe that the introduction of other covariates to the model—such as daily vital signs, laboratory results, medications, or time from operations—could increase prediction accuracy. Finally, it is uncertain whether or not knowing the predicted number of discharges will improve the efficiency of bed management within the hospital. It seems logical that an accurate prediction of the number of beds that will be made available in the next day should improve decisions regarding the number of patients who could be admitted electively to the hospital. It remains to be seen, however, whether this truly happens.

In summary, we found that the TEND model used a handful of patient and hospitalization factors to accurately predict the expected number of discharges from hospital in the next day. Further work is required to implement this model into our institution's data warehouse and then determine whether this prediction will improve the efficiency of bed management at our hospital.

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Derivation of a Clinical Model to Predict Unchanged Inpatient Echocardiograms

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BACKGROUND: Transthoracic echocardiography (TTE) is one of the most commonly ordered tests in healthcare. Repeat TTE, defined as a TTE done within 1 year of a prior TTE, represents 24% to 42% of all studies. The purpose of this study was to derive a clinical prediction model to predict unchanged repeat TTE, with the goal of defining a subset of studies that are unnecessary.

METHODS: Single-center retrospective cohort study of all hospitalized patients who had a repeat TTE between October 1, 2013, and September 30, 2014.

RESULTS: Two hundred eleven of 601 TTEs were repeat studies, of which 78 (37%) had major changes. Five variables were independent predictors of major new TTE changes, including history of intervening acute myocardial infarction, cardiothoracic surgery, major new electrocardiogram (ECG) changes, prior valve disease, and chronic kidney disease. Using the β-coefficient for each of these variables, we defined a clinical prediction model that we named the CAVES score. The acronym CAVES stands for chronic kidney disease, acute myocardial infarction, valvular disease, ECG changes, and surgery (cardiac). The prevalence of major TTE change for the full cohort was 35%. For the group with a CAVES score of −1, that probability was only 5.6%; for the group with a score of 0, the probability was 17.7%; and for the group with a score ≥1, the probability was 55.3%. The bootstrap corrected C statistic for the model was 0.78 (95% confidence interval, 0.72-0.85), indicating good discrimination.

CONCLUSIONS: Overall, the CAVES score had good discrimination and calibration. If further validated, it may be useful to predict repeat TTEs that are unlikely to have major changes. *Journal of Hospital Medicine* 2018;13:164-169. Published online first October 18, 2017. © 2018 Society of Hospital Medicine

Transthoracic echocardiography (TTE) is one of the most commonly ordered diagnostic tests in healthcare. Studies of Medicare beneficiaries, for example, have shown that each year, approximately 20% undergo at least 1 TTE, including 4% who have 2 or more.[1] TTE utilization rates increased dramatically in the 1990s and early 2000s. Between 1999 and 2008, for example, the rate of use of TTE per Medicare beneficiary nearly doubled.[2] In 2014, echocardiography accounted for 10% of all Medicare spending for imaging services, or approximately $930 million.[3] In response to concerns about the possible unnecessary use of TTE, the American Heart Association and American Society of Echocardiography developed Appropriate Use Criteria (AUC) in 2007 and 2011, which describe appropriate versus inappropriate indications for TTE.[4] Subsequent studies have shown that rather than rooting out inappropriate studies, the vast majority of ordered studies appear to be appropriate according to the AUC criteria.[5] The AUC criteria have also been criticized for being based on expert opinion rather than clinical evidence.[6] Repeat TTE, defined as TTE done within 1 year of a prior TTE, represents 24% to 42% of all studies,[7-9] and 31% of all Medicare beneficiaries who have a TTE get a repeat TTE within 1 year.[10] In the present study, we reviewed all inpatient TTE performed over 1 year and described the group that have had a prior TTE within the past year ("repeat TTE"). We then derived a clinical prediction model to predict unchanged repeat TTE, with the goal of defining a subset of studies that are potentially unnecessary.

METHODS

The West Haven Connecticut Veteran's Administration Hospital (WHVA), located outside New Haven, Connecticut, is a 228-bed tertiary care center affiliated with Yale University School of Medicine. Potential subjects were identified from review of the electronic medical records of all inpatients who had an inpatient echocardiogram between October 1, 2013, and September 30, 2014. Patient's records were reviewed by

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using a standardized data extraction form for demographics, comorbidity, cardiovascular risk factors, service ordering the TTE, intensive care unit (ICU) location, prior TTE abnormalities, TTE indication, AUC category, time between TTEs, technical quality of TTE, electrocardiogram (ECG) abnormalities, history of intervening acute coronary syndrome, cardiac surgery, and revascularization. Candidate predictors included any variables suspected by the authors as being potentially associated with the primary outcome of changed repeat TTE. All patients who had an inpatient TTE and a prior TTE within the Veterans Affairs (VA) system within the past year were included in the study. Repeat studies from the same admission were only counted as 1 TTE and patients had to have had a prior TTE from a different admission or a prior outpatient TTE to be included. Patients who did not have a prior TTE within the past year or who had only a transesophageal echocardiogram or stress echocardiography were excluded. Suboptimal studies were included but noted as limited quality. The study was approved by the WHVA Institutional Review Board. The Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis statement was used in planning and reporting this study.[11]

TTEs were classified as normal, mildly abnormal, or with a major abnormality based on previously published definitions.[12-14] Any abnormality was defined as any left ventricle (LV) dysfunction (left ventricular ejection fraction [LVEF] <55%), any aortic or mitral valve stenosis, any regional wall motion abnormality, any right ventricular dysfunction, any pulmonary hypertension, mild or greater valvular regurgitation, any diastolic dysfunction, moderate or greater pericardial effusion, any ventricular hypertrophy, or any other significant abnormality including thrombus, vegetation, or tamponade. Major abnormality was defined as moderate or greater LV dysfunction (LVEF <45%), moderate or greater valvular regurgitation, moderate or greater valvular stenosis (aortic or mitral valve area <1.5 cm^2), any regional wall motion abnormality, right ventricular dysfunction, moderate or greater pulmonary hypertension, moderate or greater diastolic dysfunction, moderate or greater pericardial effusion, or any other major abnormality including thrombus, vegetation, tumor, or tamponade. Repeat TTEs were classified as changed or unchanged. Changed TTEs were divided into any new abnormality or improvement or a new major abnormality or improvement. Any new abnormality or improvement was defined as any new TTE abnormality that had not previously been described or in which there was a change of at least 1 severity grade from a prior TTE, including improvement by 1 grade. A new major TTE abnormality or improvement was defined as any new major TTE abnormality that had previously been normal, or if there had been a prior abnormality, a change in at least 1 severity grade for LVEF or 2 severity grades for abnormal valvular, pericardial, or prior pulmonary hypertension, including improvement by 2 severity grades. A change from mild to moderate mitral regurgitation therefore was classified as a nonmajor change, whereas a change from mild to severe was classified as major. All TTE classifications were based on the electronic TTE reports and were reviewed by 2 independent investigators (CG and JC) blinded to the patients' other clinical characteristics. For TTE studies in which the investigators agreed, that determination was the final classification. Disagreements were reviewed and the final classification was determined by consensus.

In an analogous manner, ECGs were classified as normal, mildly abnormal, or with a major abnormality based on previous definitions in the literature.[15] Major abnormality was defined as atrial fibrillation or flutter, high-degree atrioventricular blocks, left bundle-branch block, right bundle-branch block, indeterminate conduction delay, q-wave myocardial infarction, isolated ischemic abnormalities, left ventricular hypertrophy with ST-T abnormalities, other arrhythmias including supraventricular tachycardia (SVT) or ventricular tachycardia (VT), low voltage (peak-to-peak QRS amplitude of <5 mm in the limb leads and/or <10 mm in the precordial leads), paced rhythm, sinus tachycardia (heart rate [HR] >100) or bradycardia (HR <50). Mild ECG abnormality was defined as low-grade atrioventricular blocks, borderline prolonged ventricular excitation, prolonged ventricular repolarization, isolated minor Q and ST-T abnormalities, left ventricular hypertrophy without ST-T abnormalities, left atrial enlargement, atrial or ventricular premature beats, or fascicular blocks. New major ECG abnormalities were any of the listed major ECG abnormalities that were not present on ECGs prior to the admission during which the repeat TTE was performed.

Other study definitions included intervening acute myocardial infarction (AMI), which was defined by any intervening history of elevated troponins, regardless of symptoms or ECG changes and including demand ischemia. Chronic kidney disease (CKD) was defined as an abnormal serum creatinine on 2 or more occasions 3 months apart. Active cancer was defined as receiving chemotherapy or palliative care for advanced cancer. Valvular heart disease was defined as prior moderate or severe valvular stenosis or regurgitation.

For analysis, we first compared patients with repeat TTE with major changes with those without major changes. For comparison of dichotomous variables, χ^2 or Fisher exact tests were used. For continuous variables, Student t test or the Mann-Whitney *U* test were performed. Because many of the frequencies of individual AUC criteria were small, related AUC criteria were grouped for analysis as grouped by the tables of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance (ACCF/ASE/AHA) Guideline.[4] Criteria groupings that were significantly less likely to have major TTE changes on analysis were classified as low risk and criteria that were significantly more likely were classified as high risk. Criteria groupings that were not significantly associated with TTE change were classified as average risk. All variables with *P* values less than .05 on bivariate analysis were then entered

TABLE 1. **Most Common AUC Indications for Repeat TTE and Associated Rates of Major TTE Changes**

AUC #	AUC Description	N (%)	N (% Row) With Major Change	AUC Risk Category
1	Symptoms potentially related to cardiac etiology, including dyspnea, chest pain, stroke	24 (11)	6 (25)	Low
71	Re-evaluation of known HF with a change in clinical status or exam without clear precipitant	22 (10)	5 (23)	Average
5	Atrial fibrillation, SVT, or VT	20 (9)	6 (30)	Average
2	Prior testing that is concerning for heart disease, including chest x-ray, ECG, or cardiac biomarkers	15 (7)	3 (20)	Low
22	Evaluation of a patient without chest pain but other features of ischemia or lab markers indicative of MI	14 (7)	11(79)	High
59	Suspected pericardial condition	14 (7)	6 (43)	Average
70	Initial evaluation of known or suspected HF	12 (6)	4 (33)	Average
19	Hypotension of uncertain or suspected cardiac etiology	11 (5)	4 (44)	Average
47	Initial postoperative evaluation of prosthetic valve	10 (5)	10 (100)	High
37	Re-evaluation of known valvular heart disease with a change in clinical status	9 (4)	2 (22)	Average

NOTE: Abbreviations: AUC, appropriate use criteria; ECG, electrocardiogram; HF, heart failure; MI, myocardial infarction; SVT, supraventricular tachycardia; TTE, transthoracic echocardiogram; VT, ventricular tachycardia.

into a multivariate logistic regression analysis with major TTE change as the dependent variable, using backward stepwise variable selection with entry and exit criteria of $P < .05$ and $P > .10$, respectively. Scores were derived by converting the regression coefficients of independently predictive variables in the logistic regression model into corresponding integers. A total score was calculated for each patient by summing up the points for each independently significant variable. Model performance was described by calculating a C statistic by creation of a receiver operating characteristic curve to assess discrimination, and by performing the Hosmer and Lemeshow test to assess calibration. Internal validation was assessed by calculating the C statistic using the statistical method of bootstrapping in which the data were resampled multiple times (n = 200) and the average resultant C statistic reported. The bootstrap analysis was performed using R version 3.1 (R Foundation for Statistical Computing, Vienna, Austria). All other analyses were performed using SPSS version 21.0 (IBM, Armonk, New York). *P* values <.05 were considered significant.

RESULTS

During the 1-year study period, there were 3944 medical/surgical admissions for 3266 patients and 845 inpatient TTEs obtained on 601 patients. Of all patients who were admitted, 601/3266 (18.4%) had at least 1 inpatient TTE. Of these 601 TTEs, 211 (35%) had a TTE within the VA system during the prior year. Of the 211 repeat TTEs, 67 (32%) were unchanged, 66 (31%) had minor changes, and 78 (37%) had major changes. The kappa statistic for agreement between extractors for "major TTE change" was 0.91, $P < .001$. The 10 most common AUC indications for TTE, which accounted for 72% of all studies, are listed in Table 1. The initial AUCs assigned by reviewers were the same in 187 of 211 TTEs (kappa 0.86, $P < .001$). Most indications were not associated with TTE outcome, although studies ordered for AUC indications 1 and 2 were less likely be associated with major changes and AUC indications 22 and 47 were more likely to be associated with major changes. Table 2 shows the comparison of the 78 patients that had repeat TTE with major changes compared with the 133 patients that did not. Nine variables were significantly different between the 2 groups; repeat TTEs with major changes were more likely to have dementia, be ordered by the surgery service, be located in an ICU, have major new ECG changes, have had prior valvular heart disease, have had an intervening AMI or cardiac surgery, or be in a high-risk AUC category. Patients with CKD were less likely to have major changes. Table 3 shows the results of the multivariate analysis; CKD, intervening AMI, prior valvular heart disease, major new ECG changes, and intervening cardiac surgery all independently predicted major changes on repeat TTE. Based on the β-coefficient for each variable, a point system was assigned to each variable and a total score calculated for each patient. Most variables had β-coefficients close to 1 and were therefore assigned a score of 1. CKD was associated with a lower risk of major TTE abnormality and was assigned a negative score. Intervening AMI was associated with a β-coefficient of 2.2 and was assigned a score of 2. Based on the points assigned to each variable and its presence or absence for each patient, a total score, which we named the CAVES score, was calculated. The acronym CAVES stands for CKD, AMI, valvular disease, ECG changes, and surgery (cardiac). Table 4 shows the frequencies of each score for each patient, ranging from patients with CKD and no other risk factors who scored −1 to patients without CKD who had all 4 of the other variables who scored 5. The prevalence of major TTE change for the full cohort was 37%. For the group with a CAVES score of −1, the probability was only 5.6%; for the group with a score of 0, the probability was 17.7%; and for the group with a score ≥1, the probability was 55.3%.

TABLE 2. **Results of Bivariate Analysis of Possible Predictors of Changed TTE**

Characteristics	Major TTE Change (n = 78)	No Major TTE Change (n = 133)	*P* Value
Age, mean ± SD (years)	70.9 ± 10.0	71.0 ± 11.7	.95
Male gender	77	129	.43
Diabetes	32 (41)	61 (46)	.49
Coronary artery disease	47 (60)	75 (56)	.58
HFREF	20 (26)	48 (36)	.12
HFPEF	6 (8)	16 (12)	.32
Pulmonary hypertension	6 (8)	13 (10)	.61
Hypertension	47 (60)	97 (73)	.06
Chronic obstructive lung disease	17 (22)	36 (27)	.39
Other lung disease	1 (1)	7 (5)	.14
End-stage kidney disease	5 (6)	8 (6)	.91
Chronic kidney disease	12 (15)	38 (29)	.03
Obesity	31 (40)	56 (42)	.74
Alcohol use disorder	2 (3)	5 (4)	.64
Opiate dependence	0	1 (1)	.43
Dementia	11 (14)	8 (6)	.05
Chronic psychotic disorder	1 (1)	6 (5)	.21
Active cancer	14 (18)	21 (16)	.68
Service			.02
Medicine	53 (68)	107 (80)	
Neurology	1 (1)	6 (5)	
Surgery	24 (31)	20 (15)	
ICU location	27 (35)	23 (17)	.004
Prior ECG major abnormality	41/72 (57)	82/126 (65)	.26
Chronic atrial fibrillation	34 (44)	50 (38)	.39
Major new ECG changes	39/71 (55)	33/126 (26)	.000
New atrial fibrillation	11 (14)	12 (9)	.25
Prior TTE			.13
Normal	8 (10)	14 (11)	
Minor abnormal	17 (22)	46 (35)	
Major abnormal	53 (68)	73 (55)	
Prior TTE suboptimal	9 (12)	14 (11)	.82
Prior TTE non-VHA	12 (15)	11 (8)	.11
Prior valve disease	34 (44)	29 (22)	.001
Time between TTEs (months)	4.6 ± 3.4	5.4 ± 3.6	.15
Intervening AMI	21 (27)	7 (5)	.000
Intervening revascularization	13 (17)	13 (10)	.14
Intervening cardiothoracic surgery	23 (29)	5 (4)	.000
AUC category			.000
Low-risk categories	9 (12)	30 (23)	
Average-risk categories	45 (58)	97 (73)	
High-risk categories	24 (31)	6 (5)	
Chronic opiate therapy	7 (9)	18 (14)	.32

NOTE: Abbreviations: AMI, acute myocardial infarction; AUC, appropriate use criteria; ECG, electrocardiogram; HFPEF, heart failure with preserved ejection fraction; HFREF, heart failure with reduced ejection fraction; ICU, intensive care unit; SD, standard deviation; TTE, transthoracic echocardiogram; VHA, Veterans health administration.

TABLE 3. **Results from Multivariate Analysis of Risk Factors for Changed TTE and the Corresponding Score Assigned for Each Significant Variable**

Covariate	Odds Ratio (95% CI)	*P* Value	β-Coefficient	Score
Intervening AMI	9.3 (3.3-25.6)	.000	2.2	**2**
Intervening CT Surgery	3.8 (1.6-8.8)	.002	1.3	1
Valvular heart disease	3.4 (1.7-7.1)	.001	1.2	1
Major new ECG change	2.7 (1.3-5.4)	.006	1.0	1
CKD	0.4 (0.2-0.9)	.032	−0.9	−1

NOTE: Abbreviations: AMI, acute myocardial infarction; CI, confidence interval; CKD, chronic kidney disease; CT, cardiothoracic; ECG, electrocardiogram; TTE, transthoracic echocardiogram.

The only missing data were for the variables of admission or baseline ECG, which were missing for 13 patients (6.1%). Ten of these 13 were patients referred for cardiac surgery or revascularization from nonlocal VA hospitals and hence had no prior ECGs in our electronic records. We included these patients and assumed for analysis that their ECGs were unchanged.

The bootstrap corrected C statistic for the model was 0.78 (95% confidence interval, 0.72-0.85), indicating good discrimination. The Hosmer and Lemeshow test showed nonsignificance, indicating good calibration ($\chi^2 = 5.20$, df = 6, $P = .52$).

DISCUSSION

In this retrospective study, we found that approximately 18% of all patients admitted to the hospital had an inpatient TTE performed, and that approximately 35% of this group had a prior TTE within the past year. Of the group with prior TTEs within the past year, 37% had a major new change and 63% had either minor or no changes. Prior studies have reported similar high rates of repeat TTE[7-9] and of major changes on repeat TTE.[8,14,16] On multivariate analysis, we found that 5 variables were independent predictors of new changes on TTE—absence of CKD, intervening AMI, intervening cardiac surgery, history of valvular heart disease, and major new ECG changes. We developed and internally validated a risk score based on these 5 variables, which was found to have good overall accuracy as measured by the bootstrap corrected C statistic. The simplified version of the score divides patients into low, intermediate, and high risk for major changes on TTE. The low-risk group, defined as the group with no risk factors, had an approximately 6% risk of a major TTE change; the intermediate risk group, defined as a score of 0, had an 18% risk of major TTE change; and the high-risk group, defined as a score of 1 or greater, had a 55% chance of major TTE change. We believe that this risk score, if further validated, will potentially allow hospital-based clinicians to estimate the chance of a major change on TTE prior to ordering the study. For the low-risk group, this may indicate that the study is unnecessary. Conversely, for patients at high risk, this may offer further evidence that it will be useful to obtain a repeat TTE.

TABLE 4. **CAVES Score Frequencies and Associated Rates of Major TTE Changes**

CAVES Score	Number (%) N = 211	Major TTE Change N (% of Row)
−1[a]	**18 (8.5)**	**1 (5.6)**
0	**79 (37.4)**	**14 (17.7)**
1	**60 (28.4)**	**24 (40)**
2	**33 (15.6)**	**20 (60.6)**
3	**12 (5.7)**	**11 (91.7)**
4	**8 (3.8)**	**7 (87.5)**
5	**1 (0.5)**	**1 (100)**
Simplified CAVES Score		
−1	18 (8.5)	1 (5.6)
0	79 (37.4)	14 (17.7)
≥1	114 (54.0)	63 (55.3)

[a]Patients with chronic kidney disease subtract one point on the CAVES score.

NOTE: Abbreviations: CAVES; C, Chronic kidney disease (CKD); A, Acute myocardial infarction since the prior TTE; V, Valvular heart disease on the prior TTE; E, ECG with major new changes since prior study; S, Surgery on the heart since prior TTE; TTE, transthoracic echocardiogram.

The primary limitation of the study is that it was relatively small and derived at a single institution and will thus need to be externally validated prior to adoption. Although there are no widely accepted criteria for calculating study sizes for clinical prediction models, a small study increases the chance of overfitting, as does the lack of external validation. Because of the relatively small size, it is possible that important variables were found to lack association with the outcome because of their rarity. Many of the individual AUC indications, for example, were infrequent. Another limitation is the lack of female patients, which may limit generalizability. Finally, although the overall performance of the model was good, the lowest-risk group was only 8.5% of the cohort, which may limit its ability

to decrease the number of repeat TTE. The intermediate-risk group represented a much larger proportion of 37% but still had an 18% risk of major TTE changes.

Strengths of the study included the careful definitions of study variables, particularly of AUC, major TTE, and ECG changes. The 5 variables in the final model are clinically plausible, with the possible exception of CKD, which was associated with a lower risk of having a changed repeat TTE, possibly because of the nonspecificity of edema in patients with CKD. There were also minimal missing data, which only occurred in 6% of patients, and for only 1 variable, baseline ECG.

In summary, we have developed a simple score to predict the likelihood of major changes on repeat TTEs for hospitalized patients. The CAVES score identified 8.5% of patients as being low risk for changed repeat TTE, 37% at intermediate risk, and 54% at high risk for major changes. We believe that the CAVES score, if further validated, may be used to risk stratify patients for ordering TTE and to potentially avoid unnecessary repeat studies.

Disclosure: The authors indicated no conflicts of interest.

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Relationship between Hospital 30-Day Mortality Rates for Heart Failure and Patterns of Early Inpatient Comfort Care

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BACKGROUND: The Centers for Medicare & Medicaid Services rewards hospitals that have low 30-day risk-standardized mortality rates (RSMR) for heart failure (HF).

OBJECTIVE: To describe the use of early comfort care for patients with HF, and whether hospitals that more commonly initiate comfort care have higher 30-day mortality rates.

DESIGN: A retrospective, observational study.

SETTING: Acute care hospitals in the United States.

PATIENTS: A total of 93,920 fee-for-service Medicare beneficiaries admitted with HF from January 2008 to December 2014 to 272 hospitals participating in the Get With The Guidelines-Heart Failure registry.

EXPOSURE: Early comfort care (defined as comfort care within 48 hours of hospitalization) rate.

MEASUREMENTS: A 30-day RSMR.

RESULTS: Hospitals' early comfort care rates were low for patients admitted for HF, with no change over time (2.5% to 2.6%, from 2008 to 2014, $P = .56$). Rates varied widely (0% to 40%), with 14.3% of hospitals not initiating comfort care for any patients during the first 2 days of hospitalization. Risk-standardized early comfort care rates were not correlated with RSMR (median RSMR = 10.9%, 25th to 75th percentile = 10.1% to 12.0%; Spearman's rank correlation = 0.13; $P = .66$).

CONCLUSIONS: Hospital use of early comfort care for HF varies, has not increased over time, and on average, is not correlated with 30-day RSMR. This suggests that current efforts to lower mortality rates have not had unintended consequences for hospitals that institute early comfort care more commonly than their peers. *Journal of Hospital Medicine* 2018;13:170-176. © 2018 Society of Hospital Medicine

In an effort to improve the quality of care delivered to heart failure (HF) patients, the Centers for Medicare & Medicaid Services (CMS) publish hospitals' 30-day risk-standardized mortality rates (RSMRs) for HF.[1] These mortality rates are also used by CMS to determine the financial penalties and bonuses that hospitals receive as part of the national Hospital Value-based Purchasing program.[2] Whether or not these efforts effectively direct patients towards high-quality providers or motivate hospitals to provide better care, few would disagree with the overarching goal of decreasing the number of patients who die from HF.

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However, for some patients with chronic disease at the end of life, goals of care may change. The quality of days lived may become more important than the quantity of days lived. As a consequence, high-quality care for some patients at the end of life is associated with withdrawing life-sustaining or life-extending therapies. Over time, this therapeutic perspective has become more common, with use of hospice care doubling from 23% to 47% between 2000 and 2012 among Medicare beneficiaries who died.[3] For a national cohort of older patients admitted with HF—not just those patients who died in that same year—hospitals' rates of referral to hospice are considerably lower, averaging 2.9% in 2010 in a national study.[4] Nevertheless, it is possible that hospitals that more faithfully follow their dying patients' wishes and withdraw life-prolonging interventions and provide comfort-focused care at the end of life might be unfairly penalized if such efforts resulted in higher mortality rates than other hospitals.

Therefore, we used Medicare data linked to a national HF registry with information about end-of-life care, to address 3 questions: (1) How much do hospitals vary in their rates of early

comfort care and how has this changed over time; (2) What hospital and patient factors are associated with higher early comfort care rates; and (3) Is there a correlation between 30-day risk-adjusted mortality rates for HF with hospital rates of early comfort care?

METHODS

Data Sources

We used data from the American Heart Association's Get With The Guidelines-Heart Failure (GWTG-HF) registry. GWTG-HF is a voluntary, inpatient, quality improvement registry[5-7] that uses web-based tools and standard questionnaires to collect data on patients with HF admitted to participating hospitals nationwide. The data include information from admission (eg, sociodemographic characteristics, symptoms, medical history, and initial laboratory and test results), the inpatient stay (eg, therapies), and discharge (eg, discharge destination, whether and when comfort care was initiated). We linked the GWTG-HF registry data to Medicare claims data in order to obtain information about Medicare eligibility and patient comorbidities. Additionally, we used data from the American Hospital Association (2008) for hospital characteristics. Quintiles Real-World & Late Phase Research (Cambridge, MA) serves as the data coordinating center for GWTG-HF and the Duke Clinical Research Institute (Durham, NC) serves as the statistical analytic center. GWTG-HF participating sites have a waiver of informed consent because the data are de-identified and primarily used for quality improvement. All analyses performed on this data have been approved by the Duke Medical Center Institutional Review Board.

Study Population

We identified 107,263 CMS-linked patients who were 65 years of age or older and hospitalized with HF at 348 fully participating GWTG-HF sites from February 17, 2008, to December 1, 2014. We excluded an additional 12,576 patients who were not enrolled in fee-for-service Medicare at admission, were transferred into the hospital, or had missing comfort measures only (CMO) timing information. We also excluded 767 patients at 68 sites with fewer than 30 patients. These exclusions left us with 93,920 HF patients cared for at 272 hospitals for our final study cohort (Supporting Figure 1).

Study Outcomes

Our outcome of interest was the correlation between a hospital's rate of initiating early CMO for admitted HF patients and a hospital's 30-day RSMR for HF. The GWTG-HF questionnaire[8] asks "When is the earliest physician/advanced practice nurse/physician assistant documentation of comfort measures only?" and permits 4 responses: day 0 or 1, day 2 or after, timing unclear, or not documented/unable to determine. We defined early CMO as CMO on day 0 or 1, and late/no CMO as any other response. We chose to examine early comfort care because many hospitalized patients transition to comfort care before they die if the death is in any way predictable. Thus, if comfort care is measured at any time during the hospitalization, hospitals that have high mortality rates are likely to have high

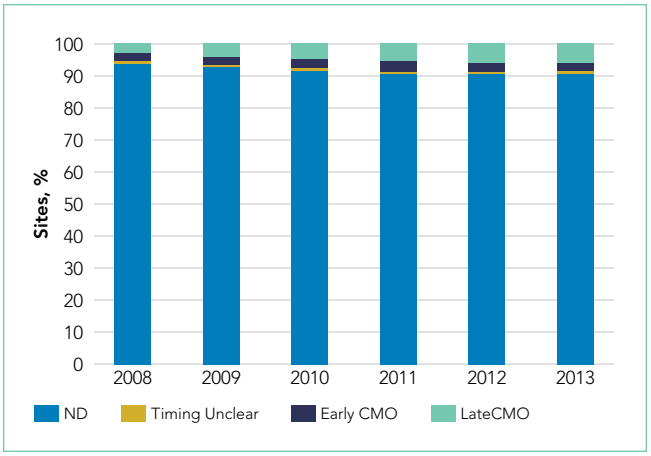

FIG 1. Trends in comfort care rates, stratified by timing of comfort care during a hospitalization, 2008-2013. ND indicates comfort measures not documented. CMO is comfort measures only, with early CMO defined as Day 0 or 1 in response to the question: "When is the earliest physician/APN/PA documentation of comfort measures only?" Late CMO is defined as CMO on Day 2 or later. For not documented, timing unclear, early CMO, and late CMO, P values are <.001, .02, .56, and <.001, respectively.

NOTE: Abbreviations: APN, advanced practice nurse; CMO, comfort measures only; PA, physician assistant.

comfort care rates. Therefore, we chose to use the more precise measure of early comfort care. We created hospital-level, risk-standardized early comfort care rates using the same risk-adjustment model used for RSMRs but with the outcome of early comfort care instead of mortality.[9,10]

RSMRs were calculated using a validated GWTG-HF 30-day risk-standardized mortality model[9] with additional variables identified from other GWTG-HF analyses.[10] The 30 days are measured as the 30 days after the index admission date.

Statistical Analyses

We described trends in early comfort care rates over time, from February 17, 2008, to February 17, 2014, using the Cochran-Armitage test for trend. We then grouped hospitals into quintiles based on their unadjusted early comfort care rates. We described patient and hospital characteristics for each quintile, using χ^2 tests to test for differences across quintiles for categorical variables and Wilcoxon rank sum tests to assess for differences across quintiles for continuous variables. We then examined the Spearman's rank correlation between hospitals' RSMR and risk-adjusted comfort care rates. Finally, we compared hospital-level RSMRs before and after adjusting for early comfort care.

We performed risk-adjustment for these last 2 analyses as follows. For each patient, covariates were obtained from the GWTG-HF registry. Clinical data captured for the index admission were utilized in the risk-adjustment model (for both RSMRs and risk-adjusted comfort care rates). Included covariates were as follows: age (per 10 years); race (black vs non-black); systolic blood pressure at admission ≤170 (per 10 mm Hg); respiratory rate (per 5 respirations/min); heart rate ≤105 (per 10 beats/min); weight ≤100 (per 5 kg); weight >100 (per 5 kg); blood urea nitrogen (per 10 mg/dl); brain natriuretic peptide ≤2000 (per 500 pg/ml); hemoglobin 10-14 (per 1 g/dl); troponin abnormal

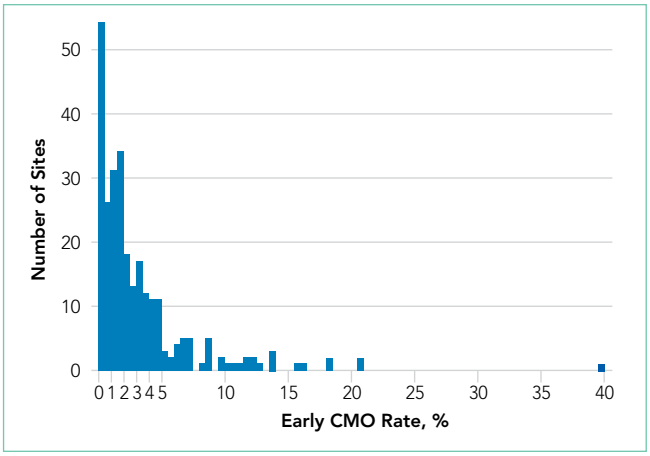

FIG 2. Hospital-level variation in comfort care rates. CMO is comfort measures only, with early CMO defined as Day 0 or 1 in response to the question: "When is the earliest physician/APN/PA documentation of comfort measures only?"

NOTE: Abbreviations: APN, advanced practice nurse; CMO, comfort measures only; PA, physician assistant.

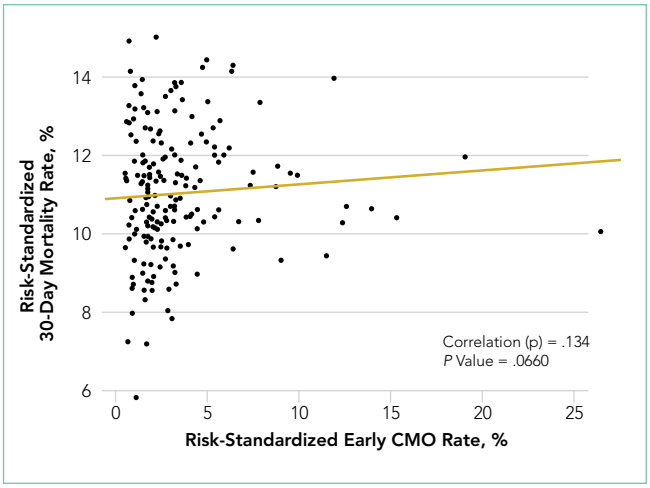

FIG 3. Correlation between hospitals' risk-standardized 30-day mortality rates and risk-adjusted comfort care rates. Each dot represents a single hospital. CMO is comfort measures only, with early CMO defined as Day 0 or 1 in response to the question: "When is the earliest physician/APN/PA documentation of comfort measures only?"

NOTE: Abbreviations: APN, advanced practice nurse; CMO, comfort measures only; PA, physician assistant.

(vs normal); creatinine ≤1 (per 1 mg/dl); sodium 130-140 (per 5 mEq/l); and chronic obstructive pulmonary disease or asthma.

Hierarchical logistic regression modeling was used to calculate the hospital-specific RSMR. A predicted/expected ratio similar to an observed/expected (O/E) ratio was calculated using the following modifications: (1) instead of the observed (crude) number of deaths, the numerator is the number of deaths predicted by the hierarchical model among a hospital's patients given the patients' risk factors and the hospital-specific effect; (2) the denominator is the expected number of deaths among the hospital's patients given the patients' risk factors and the average of all hospital-specific effects overall; and (3) the ratio of the numerator and denominator are then multiplied by the observed overall mortality rate (same as O/E). This calculation is the method used by CMS to derive RSMRs.[11] Multiple imputation was used to handle missing data in the models; 25 imputed datasets using the fully conditional specification method were created. Patients with missing prior comorbidities were assumed to not have those conditions. Hospital characteristics were not imputed; therefore, for analyses that required construction of risk-adjusted comfort care rates or RSMRs, we excluded 18,867 patients cared for at 82 hospitals missing hospital characteristics. We ran 2 sets of models for risk-adjusted comfort care rates and RSMRs: the first adjusted only for patient characteristics, and the second adjusted for both patient and hospital characteristics. Results from the 2 models were similar, so we present only results from the latter. Variance inflation factors were all <2, indicating the collinearity between covariates was not an issue.

All statistical analyses were performed by using SAS version 9.4 (SAS Institute, Cary, NC). We tested for statistical significance by using 2-tailed tests and considered *P* values <.05 to be statistically significant.

RESULTS

Of the 272 hospitals included in our final study cohort, the observed median overall rate of early comfort care in this study was 1.9% (25th to 75th percentile: 0.9% to 4.0%); hospitals varied widely in unadjusted early comfort care rates (0.00% to 0.46% in the lowest quintile, and 4.60% to 39.91% in the highest quintile; Table 1).

The sociodemographic characteristics of the 93,920 patients included in our study cohort differed across hospital comfort care quintiles. Compared with patients cared for by hospitals in the lowest comfort care quintile, patients cared for by hospitals in the highest comfort care quintile were less likely to be male (44.6% vs 46.7%, *P* = .0003), and less likely to be black (8.1% vs 14.0%), Asian (0.9% vs 1.2%), or Hispanic (6.2% vs 11.6%; *P* < .0001). Patients cared for at hospitals in the highest versus the lowest comfort care quintiles had slightly higher rates of prior stroke or transient ischemic attack (17.9% vs 13.5%; *P* < .0001), chronic dialysis (4.7% vs 2.9%; *P* = .002), and depression (12.8% vs 9.3%, *P* < .0001).

Compared to hospitals in the lowest comfort care quintile, hospitals in the highest comfort care quintile were as likely to be academic teaching hospitals (38.9% vs 47.2%; *P* = .14; Table 2). Hospitals in the highest comfort care quintiles were less likely to have the ability to perform surgical interventions, such as cardiac surgery (52.6% vs 66.7%, *P* = .04) or heart transplants (2.5% vs 12.1%; *P* = .04).

Early comfort care rates showed minimal change from 2.60% in 2008 to 2.49% in 2013 (*P* = 0.56; Figure 1). For this entire time period, there were a few hospitals that had very high early comfort care rates, but 90% of hospitals had comfort care rates that were 7.2% or lower. About 19.9% of hospitals (54 hospitals) initiated early comfort care on 0.5% or less of their patients admitted with HF; about half of hospitals initiated comfort care for 1.9% or fewer of their patients (Figure 2). There was a more even distribution of late CMO rate across hospitals (Supporting Figure 2).

TABLE 1. **Patient Characteristics by Comfort Care Quintiles**

	Quintiles of Comfort Care Rate					
	Quintile 1 (Low)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (High)	
	(N = 39)	(N = 39)	(N = 40)	(N = 39)	(N = 39)	
Patient Characteristics	(n = 13,231)	(n = 24,180)	(n = 20,316)	(n = 21,903)	(n = 14,290)	***P* Value**
Comfort care rates, %	0.00 to 0.46	0.52 to 1.49	1.49 to 2.45	2.51 to 4.55	4.60 to 39.91	
Demographics						
Age						<.0001
Mean ± SD	80.1 ± 8.5	80.5 ± 8.4	81.0 ± 8.5	81.6 ± 8.4	80.9 ± 8.4	
Median (IQR)	81 (73, 87)	81 (74, 87)	82 (74, 87)	82 (75, 88)	82 (74, 87)	
Male	6178 (46.7)	11,093 (45.9)	9222 (45.4)	9918 (45.3)	6375 (44.6)	.0003
Race						<.0001
White	9274 (70.3)	18,591 (80.7)	16,483 (82.1)	19,011 (87.2)	11,690 (82.9)	
Black	1851 (14.0)	2846 (12.4)	1925 (9.6)	1229 (5.6)	1145 (8.1)	
Asian	156 (1.2)	194 (0.84)	521 (2.6)	313 (1.4)	123 (0.9)	
Hispanic (any race)	1526 (11.6)	740 (3.2)	574 (2.9)	782 (3.6)	873 (6.2)	
Medical history (panel missing excluded)						
Atrial fibrillation or flutter	5072 (41.3)	9807 (43.4)	8741 (45.7)	9419 (45.9)	6136 (44.7)	<.0001
Diabetes	4733 (38.6)	9330 (41.2)	7645 (40.0)	7700 (37.5)	5698 (41.5)	.64
Hypertension	9229 (75.2)	18,367 (81.2)	15,311 (80.1)	16,130 (78.6)	11,000 (80.1)	<.0001
Ischemic etiology[a]	6957 (56.7)	13,493 (59.7)	11,267 (58.9)	11,730 (57.2)	7906 (57.6)	.050
Prior stroke/TIA	1651 (13.5)	4000 (17.7)	3454 (18.1)	3467 (16.9)	2458 (17.9)	<.0001
HF prior to index admission	8587 (70.0)	15,295 (67.6)	13,074 (68.4)	13,111 (63.9)	9750 (71.0)	.01
Chronic dialysis	361 (2.9)	756 (3.3)	610 (3.2)	460 (2.2)	638 (4.7)	.0022
Depression	1135 (9.3)	2597 (11.5)	2447 (12.8)	2082 (10.2)	1756 (12.8)	<.0001
Valvular heart disease	1817 (14.8)	4383 (19.4)	4597 (24.1)	4278 (20.9)	3036 (22.1)	<.0001
Labs at Admission						
Ejection Fraction						
Preserved EF	6250 (48.5)	11,719 (49.6)	9716 (49.1)	10,851 (50.9)	6922 (50.5)	<.0001
Borderline EF	1803 (14.0)	3154 (13.3)	2718 (13.7)	2835 (13.3)	1918 (14.0)	
Reduced EF	4839 (37.5)	8775 (37.1)	7368 (37.2)	7620 (35.8)	4864 (35.5)	
Serum Creatinine, mg/dL						.054
Mean ± SD	1.7 ± 1.3	1.6 ± 1.3	1.6 ± 1.2	1.6 ± 1.2	1.7 ± 1.3	
Median (IQR)	1.3 (1, 1.9)	1.3 (1, 1.8)	1.3 (1, 1.8)	1.3 (1, 1.8)	1.3 (1, 1.8)	
Outcome						<.0001
30-Day Mortality	1269 (9.6)	2555 (10.6)	2249 (11.1)	2561 (11.7)	1740 (12.2)	

[a]Medical history of coronary artery disease, myocardial infarction, prior percutaneous coronary intervention, prior coronary artery bypass graft, or prior percutaneous coronary intervention and coronary artery bypass graft.

NOTE: N refers to number of hospitals; n refers to number of patients. Abbreviations: EF, ejection fraction; HF, heart failure; IQR is interquartile range; SD, standard deviation; TIA, transient ischemic attack.

Hospitals' 30-day RSMR and risk-adjusted comfort care rates showed a very weak, but statistically insignificant positive correlation (Spearman's rank correlation ρ = 0.13, *P* = .0660; Figure 3). Hospitals' 30-day RSMR before versus after adjusting for comfort care were largely similar (Supporting Figure 3). The median hospital-level RSMR was 10.9%, 25th to 75th percentile, 10.1% to 12.0% (data not displayed). The mean difference between RSMR after comfort care adjustment, compared to before adjustment, was 0.001% (95% confidence interval [CI], −0.014% to 0.017%). However, for the 90 hospitals with comfort care rates of 1.9% (ie, the median) or above, mortality rates decreased slightly after comfort care adjustment (mean change of −0.07%; 95% CI, −0.06 to −0.08; *P* < .0001). Patient-level RSMR decreased after excluding early comfort care patients, although the shape of the distribution remained the same (Supporting Figure 4).

DISCUSSION

Among a national sample of US hospitals, we found wide variation in how frequently health care providers deliver comfort care within the first 2 days of admission for HF. A minority of hospitals reported no early comfort care on any patients throughout the 6-year study period, but hospitals in the highest quintile initiated early comfort care rates for at least 1 in

TABLE 2. **Hospital Characteristics by Comfort Care Quintiles (at the Hospital Level)**

	Quintiles of Comfort Care Rate					
	Quintile 1 (Low)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (High)	
	(N = 54)	(N = 55)	(N = 54)	(N = 55)	(N = 54)	
Hospital Characteristics	(n = 5650)	(n = 13,420)	(n = 12,365)	(n = 10,885)	(n = 9300)	*P* Value
Comfort care rates, %	0.00 to 0.46	0.52 to 1.49	1.49 to 2.45	2.51 to 4.55	4.60 to 39.91	
Early comfort care rate (%)						
Mean ± SD	0.1 ±0.2	1.0 ±0.2	1.9 ±0.3	3.5 ±0.6	9.6 ±6.0	
Median (IQR)	0 (0.0, 0.2)	1.0 (0.82, 1.2)	1.9 (1.7, 2.2)	3.4 (3.0, 4.0)	7.3 (5.9, 11.8)	
Academic/teaching hospital	25 (47.2)	32 (60.4)	30 (55.6)	25 (45.5)	21 (38.9)	.14
Number of beds						.14
Mean ± SD	316.8 ±218.2	403.8 ±248.8	335.6 ±199.7	305.4 ±194.4	279 ±155.2	
Median (IQR)	279 (150, 410)	355 (227, 550)	312 (177, 440)	270 (165, 405)	253 (161, 368)	
Primary PTCA performed for AMI	29 (80.6)	36 (87.8)	37 (84.1)	39 (81.3)	29 (70.7)	.16
Cardiac surgery performed at site	24 (66.7)	32 (80.0)	31 (70.5)	28 (60.9)	20 (52.6)	.04
Heart transplants performed at site	4 (12.1)	5 (12.5)	4 (11.1)	2 (4.4)	1 (2.5)	.04
Rural Location	5 (9.3)	5 (9.1)	5 (9.3)	4 (7.3)	8 (15.4)	.44
Region						.15
West	6 (11.1)	4 (7.3)	7 (13.0)	10 (18.2)	9 (16.7)	
South	26 (48.2)	22 (40.0)	13 (24.1)	16 (29.1)	18 (33.3)	
Midwest	9 (16.7)	11 (20.0)	12 (22.2)	12 (21.8)	13 (24.1)	
Northeast	13 (24.1)	18 (32.7)	22 (40.7)	17 (30.9)	14 (25.9)	
Length of stay						<.0001
Mean ± SD	5.7 ±6.5	5.4 ±5.3	5.4 ±4.7	5.1 ±4.8	5.0 ±5.6	
Median (IQR)	4.0 (3.0, 7.0)	4.0 (3.0, 7.0)	4.0 (3.0, 7.0)	4.0 (3.0, 6.0)	4.0 (3.0, 6.0)	

NOTE: N refers to number of hospitals; n refers to number of patients. Abbreviations: AMI, acute myocardial infarction; HF, heart failure; IQR is interquartile range; PTCA, percutaneous transluminal coronary angioplasty; SD, standard deviation; TIA, transient ischemic attack.

20 HF patients. Hospitals that were more likely to initiate early comfort care had a higher proportion of female and white patients and were less likely to have the capacity to deliver aggressive surgical interventions such as heart transplants. Hospital-level 30-day RSMRs were not correlated with rates of early comfort care.

While the appropriate rate of early comfort care for patients hospitalized with HF is unknown, given that the average hospital RSMR is approximately 12% for fee-for-service Medicare patients hospitalized with HF,[12] it is surprising that some hospitals initiated early comfort care on none or very few of their HF patients. It is quite possible that many of these hospitals initiated comfort care for some of their patients after 48 hours of hospitalization. We were unable to estimate the average period of time patients received comfort care prior to dying, the degree to which this varies across hospitals or why it might vary, and whether the length of time between comfort care initiation and death is related to satisfaction with end-of-life care. Future research on these topics would help inform providers seeking to deliver better end-of-life care. In this study, we also were unable to estimate how often early comfort care was not initiated because patients had a good prognosis. However, prior studies have suggested low rates of comfort care or hospice referral even among patients at very high estimated mortality risk.[4] It is also possible that providers and families had concerns about the ability to accurately prognosticate, although several models have been shown to perform acceptably for patients hospitalized with HF.[13]

We found that comfort care rates did not increase over time, even though use of hospice care doubled among Medicare beneficiaries between 2000 and 2012. By way of context, cancer—the second leading cause of death in the US—was responsible for 38% of hospice admissions in 2013, whereas heart disease (including but not limited to HF)—the leading cause of death— was responsible for 13% of hospice admissions.[14] The 2013 American College of Cardiology Foundation and the American Heart Association guidelines for HF recommend consideration of hospice or palliative care for inpatient and transitional care.[15] In future work, it would be important to better understand the drivers behind decisions around comfort care for patients hospitalized with HF.

With regards to the policy implications of our study, we found that on average, adjusting 30-day mortality rates for early comfort care was not associated with a change in hospital mortality rankings. For those hospitals with high comfort care rates, adjusting for comfort care did lower mortality rates, but

the change was so small as to be clinically insignificant. CMS' RSMR for HF excludes patients enrolled in hospice during the 12 months prior to index admission, including the first day of the index admission, acknowledging that death may not be an untoward outcome for such patients.[16] Fee-for-service Medicare beneficiaries excluded for hospice enrollment comprised 1.29% of HF admissions from July 2012 to June 2015[16] and are likely a subset of early comfort care patients in our sample, both because of the inclusiveness of chart review (vs claims-based identification) and because we defined early comfort care as comfort care initiated on day 0 or 1 of hospitalization. Nevertheless, with our data we cannot assess to what degree our findings were due solely to hospice patients excluded from CMS' current estimates.

Prior research has described the underuse of palliative care among patients with HF[17] and the association of palliative care with better patient and family experiences at the end of life.[18-20] We add to this literature by describing the epidemiology—prevalence, changes over time, and associated factors—of early comfort care for HF in a national sample of hospitals. This serves as a baseline for future work on end-of-life care among patients hospitalized for HF. Our findings also contribute to ongoing discussion about how best to risk-adjust mortality metrics used to assess hospital quality in pay-for-performance programs. Recent research on stroke and pneumonia based on California data suggests that not accounting for do-not-resuscitate (DNR) status biases hospital mortality rates.[21,22] Earlier research examined the impact of adjusting hospital mortality rates for DNR for a broader range of conditions.[23,24] We expand this line of inquiry by examining the hospital-level association of early comfort care with mortality rates for HF, utilizing a national, contemporary cohort of inpatient stays. In addition, while studies have found that DNR rates within the first 24 hours of admission are relatively high (median 15.8% for pneumonia; 13.3% for stroke),[21,22] comfort care is distinct from DNR.

Our findings should be interpreted in the context of several potential limitations. First, we did not have any information about patient or family wishes regarding end-of-life care, or the exact timing of early comfort care (eg, day 0 or day 1). The initiation of comfort care usually follows conversations about end-of-life care involving a patient, his or her family, and the medical team. Thus, we do not know if low early comfort care rates represent the lack of such a conversation (and thus poor-quality care) or the desire by most patients not to initiate early comfort care (and thus high-quality care). This would be an important area for future research. Second, we included only patients admitted to hospitals that participate in GWTG-HF, a voluntary quality improvement initiative. This may limit the generalizability of our findings, but it is unclear how our sample might bias our findings. Hospitals engaged in quality improvement may be more likely to initiate early comfort care aligned with patients' wishes; on the other hand, hospitals with advanced surgical capabilities are over-represented in our sample and these hospitals are less likely to initiate early comfort care. Third, we examined associations and cannot make conclusions about causality. Residual measured and unmeasured confounding may influence these findings.

In summary, we found that early comfort care rates for fee-for-service Medicare beneficiaries admitted for HF varies widely among hospitals, but median rates of early comfort care have not changed over time. On average, there was no correlation between hospital-level, 30-day, RSMRs and rates of early comfort care. This suggests that current efforts to lower mortality rates have not had unintended consequences for hospitals that institute early comfort care more commonly than their peers.

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Primary Care Provider Preferences for Communication with Inpatient Teams: One Size Does Not Fit All

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As the hospitalist's role in medicine grows, the transition of care from inpatient to primary care providers (PCPs, including primary care physicians, nurse practitioners, or physician assistants), becomes increasingly important. Inadequate communication at this transition is associated with preventable adverse events leading to rehospitalization, disability, and death.[1-3] While professional societies recommend PCPs be notified at every care transition, the specific timing and modality of this communication is not well defined.[4]

Providing PCPs access to the inpatient electronic health record (EHR) may reduce the need for active communication. However, a recent survey of PCPs in the general internal medicine division of an academic hospital found a strong preference for additional communication with inpatient providers, despite a shared EHR.[5]

We examined communication preferences of general internal medicine PCPs at a different academic institution and extended our study to include community-based PCPs who were both affiliated and unaffiliated with the institution.

METHODS

Between October 2015 and June 2016, we surveyed PCPs from 3 practice groups with institutional affiliation or proximity to The Johns Hopkins Hospital: all general internal medicine faculty with outpatient practices ("academic," 2 practice sites, n = 35), all community-based PCPs affiliated with the health system ("community," 36 practice sites, n = 220), and all PCPs from an unaffiliated managed care organization ("unaffiliated," 5 practice sites ranging from 0.3 to 4 miles from The Johns Hopkins Hospital, n = 29).

All groups have work-sponsored e-mail services. At the time of the survey, both the academic and community groups used an EHR that allowed access to inpatient laboratory and radiology data and discharge summaries. The unaffiliated group used paper health records. The hospital faxes discharge summaries to all PCPs who are identified by patients.

The investigators and representatives from each practice group collaborated to develop 15 questions with mutually exclusive answers to evaluate PCP experiences with and preferences for communication with inpatient teams. The survey was constructed and administered through Qualtrics' online platform (Qualtrics, Provo, UT) and distributed via e-mail. The study was reviewed and acknowledged by the Johns Hopkins institutional review board as quality improvement activity.

The survey contained branching logic. Only respondents who indicated preference for communication received questions regarding preferred mode of communication. We used the preferred mode of communication for initial contact from the inpatient team in our analysis. χ^2 and Fischer's exact tests were performed with JMP 12 software (SAS Institute Inc, Cary, NC).

RESULTS

Fourteen (40%) academic, 43 (14%) community, and 16 (55%) unaffiliated PCPs completed the survey, for 73 total responses from 284 surveys distributed (26%).

Among the 73 responding PCPs, 31 (42%) reported receiving notification of admission during "every" or "almost every" hospitalization, with no significant variation across practice groups ($P = .5$).

Across all groups, 64 PCPs (88%) preferred communication at 1 or more points during hospitalizations (panel A of Figure). "Both upon admission and prior to discharge" was selected most frequently, and there were no differences between practice groups ($P = .2$).

Preferred mode of communication, however, differed significantly between groups (panel B of Figure). The academic group had a greater preference for telephone (54%) than the community (8%; $P < .001$) and unaffiliated groups (8%; $P < .001$), the community group a greater preference for EHR (77%) than the academic (23%; $P = .002$) and unaffiliated groups (0%; $P < .001$), and the unaffiliated group a greater preference for fax (58%) than the other groups (both 0%; $P < .001$).

DISCUSSION

Our findings add to previous evidence of low rates of communication between inpatient providers and PCPs[6] and a pref-

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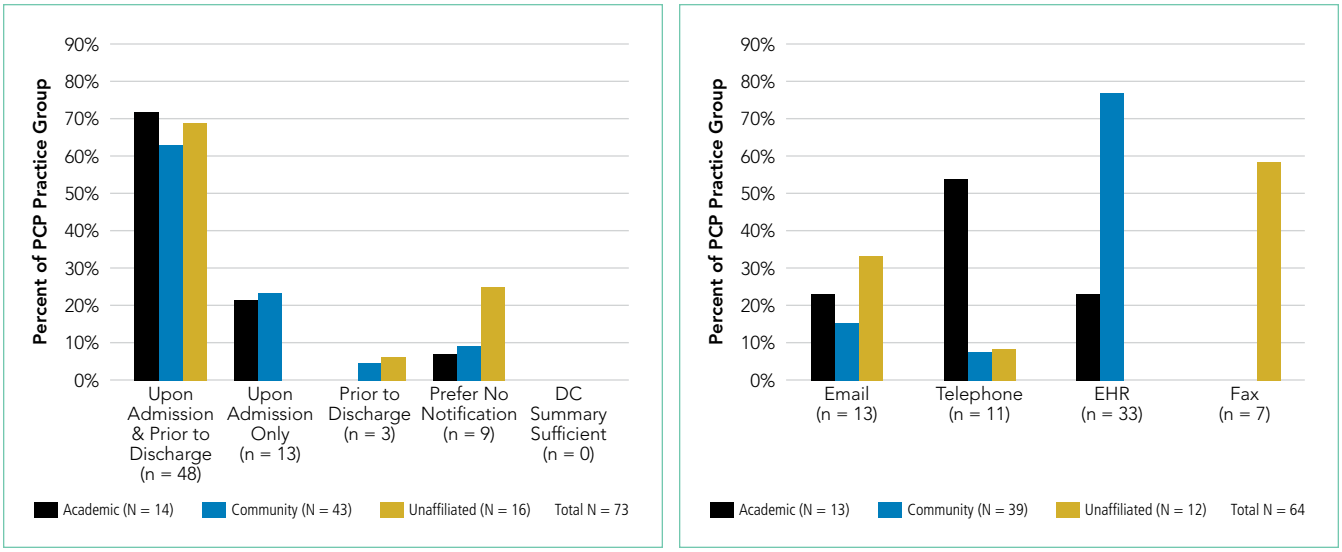

FIG. (A) PCP preferences for timing of inpatient team communication by practice group. (B) PCP preference for mode of communication by practice group. Branching logic survey design reduced total respondents to 64, representing those who desired communication either upon admission, prior to discharge, or both.

NOTE: Abbreviation: DC, discharge; EHR, electronic health record; PCP, primary care provider.

erence from PCPs for communication during hospitalizations despite shared EHRs.[5] We extend previous work by demonstrating that PCP preferences for mode of communication vary by practice setting. Our findings lead us to hypothesize that identifying and incorporating PCP preferences may improve communication, though at the potential expense of standardization and efficiency.

There may be several reasons for the differing communication preferences observed. Most academic PCPs are located near or have admitting privileges to the hospital and are not in clinic full time. Their preference for the telephone may thus result from interpersonal relationships born from proximity and greater availability for telephone calls, or reduced fluency with the EHR compared to full-time community clinicians.

The unaffiliated group's preference for fax may reflect a desire for communication that integrates easily with paper charts and is least disruptive to workflow, or concerns about health information confidentiality in e-mails.

Our study's generalizability is limited by a low response rate, though it is comparable to prior studies.[7] The unaffiliated group was accessed by convenience (acquaintance with the medical director); however, we note it had the highest response rate (55%).

In summary, we found low rates of communication between inpatient providers and PCPs, despite a strong preference from most PCPs for such communication during hospitalizations. PCPs' preferred mode of communication differed based on practice setting. Addressing PCP communication preferences may be important to future care transition interventions.

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Hospital Administrators' Perspectives on Physician Engagement: A Qualitative Study

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Disengaged physicians perform worse on multiple quality metrics and are more likely to make clinical errors.[1,2] A growing body of literature has examined factors contributing to rising physician burnout, yet limited research has explored elements of physician engagement.[3] Although some have described engagement as the polar opposite of burnout, addressing factors that contribute to burnout may not necessarily build physician engagement.[4] The National Health Service (NHS) in the United Kingdom defines physician engagement as "the degree to which an employee is satisfied in their work, motivated to perform well, able to suggest and implement ideas for improvement, and their willingness to act as an advocate for their organization by recommending it as a place to work or be treated."[5]

Few studies have attempted to document and interpret the variety of approaches that healthcare organizations have taken to identify and address this problem.[6] The purpose of this study was to understand hospital administrators' perspectives on issues related to physician engagement, including determinants of physician engagement, organizational efforts to improve physician engagement, and barriers to improving physician engagement.

METHODS

We conducted a qualitative study of hospital administrators by using an online anonymous questionnaire to explore perspectives on physician engagement. We used a convenience sample of hospital administrators affiliated with Vizient Inc. member hospitals. Vizient is the largest member-owned healthcare services company in the United States; and at the time of the study, it was composed of 1519 hospitals. Eligible hospital administrators included 2 hospital executive positions: Chief Medical Officers (CMOs) and Chief Quality Officers (CQOs). We chose to focus on CMOs and CQOs because their leadership roles overseeing physician employees may require them to address challenges with physician engagement.

The questionnaire focused on administrators' perspectives on physician engagement, which we defined using the NHS definition stated above. Questions addressed perceived determinants of engagement, effective organizational efforts to improve engagement, and perceived barriers to improving engagement (supplementary Appendix 1). We included 2 yes/no questions and 4 open-ended questions. In May and June of 2016, we sent an e-mail to 432 unique hospital administrators explaining the purpose of the study and requested their participation through a hyperlink to an online questionnaire.

We used summary statistics to report results of yes/no questions and qualitative methods to analyze open-ended responses according to the principles of conventional content analysis, which avoids using preconceived categories and instead relies on inductive methods to allow categories to emerge from the data.[7] Team members (T.J.R., K.O., and S.T.R.) performed close readings of responses and coded segments representing important concepts. Through iterative discussion, members of the research team reached consensus on the final code structure.

RESULTS

Our analyses focused on responses from 39 administrators that contained the most substantial qualitative information to the 4 open-ended questions included in the questionnaire. Among these respondents, 31 (79%) indicated that their hospital had surveyed physicians to assess their level of engagement, and 32 (82%) indicated that their hospital had implemented organizational efforts to improve physician engagement within the previous 3 years. Content analysis of open-ended responses yielded 5 themes that summarized perceived contributing factors to physician engagement: (1) physician-administration alignment, (2) physician input in decision-making, (3) appreciation of physician contributions, (4) communication between physicians and administration, and (5) hospital systems and workflow. In the Table, we present exemplary quotations for each theme and the question that prompted the quote.

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TABLE. **Exemplary Responses to Open-Ended Questions About Determinants, Organizational Efforts, and Barriers to Improving Physician Engagement**

Physician-Administration Alignment
Determinants
"Unified sense of vision and mission."
"Physician engagement has a lot to do with the physicians' goals. Predominant goals of personal success in research, teaching, or individual clinical productivity may detract from institutional engagement, input/participation."
Organizational efforts
"Physician leader responsibility as medical director for service line performance in dyad structure with administrative/nursing leader."
Barriers
"Getting past the admin/doc, 'us vs them' mentality."
"Belief that leadership is only interested in money."
Physician Input in Decision Making
Determinants
"Inclusion by administration to be at the table for strategic discussions and significant decisions."
"Whether they feel their voice will be heard."
Organizational efforts
"Involvement in design of new patient pavilion."
"Joint Leadership Committee brings together physicians and nursing leaders to endorse important clinical changes."
"We have created my role as medical director of provider experience. In that role, I have time dedicated to measurement of provider experience and working with departments and physicians groups and leaders on improvement."
Barriers
"Apathy due to sense of no voice in the institution."
"Physicians' belief that they are not given opportunity to give input."
Communication Between Physicians and Administration
Determinants
"Providing frequent background information on current state of healthcare economics."
"Listen as they tell you what they need for the patients."
"Doctors said they need to be understood, so we are getting out into the details of their work life to understand that there are so many clicks, tasks, forms, interruptions, phone calls, and interferences with their delivery of care that we need to reorganize our view of what administration should do."
Organizational efforts
"Provider portal where providers can post concerns related to provider experience and get a reply."
"Performance feedback process."
"CEO blog."
Barriers
"The barrier is an effective and meaningful communication between hospital administrators and the medical staff."
Appreciation of Physician Contribution
Determinants
"Understanding that they are valued and a critical part of the organization."
Organizational efforts
"Tying quality metrics to compensation mostly at leadership level."
"Physician wellness program."
Barriers
"Decreased reimbursement."
"Uncompensated time."
"Inadequate incentives."
Hospital Systems and Work Flow
Determinants
"The top problem is excessive regulatory and administrative task overload, explicitly and implicitly driving inefficiencies, without commensurate effort to maximize work efficiency."
"Changes in how healthcare is organized and reimbursed."
Organizational efforts
"Performance improvement training."
Barriers
"Limited resources, limited time, high patient volumes."
"Overload of admin burdens, goals, metrics, expectations."

NOTE: Abbreviation: CEO, chief executive officer.

DISCUSSION

Results of this study provide insight into administrators' perspectives on organizational factors affecting physician engagement in hospital settings. The majority of respondents believed physician engagement was sufficiently important to survey physicians to assess their level of engagement and implement interventions to improve engagement. We identified several overarching themes that transcend individual

questions related to the determinants of engagement, organizational efforts to improve engagement, and barriers to improving engagement. Many responses focused on the relationship between administrators and physicians. Administrators in our study may also have backgrounds as physicians, providing them with a unique perspective on the importance of this relationship.

The evolution of healthcare over the past several decades has shifted power dynamics away from autonomous physician practices, particularly in hospital settings.[8] Our study suggests that hospital administrators recognize the potential impact these changes have had on physician engagement and are attempting to address the detrimental effects. Furthermore, administrators acknowledged the importance of organization-directed solutions to address problems with physician morale. This finding represents a paradigm shift away from previous approaches that involved interventions directed at individual physicians.[9]

Our results represent a call to action for both physicians and administrators to work together to develop organizational solutions to improve physician engagement. Further research is needed to investigate the most effective ways to improve and sustain engagement. At a time when physicians are increasingly dissatisfied with their current work, understanding how to improve physician engagement is critical to maintaining a healthy and productive physician workforce.

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The Association of Frailty with Discharge Disposition for Hospitalized Community Dwelling Elderly Patients

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Frailty is a common geriatric syndrome characterized by decreased physiological reserves leading to increased vulnerability to stressors.[1] Frail individuals are at increased risk of adverse health outcomes including falls, disability, hospitalization, and mortality.[1] Discharge to skilled nursing facilities (SNFs) is also associated with adverse outcomes,[2,3] but limited data exist on the utility of frailty in predicting discharge location in medical elders. We aimed to evaluate the association of frailty assessed by the Reported Edmonton Frailty Scale (REFS) with discharge disposition in hospitalized medical patients who were previously living in the community.

METHODS

We conducted a prospective study of community dwelling elders (≥65 years) hospitalized to the medical service from January 2014 to April 2016. Trained research assistants interviewed patients and/or caregivers on hospital day 1; the REFS was used to screen for frailty and the Mini-Cog assessment for cognitive impairment (supplementary Appendixes 1 and 2). The primary outcome was discharge disposition categorized as discharge to home (with or without home health services) or discharge to a postacute care (PAC) facility (SNF or inpatient rehabilitation). Multivariable Poisson regression analysis was used to estimate the relative risk of discharge to a PAC facility. Frailty was grouped into the following 3 categories: (1) not frail, (2) apparently vulnerable/mildly frail, and (3) moderately/severely frail.

RESULTS

Among the 775 patients screened, 272 declined to participate, were non-English speakers, were transferred from another facility, were admitted under observation status, had advanced dementia, or died during hospitalization. Five hundred and three medical patients were included: median age was 80 years (interquartile range 75-86 years); 54.1% were female and 82.9% were white. The most common comorbidities were hypertension (51.7%), diabetes (26.0%), and renal failure (26.0%). Of the included patients, 11.1% had a known diagnosis of dementia and 52.1% screened positive for cognitive impairment (Table).

Overall, 24.9% were not frail, 49.5% were apparently vulnerable/mildly frail, and 25.6% were moderately/severely frail. About two-thirds (64.8%) returned home (40.0% with home healthcare) and 35% were discharged to a PAC facility (97.1% of them to SNF). Compared with patients who were discharged home, those discharged to a PAC facility were older (≥85 years; 26.7% vs 40.1%) and more likely to have dementia (7.7% vs 17.5%) and be frail (apparently vulnerable/mild frailty = 48.5% vs 51.4%%, moderate/severe frailty = 19.9% vs 36.2%; $P < .001$). Median length of hospital stay was shorter in those returning home (4 vs 5 days, $P < .001$).

In the multivariate analysis, which was adjusted for demographics, comorbidities, and principal diagnosis, frailty was strongly associated with discharge to PAC facility (apparently vulnerable/mild frailty vs no frailty, relative ratio [RR] = 2.00; 95% confidence interval [CI], 1.28-3.27, and moderate/severe frailty vs no frailty; RR = 2.66, 95% CI, 1.67-4.43). When the frailty score was included as a continuous variable, 1 unit increase in the score was associated with a 12% higher risk for discharge to a PAC facility (RR = 1.12; 95% CI, 1.07-1.17).

DISCUSSION

In this analysis of over 500 community-dwelling elderly medical patients hospitalized at one large tertiary center, we found that almost half of the patients were frail and over one-third had a new discharge to a PAC facility. Frailty, as assessed by REFS, was strongly associated with discharge to a PAC facility after adjusting for possible confounders.

Frailty is increasingly recognized as a useful tool to risk stratify the highly heterogeneous population of elderly people.[4] Previous studies reported that frailty was predictive of discharge to PAC facilities in geriatric trauma and burn injury patients.[5,6] We found similar results in a population of elderly medical patients. A recent study showed that the Hospital Admission Risk Profile score comprising of age, modified Mini-Mental State Examination (MMSE), and functionality prior to admission was

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TABLE. **Characteristics of the Study Population Overall and by Discharge Disposition**

Characteristic	Total Cohort n = 503	Home N = 326	Postacute care facility n = 177	*P* value
Age category, n (%)				<.001
65-74	109 (21.7)	87 (26.7)	22 (12.4)	
75-84	236 (46.9)	152 (46.6)	84 (47.5)	
≥85	158 (31.4)	87 (26.7)	71 (40.1)	
Female, n (%)	272 (54.1)	173 (53.1)	99 (55.9)	.54
White race, n (%)	417 (82.9)	266 (81.6)	151 (85.3)	.66
Insurance, n (%)				.14
Medicare	366 (72.8)	234 (71.8)	132 (74.6)	
Other[a]	137 (27.2)	92 (28.2)	45 (25.4)	
Principal diagnosis, n (%)				.08
Cardiac	94 (18.7)	61 (18.1)	33 (18.6)	
Gastrointestinal	74 (14.7)	54 (16.6)	20 (11.3)	
Infection	111 (22.1)	69 (21.2)	42 (23.7)	
Pulmonary	103 (20.5)	73 (22.4)	30 (16.9)	
Renal	27 (5.4)	14 (4.3)	13 (7.3)	
Hematological	26 (5.2)	19 (5.8)	7 (4.0)	
Other	68 (13.5)	36 (11.0)	32 (18.1)	
Gagne comorbidity score, median (IQR)	1 (0-4)	1 (0-4)	2 (0-5)	.21
Comorbidities, n (%)				
Dementia	56 (11.1)	25 (7.7)	31 (17.5)	.003
Congestive heart failure	92 (18.3)	54 (16.6)	38 (21.5)	.17
Hypertension	260 (51.7)	171 (52.5)	89 (50.3)	.64
Diabetes	131 (26.0)	89 (27.3)	42 (23.7)	.38
Renal failure	131 (26.0)	85 (26.1)	46 (26.0)	.98
Fluid/Electrolytes disorders	126 (25.0)	72 (22.1)	54 (30.5)	.37
Depression	68 (13.5)	37 (11.3)	31 (17.5)	.05
Mini-Cog <3, n (%)	262 (52.1)	147 (45.1)	115 (65.0)	<.001
Frailty category[b], n (%)				<.001
Not frail	125 (24.9)	103 (31.6)	22 (12.4)	
Apparently vulnerable/mildly frail	249 (49.5)	158 (48.5)	91 (51.4)	
Moderately/severely frail	129 (25.6)	65 (19.9)	64 (36.2)	
Total Edmonton score, median (IQR)	7 (6-10)	7 (5-9)	9 (7-10)	<.001
Length of stay, median (IQR)	4 (3,6)	4 (2,5)	5 (3,8)	<.001

[a]Other insurance: Medicaid, Private.
[b]Frailty category as assessed by Reported Edmonton Frail Scale with scoring: not frail: 0-5, apparently vulnerable: 6-7, mildly frail: 8-9 moderately frail: 10-11, or severely frail: 12-18.
Note: Abbreviation: IQR, interquartile range.

associated with discharge disposition in elderly patients admitted to a single geriatric unit in a rural hospital.[7] Our study supports this finding by using a validated measure of frailty, the RFS, and does not include the lengthy MMSE.

Our study has several limitations. First, it a single-center study and results may not be generalizable; however, we included a large sample of patients with a variety of medical diagnoses. Second, the REFS is self-reported posing the risks of recall, respondent bias, and interview bias. We chose the REFS to assess frailty due to its practicality and ease of administration but also its completeness of assessing multiple important geriatric domains. Lastly, we did not collect the reason for discharge to PAC and it may have been a potential confounder.

In conclusion, our study demonstrates that frailty assessed by a practical validated scale, the REFS, is a strong predictor of a new discharge to PAC facilities in older medical patients. Accurate identification of elders at risk for discharge to PAC facilities provides the potential to counsel patients and families and plan for complex post discharge needs. Future studies should identify potential interventions targeting frail patients in which PAC is not obligatory, aiming to increase their chance of being discharged home.

Disclosure: Drs. Stefan and Ramdass had full access to all the data in the study. They take responsibility for the integrity of the data and the accuracy of the analysis. Drs. Stefan, Starr, Brennan, and Ramdass conceived the study. Ms. Liu and Dr. Pekow analyzed the data. Dr. Ramdass prepared the manuscript. Drs. Stefan, Brennan, Lindenauer, and Starr critically reviewed the manuscript for important intellectual content. A subset of the patients included in this study was part of a Health Resources and Services Administration funded Geri-Pal Transformation through Learning and Collaboration project awarded to Baystate Medical Center, grant number U1QHP28702 (PI: Maura J. Brennan). The investigators retained full independence in the conduct of this research. The authors have no conflicts of interest.

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Proposed In-Training Electrocardiogram Interpretation Competencies for Undergraduate and Postgraduate Trainees

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Despite its importance in everyday clinical practice, the ability of physicians to interpret electrocardiograms (ECGs) is highly variable. ECG patterns are often misdiagnosed, and electrocardiographic emergencies are frequently missed, leading to adverse patient outcomes. Currently, many medical education programs lack an organized curriculum and competency assessment to ensure trainees master this essential skill.

ECG patterns that were previously mentioned in literature were organized into groups from A to D based on their clinical importance and distributed among levels of training. Incremental versions of this organization were circulated among members of the International Society of Electrocardiology and the International Society of Holter and Noninvasive Electrocardiology until complete consensus was reached.

We present reasonably attainable ECG interpretation competencies for undergraduate and postgraduate trainees. Previous literature suggests that methods of teaching ECG interpretation are less important and can be selected based on the available resources of each education program and student preference. The evidence clearly favors summative trainee evaluation methods, which would facilitate learning and ensure that appropriate competencies are acquired. Resources should be allocated to ensure that every trainee reaches their training milestones and should ensure that no electrocardiographic emergency (class A condition) is ever missed.

We hope that these guidelines will inform medical education programs and encourage them to allocate sufficient resources and develop organized curricula. Assessments must be in place to ensure trainees acquire the level-appropriate ECG interpretation skills that are required for safe clinical practice. *Journal of Hospital Medicine* 2018;13:185-193. Published online first November 8, 2017. © 2018 Society of Hospital Medicine

The 12-lead electrocardiogram (ECG) remains one of the most widely used and readily available diagnostic tests in modern medicine.[1] Reflecting the electrical behavior of the heart, this point-of-care diagnostic test is used in almost every area of medicine for diagnosis, prognostication, and selection of appropriate treatment. The ECG is sometimes the only and most efficient way of detecting life-threatening conditions, thus allowing a timely delivery of emergency care.[2] However, the practical power of the 12-lead ECG relies on the ability of the clinician to interpret this test correctly.

For decades, ECG interpretation has been a core component of undergraduate and postgraduate medical training.[3-5] Unfortunately, numerous studies have demonstrated alarming rates of inaccuracy and variability in interpreting ECGs among trainees at all levels of education.[4,6,7] Senior medical students have been repeatedly shown to miss 26% to 62% of acute myocardial infarctions (MI).[6,8-10] Another recent study involving internal medicine residents demonstrated that only half of the straightforward common ECGs were interpreted correctly, while 26% of trainees missed an acute MI and 56% missed ventricular tachycardia (VT).[11] Even cardiology subspecialty fellows demonstrated poor performance, missing up to 26% of ST-elevation MIs on ECGs that had multiple findings.[12] Inaccurate interpretations of ECGs can lead to inappropriate management decisions, adverse patient outcomes, unnecessary additional testing, and even preventable deaths.[4,13-15]

Several guidelines have emphasized the importance of

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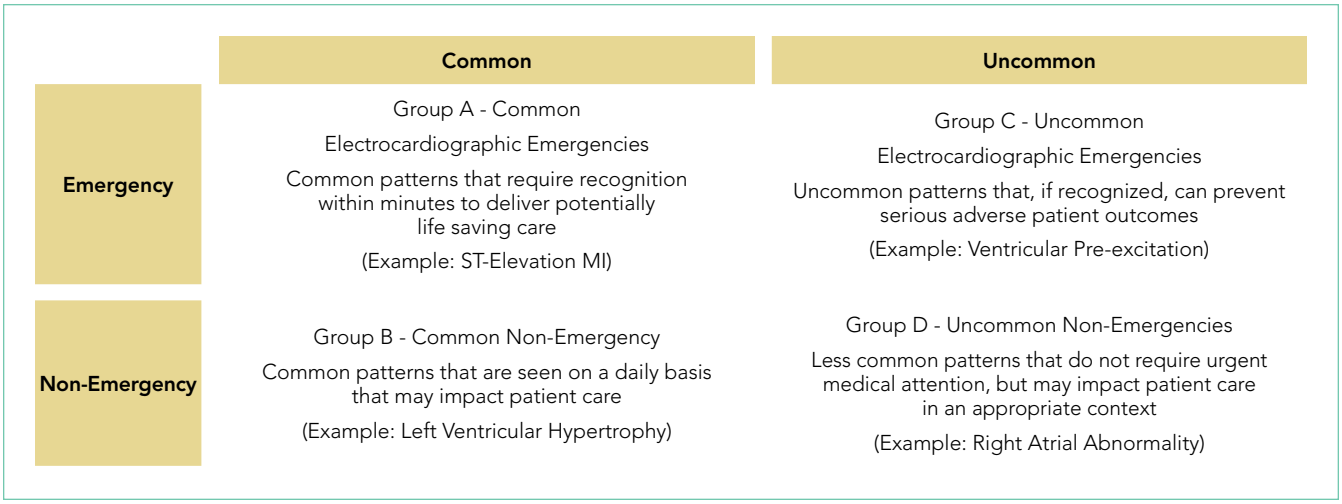

FIG 1. Grouping ECG interpretation patterns. ECG findings were grouped under classes A to D based on emergency/nonemergency and common/uncommon criteria. Medical students must be proficient in class A and class B patterns, whereas residents at the end of postgraduate year 1 should additionally be proficient in classes C and D (with a few exceptions).

NOTE: Abbreviations: ECG, electrocardiogram; MI, myocardial infarction.

teaching trainees 12-lead ECG interpretation and have recognized the value of assessments in ensuring that learners acquire the necessary competencies.[16-19] Similarly, there have been many calls for more rigorous and structured curricula for ECG interpretation throughout undergraduate and postgraduate medical education.[11,16] However, we still lack a thoughtful guideline outlining the specific competencies that medical trainees should attain. This includes medical students, nurses working in hospital and in out-of-hospital settings, and residents of different specialties, including emergency medicine, cardiology, and electrophysiology (EP) fellows.

Setting goals and objectives for target learners is recognized to be the initial step and a core prerequisite for effective curriculum development.[20] In this publication, we summarize the objectives from previously published trainee assessments and propose reasonably attainable ECG interpretation competencies for both graduating medical students and residents at the end of their postgraduate training. This document is being endorsed by researchers and educators of 2 international societies dedicated to the study of electrical heart diseases: the International Society of Electrocardiology (ISE) and the International Society of Holter and Noninvasive Electrocardiology (ISHNE).

METHODS

Current Competencies in Literature

We performed a systematic search to identify ECG competencies that are currently mentioned in the literature. Information was retrieved from MEDLINE (1946-2016) and EMBASE (1947-2016) by using the following MeSH terms: electrocardiogram, electrocardiography, electrocardiogram interpretation, electrocardiogram competency, medical school, medical student, undergraduate medicine, undergraduate medical education, residency education, internship, and residency. Our search was limited to English-language articles that studied physician trainees. The references of the full-length articles were examined for additional citations. The search revealed a total of 65 publications involving medical students and 120 publications involving residents. Abstracts of publications were then assessed for relevance, and the methods of the remaining articles were scrutinized for references to specific ECG interpretation objectives. This strategy narrowed the search to 9 and 14 articles involving medical students and residents, respectively. Studies were not graded for quality because the purpose of the search was to identify the specific ECG competencies that authors expected trainees to obtain. Almost all the articles proposed teaching tools and specific objectives that were defined by the investigators arbitrarily and assessed the trainee's ability to interpret ECGs (summarized in supplementary Table).

Defining ECG Interpretation Competencies

The initial draft of proposed ECG interpretation competencies was developed at Queen's University in Ontario, Canada. A list of ECG patterns and diagnoses previously mentioned in literature was used as a starting point. From there, each item was refined and organized into 4 main categories (see Figures 1 and 2).

Class A "Common electrocardiographic emergencies" represent patterns that are frequently seen in hospitals, in which accurate interpretation of the ECG within minutes is essential for delivering care that is potentially lifesaving to the patient (eg, ST-elevation MI).

Class B "Common nonemergency patterns" represent ECG findings that are encountered daily in patients who are not acutely ill, which may impact their care in the appropriate clinical context (eg, left ventricular hypertrophy).

Class C "Uncommon electrocardiographic emergencies" represent ECG findings that are not encountered on a daily basis but can be potentially lifesaving if recognized (eg ventricular preexcitation).

	Emergency	Non-Emergency

Common	**Class A—Common Electrocardiographic Emergencies**
	• Acute ST-Elevation Myocardial Infarction[a]
	  • Hyper-acute T-Waves
	• Ventricular Tachycardia (VT)
	  • Differential Diagnosis for Wide Complex Tachycardia
	• Ventricular Fibrillation (VF)
	• Asystole
	• 3rd Degree AV Block[b]
	• 2nd Degree AV Block Mobitz II
	• Hyperkalemia/Hypokalemia Pattern
	• Unstable Supraventricular Tachycardia[c]
	• Long QT
		Class B—Common Non-Emergency
		Tachycardia Syndromes
		• Sinus Tachycardia
		• Atrial Fibrillation
		• Atrial Flutter
		• Atrial Tachycardia
		• Multifocal Atrial Tachycardia
		• Atrioventricular Nodal Reentry Tachycardia
		• Nonsustained Ventricular Tachycardia
		• Atrioventricular Reentry Tachycardia
		Bradycardia Syndromes
		• Sinus Bradycardia
		• Sinus Arrhythmia
		• 2nd Degree AV Block Mobitz I
		• Junction Rhythm
		Conduction Abnormalities
		• 1st Degree AV Block
		• Left Bundle Branch Block
		• Right Bundle Branch Block
		• Nonspecific Intraventricular Conduction Delay
		• Left Anterior Fascicular Block
		Ischemia/Injury
		• Pathological Q-Wave[a]
		• ST Depression
		• T-Wave Inversion (postischemic)
		Other
		• Left Ventricular Hypertrophy
		• Pericarditis[d]
		• Premature Ventricular Contraction
		• Electronic Pacemaker
		• Lead Misplacement and Common Artifacts
		• Left Atrial Abnormality
		• Interatrial Block
		• Benign Early Repolarization

Uncommon	**Class C—Uncommon Electrocardiographic Emergencies** • Pre-Excitation • STEMI with pre-existing LBBB • Sinus Pauses • Brugada Pattern • Hypothermia • Drug Effects • Ventricular Aneurysm • Right Ventricular Hypertrophy	**Class D—Uncommon Non-Emergency** • Right Atrial Abnormality • Left Posterior Fascicular Block • Low Atrial Rhythm • Electrolyte Abnormalities (nonhyperkalemia)

FIG 2. ECG patterns assigned to training levels. ECG patterns that were mentioned previously in literature were grouped under classes A to D and assigned to 2 training levels: graduating medical students and residents at the end of postgraduate year 1 (bold). NOTE: Abbreviations: AV, antrioventricular; LBBB, left bundle branch block; STEMI, ST-elevation myocardial infarction; VF, ventricular fibrillation; VT, Ventricular Tachycardia.

NOTE: Non-bolded terms represent patterns that shoud be recognized by a graduating medical student, and bolded terms represent patterns that should be recognized by a medical resident at the end of PGY-1

[a]Including localization of vascular territory

[b]Devine escape pattern (wide vs narrow complex)

[c]Subtypes of supraventricular tachycardias are in Class B

[d]ECG findings that would support the diagnosis of pericarditis

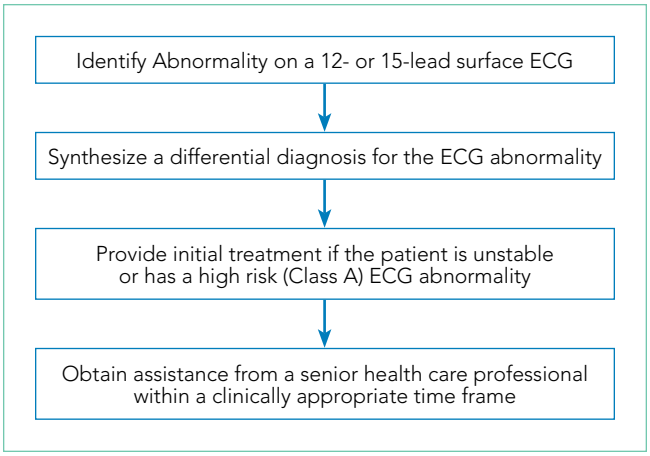

FIG 3. Learning objectives for each ECG pattern defined in Figure 2. These learning objectives should be taught for each ECG finding in Figure 2. NOTE: Abbreviation: ECG, electrocardiogram.

Class D "Uncommon nonemergency patterns" represent findings that are uncommon but may diagnostically contribute to patient care in a clinically appropriate setting (eg, right atrial abnormality).

ECG interpretation patterns were then assigned to medical students and residents based on the specific goals of training. At the time of graduation, medical students should develop the foundation for learning ECG interpretation in residency training, provide ECG interpretation and initial management for electrocardiographic emergencies, and obtain assistance from a more senior medical professional within a clinically appropriate time frame. The training goal for a resident is to develop ECG interpretation competencies for safe independent clinical practice (Figure 1).

The final segregated ECG interpretation competencies were distributed to members of ISE and ISHNE for input, modifications, and revisions. The proposed list of competencies went through several revisions until a consensus was reached.

RESULTS

The final distribution of ECG patterns is illustrated in Figure 2 (Figure 3 defines the learning objectives for each ECG pattern defined in Figure 2). Here, we provide a rationale for assigning ECG diagnoses to each specific class and level of training. It is important to note that medical students must learn the appropriate cardiac anatomy, ECG lead placement, and the EP mechanism associated with each specific ECG pattern. The prerequisite knowledge required for ECG interpretation has been reviewed in the position statement by the American Heart Association (AHA) and the American College of Cardiology (ACC).19 Similarly, all students should also learn the systematic approach behind ECG interpretation.21 Although no specific ECG interpretation structure has been shown to improve diagnostic accuracy, we believe a systematic structured assessment of an ECG is crucial to ensure the interpretation by a junior learner is complete.12,22 We propose that students should be instructed to interpret ECGs by using a systematic framework that includes (1) rate, (2) rhythm, (3) axis, (4) amplitude and duration of waveforms and intervals (including P wave, PR, QRS, QT, and Q wave), and (5) ST-T (morphology, deviations from baseline, and polarity; note: this framework is only valid for nontachycardia ECGs).23-26 Understanding the physiology of depolarization and repolarization, as well as the temporo-spatial relationship between these 2 processes, is also key to the understanding of certain ECG patterns. Vectorcardiography can help in understanding the physiologic and physiopathologic mechanisms in conduction disease. Expertise and special tools are required to make full use of vectorcardiograms.[27,28]

Class A: Common Electrocardiographic Emergencies

This group contains ECG findings that require recognition within minutes to deliver potentially lifesaving care. For this reason, undergraduate medical education programs should prioritize mastering class A conditions to minimize the risk of misdiagnosis and late recognition.

Class A patterns include ST elevation MI (STEMI) and localization of territory to ensure ST-segment elevations are seen in contiguous leads.[29,30] Students should learn the criteria for STEMI as per the "Universal Definition of Myocardial Infarction" and be aware of early signs of STEMI that may be seen prior to ST-segment changes, such as hyper-acute T-waves (increased amplitude and symmetrical).[30]

Asystole, wide complex tachycardias, and ventricular fibrillation (VF) are all crucial ECG patterns that must be identified to deliver advanced cardiac life support (ACLS) care as per the 2010 AHA Guidelines for cardiopulmonary resuscitation and emergency cardio care.[31] Of note, students should understand the differential diagnosis of wide complex tachycardias and should be able to suspect VF in clinically appropriate scenarios. We included the category "unstable/symptomatic supraventricular tachycardia" to represent rapid rhythms that are supraventricular in origin, which either produce symptoms or cause impairment of vital organ function.[31] In emergency situations, it may not be crucial to correctly identify the specific supraventricular rhythm to deliver ACLS care; hence, the specific supraventricular tachycardia diagnoses were included in Class B.

Finally, we believe that medical students should be able to recognize long QT, hypo/hyperkalemia, and distinguish types of atrioventricular (AV) block. Distinguishing types of AV block is important because both third degree AV block and second degree AV block Mobitz II can be life threatening and require further investigation or emergency treatment in an inpatient setting.[32] Prompt recognition of long QT is crucial because it can be associated with ventricular tachyarrhythmias. This includes a polymorphic pattern characterized by the twisting of QRS peaks around the baseline (torsades des pointes), which can eventually lead to VF.

Class B: Common Nonemergency Patterns

Class B patterns represent common findings that are seen on a daily basis that may impact patient care in a clinically appropriate context. Diagnoses in this section were divided into "tachycardia syndromes," "bradycardia syndromes," "con-

duction abnormalities," "ischemia," and "other."

Undergraduate trainees should become proficient in identifying the cause of bradycardia and distinguishing types of AV blocks. Similarly, they should also have an approach to differentiate tachycardia syndromes.[33,34] These skills are required to correctly manage patients in both inpatient and outpatient settings. They should be taught in undergraduate programs and reinforced in postgraduate training.

Common findings, such as bundle branch blocks, left anterior fascicular block, premature ventricular/atrial complexes, electronic pacemakers, and left ventricular hypertrophy, are essential to the daily interpretation of ECGs. Junior learners should be proficient in recognizing these patterns. Findings consistent with pericarditis are not uncommon and can be very helpful to guide the clinician to the diagnosis. Notable exceptions from the medical student competency list include detection of lead misplacement, common artifacts, nonspecific intraventricular conduction delay, interatrial block, and benign early repolarization. These findings require a deeper understanding of electrocardiography and would be more appropriate for senior learners.

Class C: Uncommon Electrocardiographic Emergencies

Class C findings represent uncommon conditions that, if recognized, can prevent serious adverse patient outcomes. These include preexcitation, STEMI with preexisting left bundle branch block sinus pauses, Brugada pattern, hypothermia, effects of toxic drugs, ventricular aneurysm, and right ventricular hypertrophy. The recognition of these patterns is crucial to avoid severe adverse patient outcomes, and independent practicing physicians should be aware of these findings. However, given that a high proportion of senior medical students miss common electrocardiographic emergencies, undergraduate medical education programs should instead focus resources on ensuring medical students are proficient in identifying class A and class B conditions.[6,8-10] Postgraduate programs should ensure that postgraduate trainees can identify these potentially life-threatening conditions (see section "How to Teach Electrocardiology").

Class D: Uncommon and Nonemergency Patterns

Class D findings represent less common findings that are not seen every day and do not require urgent medical attention. These include right atrial abnormality, left posterior fascicular block, low atrial rhythms, and electrolyte abnormalities that exclude potassium. Notably, electrolyte abnormalities are important to identify; however, typically, treatment is guided by the lab results.[35] Overall, postgraduate trainees should certainly be aware of these findings, but medical student training should instead focus on learning the framework and correctly identifying class A and class B ECG patterns.

HOW TO TEACH ELECTROCARDIOLOGY

Teaching ECG Interpretation Strategies

No clear teaching approaches to ECG interpretation have been described in the literature, and no recommendations on knowledge translation have been formally explored. A possible educational approach to the teaching of electrocardiology could involve several methods for helping students with ECG interpretation:[36]

1. Pattern recognition: The ECG, at its most immediate level, is a graphic image, and recognition of images is essentially recognition of patterns. These patterns can only be learned through repeated visualization of examples with a written or verbal explanation. Repeated visualization over time will help avoid "erosion" of knowledge. Examples of learning tools include periodic in-person ECG rounds, well-illustrated books or atlases, and online tools with good quality ECGs and explanations. These learning opportunities are strongly reinforced by collecting cases from the clinical encounters of the trainee that illustrate the aforementioned patterns. Some of these patterns can be found in guidelines, such as the one published by the AHA and ACC.[29]
2. Application of published criteria: Guidelines, review papers, and books offer diagnostic criteria for many entities, such as chamber enlargement, bundle branch blocks, and abnormal Q waves. Learning these criteria and applying them to the analysis of ECGs is a commonly used learning strategy.
3. Inductive-deductive reasoning: This strategy requires a deeper understanding of the pathophysiology behind ECG patterns. It requires ECGs to be interpreted in a certain clinical context, and the goal of ECG interpretation is to answer a clinical question that is used to guide patient care. This strategy typically employs the use of algorithms to lead the interpreter to the correct diagnosis, and mastery of this skill grows from ongoing clinical experience. Examples of the "inductive-deductive reasoning" are localizing an accessory AV pathway, the differential diagnosis of narrow or wide complex tachycardias, and identifying the site of coronary artery occlusion in a patient with a STEMI.
4. Ladder diagrams: Ladder diagrams have been used for over 100 years to graphically illustrate the mechanism of arrhythmias. They can be incredibly useful to help learners visualize impulse conduction in reentry mechanisms as well as other abnormal rhythms. However, there are some rhythms that are difficult to illustrate on ladder diagrams.[37]
5. Peer and near-peer teaching: Peer teaching occurs when learners prepare and deliver teaching material to learners of a similar training level. The expectation to deliver a teaching session encourages students to learn and organize information in thoughtful ways. It builds strong teamwork skills and has been shown to positively affect all involved learners.[38-40]

Each ECG interpretation strategy has its advantages, and we recommend that students be exposed to all available approaches if teaching resources are available.

Teaching Delivery Format

Each of the above teaching strategies can be delivered to students in various ways. The following teaching formats have

been previously documented in the literature:

1. Classroom-based teaching: This is a traditional learning format that takes place in a large- or small-group classroom. Typically, these sessions are led by a single instructor, and they are focused on the direct sharing of information and group discussion.[41]
2. Electronic practice tools: Numerous electronic tools have been developed with the purpose of providing deliberate practice to master ECG interpretation. Some of these tools employ active learner engagement, while others provide a bank of ECGs for self-directed passive learning.[42-46]
3. Video lectures: Short video lectures have been created to facilitate self-directed lecture based learning. These lectures are hosted on a variety of web-based platforms, including YouTube and Vimeo.[47]
4. Traditional and electronic books: Numerous traditional textbooks have been published on ECG interpretation and are designed to facilitate independent learning. Some textbooks directly deliver teaching material, while others contain sets of ECGs to allow for repetitive practice. More recently, iBooks incorporating self-assessment tools have been used to assist ECG teaching.[34] The advantage of these tools is that they can also be used to supplement in-person classes.
5. Games: A unique ECG interpretation learning strategy consists of using puzzles and games to learn ECGs. This is meant to improve student engagement and interest in learning ECG interpretation.[48]

Given that there is currently a lack of evidence-based data to support 1 instructional format over another, we do not favor any particular one. This decision should be left to instructors and individual learners based on their preference and available resources. Further studies would be helpful to determine the effectiveness of various methods in teaching ECG interpretation and to identify any additional specific factors that facilitate learning.

Evaluation Strategies

1. Longitudinal ongoing feedback: This form of feedback universally takes place in all training programs and focuses on direct observation and point-of-care feedback by a senior healthcare professional during clinical practice. Typically, the feedback is informal and is centered around specific case presentations.
2. Formative testing: This assessment strategy is aimed at monitoring the learning of trainees and providing them with appropriate feedback. Tutors and teachers can use this data to individualize instruction and fill any training gaps that individuals and the class may have. Students themselves can use this information to encourage additional study to ensure they acquire required skills. Examples of formative testing are low-stakes in-training exams and asking audience questions during a workshop or lecture.[49]
3. Summative testing: Summative assessments are created to measure the level of proficiency developed by a learner and compare it against some standard or benchmark. This form of assessment establishes the extent to which educational objectives have been met. The most common example is an end-of-term examination.

Online ECG examination has been successfully used to provide methods of testing. They are easy to distribute, highly convenient for learners, and allow the display of high-quality graphics. They can also be graded electronically, thereby minimizing the resources required to administer and grade exams.[36,50]

We recommend using a combination of assessment formats to ensure the optimal evaluation of learner skill and to focus learning on areas of weakness. Summative assessments are highly valuable to ensure learners acquired the necessary ECG interpretation competencies. Remediation strategies should be available to provide additional practice to learners who do not meet competencies expected at their level of training.

DISCUSSION

The Need for ECG Interpretation Competencies and Milestones

Since the introduction of ECG in the late 1800s, there continues to be a significant variation in ECG interpretation skills among trainees and medical professionals.[4,6-12] Concerns continue to exist about the rate of missed diagnoses involving critical ECGs, leading to inappropriate patient management decisions. Despite the obvious need, teaching ECG interpretation is given little emphasis in medical education, and the curriculum remains quite disorganized. In this position paper, we call for a more structured ECG interpretation curriculum in medical education and hope to assist this process by assigning ECG patterns to 2 milestones in training: graduating medical students and first year postgraduate medical residents.

Defining competencies would help medical education programs to focus resources on teaching clinically important conditions for the appropriate level of training. We divide ECG findings into 4 categories (classes A to D), and we place emphasis on learning electrocardiographic emergencies early in training and spending less time on ECG findings that are unlikely to change patient management.

The goal is to ensure 100% recognition of class A (electrocardiographic emergencies) by the end of medical school. To ensure each medical education program fulfils this goal, a structured curriculum including a summative assessment is required.

Methods of Teaching

Various instructional mediums have been successfully implemented to teach ECG interpretation competencies, including lectures, puzzles, web-based programs, iBooks, and YouTube.[34-41-44,47,48.51-53] A survey of clerkship directors in internal medicine revealed that 75% of clerkship programs teach ECG interpretation in a classroom lecture-based setting, 44% use teaching rounds, and only 17% utilize online/web-based instruction.[3] Canadian family medicine programs have a relatively equal distribution between classroom-based, comput-

er-based, and bedside teaching.[5]

In comparing the efficacy of instructional styles, several small comparative studies favor an electronic teaching format because of the enhanced learner interaction and visual learning, but there does not appear to be a consistently proven large advantage of 1 teaching format over another.[43,48,51,54] The overall theme emerging from this literature is the importance of repetition and active engagement in ECG interpretation, which appear to be more important than 1 particular strategy.[22] Computer-based training appears to deliver these 2 qualities, unlike the traditional lecture-style passive learning model. The concept of repetition and engagement is also well supported in medical education literature outside ECG interpretation.[55,56]

Given these data, we recommend that each medical education program select teaching methods based on their available resources, as long as adequate teaching time is allotted to ensure that trainees acquire the competencies defined in this publication.

Assessment Methods

It appears that the larger factor in determining ECG interpretation performance is not the learning format, but the form of assessment. Two studies have demonstrated that summative assessment substantially improves ECG interpretation performance when compared with formative assessment; in fact, this effect was so large that it overshadowed any small difference in teaching formats.[57,58] This concept aligns with medical education literature, which acknowledges that assessment drives learning by raising the stakes, thereby boosting student effort and encouraging learning to an effect much larger than can be generated by any particular learning style.[57,59] Nevertheless, well-designed formative assessment can focus students on effective learning by identifying gaps and important information.[60] Only 33% of Canadian family medicine residency programs and 71% of American clerkship programs have formal assessment of ECG interpretation skills.[3,5] There is no doubt that assessment, both formative and summative, should be implemented in all undergraduate and postgraduate medical training programs. Online assessment methods have the advantage of delivering high-quality images and a variety of question formats; hence, their use should be encouraged.[36,50,61-63]

Teaching Personnel and Timing of Training

Who should teach ECG interpretation and when should this teaching take place? ECG interpretation in training programs is typically taught by attending physicians in each respective field. However, given that there is a large ECG interpretation error rate by noncardiologist physicians, we advise that ECG training content be created with input from own-specialty attending physicians and cardiologists.[4] This teaching should take place early in medical school at the time medical students learn pathophysiology of the heart and should continue throughout training. Longitudinal training is preferred to block-based training because of improved resident satisfaction, but medical education literature did not reveal a difference in student performance with either strategy.[64-66]

CONCLUSIONS

Despite its immense clinical value, there continues to be a lack of a comprehensive ECG interpretation curriculum in medical education programs. The goal of this position paper is to encourage the development of organized curricula in undergraduate and postgraduate medical education programs, and to ensure the acquisition of level-appropriate ECG interpretation skills while maintaining patient safety. We assist this process by grouping ECG findings into 4 classes (A to D) based on the frequency of encounter and emergent nature and by assigning them to each level of training. Methods of teaching ECG interpretation are less important and can be selected based on the available resources of each education program and student preference; however, online learning is encouraged. We also recommend that summative trainee evaluation methods be implemented in all programs to ensure that appropriate competencies are acquired and to further encourage self-directed learning. Resources should be allocated to ensure that every trainee is reaching their training milestones and should ensure that no electrocardiographic emergency (class A condition) is ever missed by a trainee. We hope that these guidelines will inform medical education systems and help prevent adverse patient outcomes caused by the misinterpretation of this valuable clinical diagnostic tool.

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Improving Quality of Care for Seriously Ill Patients: Opportunities for Hospitalists

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As the shift to value-based payment accelerates, hospitals are under increasing pressure to deliver high-quality, efficient services. Palliative care approaches improve quality of life and family well-being, and in doing so, reduce resource utilization and costs. Hospitalists frequently provide palliative care interventions to their patients, including pain and symptom management and engaging in conversations with patients and families about the realities of their illness and treatment plans that align with their priorities. Hospitalists are ideally positioned to identify patients who could most benefit from palliative care approaches and often refer the most complex cases to specialty palliative care teams. Though hospitalists are frequently called upon to provide palliative care, most lack formal training in these skills, which have not typically been included in medical education. Additional training in communication, safe and effective symptom management, and other palliative care knowledge and skills are available in both in-person and online formats. *Journal of Hospital Medicine* 2018;13:194-197. Published online first December 20, 2017.

Palliative care is specialized medical care focused on providing relief from the symptoms, pain, and stress of a serious illness. The goal is to improve the quality of life for both the patient and the family. In all settings, palliative care has been found to improve patients' quality of life,[1,2] improve family satisfaction and well-being,[3] reduce resource utilization and costs,[4] and, in some studies, increase the length of life for seriously ill patients.[5]

Given the frequency with which seriously ill patients are hospitalized, hospitalists are well positioned to identify those who could benefit from palliative care interventions.[6] Hospitalists routinely use primary palliative care skills, including pain and symptom management and skilled care planning conversations. For complex cases, such as patients with intractable symptoms or major family conflict, hospitalists may refer to specialist palliative care teams for consultation.

The Society of Hospital Medicine (SHM) defines the key primary palliative care responsibilities for hospitalists as (1) leading discussions on the goals of care and advance care planning with patients and families, (2) screening and treating common physical symptoms, and (3) referring patients to community services to provide support postdischarge.[7] According to data in the National Palliative Care Registry,[8] 48% of all palliative care referrals in 2015 came from hospitalists, which is more than double the percentage of referrals from any other specialty.[9]

In a recent survey conducted by SHM about serious illness communication, 53% of hospitalists reported concerns about a patient or family's understanding of their prognosis, and 50% indicated that they do not feel confident managing family conflict.[10]

IMPROVING VALUE

Context

Patients with multiple serious chronic conditions are often forced to rely on emergency services when crises, such as uncontrolled pain or dyspnea exacerbation, occur after hours, resulting in the revolving-door hospitalizations that typically characterize their care.[11] As the prevalence of serious illness rises and the shift to value-based payment accelerates, hospitals are under increasing pressure to deliver efficient and high-quality services that meet the needs of seriously ill patients. The integration of standardized palliative care screening and assessment enables hospitalists and other providers to identify high-need individuals and match services and delivery models to needs, whether it be respite care for an exhausted and overwhelmed family caregiver or a home protocol for managing recurrent dyspnea crises for a patient with chronic obstructive pulmonary disease (COPD). This process improves the quality of care and quality of life, and in doing so, prevents the need for costly crisis care.

Reducing Readmissions

By identifying patients in need of extra symptom management support, or those at a turning point requiring discussion about achievable priorities for care, hospitalists can avert crises for patients earlier in the disease trajectory either by managing the patient's palliative needs themselves or by connecting patients with specialty palliative care services as needed. This

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TABLE. **Palliative Care Quality and Cost Outcomes**

Value Equation	Outcome	How Does Palliative Care Help?	Evidence
Higher quality	Patients live longer with higher quality of life	More communication, improved symptom management	Temel, *N Engl J Med*, 2010[5]
	Greater family satisfaction with quality of care	More communication, greater comfort, preferences met	Casarett, *Arch Int Med*, 2011[18]
	Improved pain, symptoms, and satisfaction with care	Symptom management and multidisciplinary team	Bernacki, *JAMA Intern Med*, 2014[19]; Wright, *JAMA*, 2008[20]
Lower cost	Lower costs per day	Goal-concordant care	Morrison, *Arch Int Med*, 2008[15]
	Shorter hospital length of stay	Improved symptom management, goal-concordant care	May, *Palliat Med*, 2017[21]
	Shorter ICU length of stay	Goal-concordant care	Norton, *Crit Care Med*, 2007[22]
	Fewer ICU admissions	Improved symptom management, goal-concordant care	Gade, *J Palliat Med*, 2008[23]
	Reduced readmissions	Symptom management and goal-concordant care with use of standardized triggers for palliative care consult	Adelson, *J Oncol Pract*, 2017[24]
	Fewer hospital admissions and inpatient deaths	Better symptom management and higher hospice utilization with in-home palliative care	Lustbader, *J Palliat Med*, 2016[25]
	Fewer 30-day readmissions	Referral to outpatient support (palliative care or hospice)	Enguidanos, *J Palliat Med*, 2012[12]

NOTE: Abbreviation: ICU, intensive care unit.

leads to a better quality of life (and survival in some studies) for both patients and their families[1,3,5] and reduces unnecessary emergency department (ED) and hospital use.[12] Hospitalists providing palliative care can also reduce readmissions by improving care coordination, including clinical communication and medication reconciliation after discharge.[13]

A 2015 Harvard Business Review study found that the quality of communication in the hospital is the strongest independent predictor of readmissions when combined with process-of-care improvements, such as standardized patient screening and assessment of family caregiver capacity.[14] While medical education prepares physicians to deliver evidence-based medical care, it currently offers little to no training in communication skills, despite mounting evidence that this is a critical component of quality healthcare.

Cost Savings

Hospital palliative care teams are associated with significant hospital cost savings that result from aligning care with patient priorities, leading, in turn, to reduced nonbeneficial hospital imaging, medications, procedures, and length of stay.[15] See the table[16,17] for examples of cost and quality outcomes of specialist palliative care provision and evidence supporting each outcome.[18-25]

Multiple studies consistently demonstrate that inpatient palliative care teams reduce hospital costs.[26] One randomized controlled trial investigating the impact of an inpatient palliative care service found that patients who received care from the palliative care team reported greater satisfaction with their care, had fewer intensive care unit admissions, had more advanced directives at hospital discharge, longer hospice length of stay, and lower total healthcare costs (a net difference of $6766 per patient).[23]

Research shows that the earlier palliative care is provided, the greater the impact on the subsequent course of care,[27] suggesting that hospitalists who provide frontline palliative care interventions as early as possible in a seriously ill patient's stay will be able to provide higher quality care with lower overall costs. Notably, the majority of research on cost savings associated with palliative care has focused on the impact of specialist palliative care teams, and further research is needed to understand the economic impact of primary palliative care provision.

Improving Satisfaction

Shifting to value-based payment means that the patient and family experience determine an increasingly large percentage of hospital and provider reimbursement. Palliative care approaches, such as family caregiver assessment and support, access to 24/7 assistance after discharge, and person-centered care by an interdisciplinary team, improve performance in all of these measures. Communication skills training improves patient satisfaction scores, and skilled discussions about achievable priorities for care are associated with better quality of life, reduced nonbeneficial and burdensome treatments, and an increase in goal-concordant care.[19] Communication skills training has also been shown to reduce burnout and improve empathy among physicians.[28,29]

SKILLS TRAINING OPPORTUNITIES

Though more evidence is needed to understand the impact of primary palliative care provision by hospitalists, the strong evidence on the benefits of specialty palliative care suggests that the skilled provision of primary palliative care by hospitalists will result in higher quality, higher value care. A number of training options exist for midcareer hospital medicine clinicians, including both in-person and online training in communication and other palliative care skills.

- The Center to Advance Palliative Care (CAPC) is a membership organization that offers online continuing education unit and continuing medical education courses on communication skills, pain and symptom management, caregiver support, and care coordination. CAPC also offers courses on palliative interventions for patients with dementia, COPD, and heart failure.
- SHM is actively invested in engaging hospitalists in palliative care skills training. SHM provides free toolkits on a variety of topics within the palliative care domain, including pain management, postacute care transitions, and opioid safety. The recently released Serious Illness Communication toolkit offers background on the role of hospitalists in palliative care provision, a pathway for fitting goals-of-care conversations into hospitalist workflow and recommended metrics and training resources. SHM also uses a mentored implementation model in which expert physicians mentor hospital team members on best practices in palliative care. SHM's Palliative Care Task Force seeks to identify educational activities for hospitalists and create opportunities to integrate palliative care in hospital medicine.[30]
- The Serious Illness Care Program at Ariadne Labs in Boston aims to facilitate conversations between clinicians and seriously ill patients through its Serious Illness Conversation Guide, combined with technical assistance on workflow redesign to help clinicians conduct and document serious illness conversations.
- VitalTalk specializes in clinical communication education. Through online and in-person train-the-trainer programs, VitalTalk equips clinicians to lead communication training programs at their home institutions.
- The Education in Palliative and End-of-Life Care Program and End-of-Life Nursing Education Consortium (ELNEC) uses a train-the-trainer approach to educate providers in palliative care clinical competencies and increase the reach of primary palliative care provision. ELNEC workshops are complemented by a curriculum of online clinical training modules.

CULTURE CHANGE

Though palliative care skills training is a necessary first step, hospitalists also cite lack of time, difficulty finding records of previous patient discussions, and frequent handoffs as among the barriers to integrating palliative care into their practice.[10] Studies examining the process of palliative care and hospital culture change have found that barriers to palliative care integration include a culture of aggressive care in EDs, lack of standardized patient identification criteria, and limited knowledge about and staffing for palliative care.[31] These data indicate the need for system changes that enable hospitalists to operationalize palliative care principles.

Health systems must implement systems and processes that routinize palliative care, making it part of the mainstream course of care for seriously ill patients and their caregivers. This includes developing systems for the identification of patients with palliative care needs, embedding palliative care assessment and referral into clinical workflows, and enabling standardized palliative care documentation in electronic medical records. While palliative care skills training is essential, investment in systems change is no less critical to embedding palliative care practices in clinical norms across specialties.

CONCLUSION

Hospitalists can use a palliative approach to improve care quality and quality of life for seriously ill patients while helping to avoid preventable and unnecessary 911 calls, ED visits, and hospitalizations. The shift towards value-based payment is a strong incentive for hospitals and hospitalists to direct resources toward practices that improve the quality of life and care for the highest-need patients and their families. When equipped with the tools they need to provide palliative care, either themselves or in collaboration with palliative care teams, hospitalists have the opportunity to profoundly redirect the experience of care for seriously ill patients and their families.

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Periprocedural Bridging Anticoagulation

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

Oral anticoagulation (OAC) is commonly prescribed to patients with atrial fibrillation, venous thromboembolism (VTE), and mechanical heart valves (MHVs) for primary and secondary thromboembolism prevention. When patients require surgery or an invasive procedure, "bridging" anticoagulants (eg, enoxaparin) are commonly administered during the period of OAC interruption to reduce thromboembolic risk. This practice stems from small observational studies and expert opinion, which influenced several clinical guidelines despite the lack of high-quality evidence. Although prospective randomized trials of periprocedural bridging in patients with VTE and MHVs are lacking, available evidence is consistent with findings from the BRIDGE trial, which guides the following general recommendations: (1) avoid unnecessary periprocedural interruptions of OAC, especially for low bleeding risk procedures; (2) avoid the administration of periprocedural bridging anticoagulation in patients with low to moderate thromboembolic risk; (3) in patients with high thromboembolic risk, individually assess the patient-specific and procedure-specific bleeding risks versus thromboembolic risks.

CASE PRESENTATION

A 75-year-old man with a history of hypertension, diabetes mellitus, and atrial fibrillation is admitted for surgical repair of a comminuted intertrochanteric left hip fracture. He suffered a mechanical ground-level fall without loss of consciousness. At baseline, he denies any chest pain, dyspnea on exertion, or recent change in his exercise tolerance. A physical examination is notable for stable vital signs, irregular cardiac rhythm, and a shortened and externally rotated left lower extremity with exquisite tenderness to palpation and range of motion. The patient is taking warfarin for stroke prophylaxis based on a CHA_2DS_2VaSc score of 4 points. The international normalized ratio (INR) is 1.9 upon admission, and surgery is planned within 48 hours, once the patient is "medically cleared." Will this patient benefit from periprocedural bridging anticoagulation?

WHY YOU MIGHT THINK PERIPROCEDURAL "BRIDGING" ANTICOAGULATION IS HELPFUL

OAC is commonly prescribed to patients with atrial fibrillation, venous thromboembolism (VTE), and mechanical heart valves (MHVs) for the primary or secondary prevention of thromboembolic events, with more than 35 million prescriptions written annually in the United States alone.[1] Many of these patients will require a temporary interruption of their OAC for surgery or an invasive procedure.[2] As a result, patients may be treated with short-acting, or "bridging," anticoagulants, such as low-molecular-weight heparin (LMWH), to minimize the duration of anticoagulation interruption and theoretically reduce their thromboembolic risk. The rationale for bridging stemmed from small observational studies and expert opinion that perceived the estimated thromboembolic risk to be higher than the estimated bleeding risk.[3-5] One such example estimated that the VTE risk increased 100-fold postoperatively, whereas heparin administration only doubled the bleeding risk.[3] Furthermore, clinical practice guidelines published from the American Heart Association, American College of Cardiology, European Heart Rhythm Society, and American College of Chest Physicians recommend when and how to initiate bridging anticoagulation. Clinicians have widely adopted these recommendations despite an acknowledged paucity of high-quality supporting evidence.[6,7]

WHY PERIPROCEDURAL "BRIDGING" ANTICOAGULATION IS MORE HARMFUL THAN HELPFUL

Periprocedural Anticoagulation Interruption is Often Not Indicated

Patients undergoing a surgical or invasive procedure may require an interruption of OAC to minimize the periprocedural bleeding risk. The decision to interrupt OAC should generally be based on the procedure-specific bleeding risk. Procedures with low bleeding risk such as cataract surgery, dermatologic biopsy (including Mohs), arthrocentesis, diagnostic gastrointestinal endoscopy, and cardiac pacemaker implantation can be performed safely without OAC interruption.[5,7] Despite

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TABLE 1. **Study Characteristics and Outcomes Associated with Periprocedural Bridging Anticoagulation**

			No Bridging			Bridging				
Author, Study Year	**Study Design**	**Indication for OAC**	**Patients, n**	**Thrombo-embolic Events, n (%)**	**Major Bleeding Events, n (%)**	**Patients, n**	**Thrombo-embolic Events, n (%)**	**Major Bleeding Events, n (%)**	**Thrombo-embolic Events, *P* Value**	**Major Bleeding Events, *P* Value**
Douketis et al., 2015 [14]	Prospective randomized, double-blind	AF	918	4 (0.4)	12 (1.3)	895	3 (0.3)	29 (3.2)	.73	.005
Steinberg et al., 2015 [2]	Prospective observational registry	AF	1766	9 (0.5)	31 (1.8)	514	4 (0.8)	19 (3.7)	.3	.0007
Clark et al., 2015 [17]	Retrospective cohort	VTE	1257	3 (0.2)	2 (0.2)	555	0 (0.0)	15 (2.7)	.56	.01
Daniels et al., 2009 [16]	Retrospective cohort	MHV	213	1 (0.5)	5 (2.4)	342	4 (1.2)	15 (4.4)	NR	.26
Siegal et al., 2012 [13]	Systematic review and meta-analysis	AF, MHV, VTE	5160	32 (0.6)	18 (0.9)[a]	7118	73 (0.9)	211 (4.2)[b]	.50	.004

[a]Patients at risk major bleeding events n = 2104.

[b]Patients at risk major bleeding events n = 6404.

NOTE: Abbreviations: AF, atrial fibrillation; MHV, mechanical heart valve; NR, not reported; OAC, oral anticoagulation; VTE, venous thromboembolism.

evidence supporting the safety of periprocedural OAC continuation, unnecessary OAC interruptions remain commonplace and are associated with increased adverse outcomes.[8] The BRUISE CONTROL trial compared uninterrupted OAC to interrupted OAC with periprocedural bridging for cardiac pacemaker or defibrillator implantation in a moderate to high thromboembolic risk population. The uninterrupted OAC group experienced significantly fewer pocket hematomas, hematoma evacuations, and prolonged hospitalizations (relative risk [RR] 0.19-0.24; $P < .05$) without significantly increased thromboembolic events, highlighting the potential benefits of this approach.[9]

Nevertheless, many surgical and invasive procedures do warrant OAC interruption due to the inherent bleeding risk of the procedure or other logistical considerations. Procedures associated with an increased bleeding risk include urologic surgery (except laser lithotripsy), surgery on highly vascular organs (eg, kidney, liver, spleen), bowel resection, cardiac surgery, and intracranial or spinal surgery.[7] Alternatively, some procedures with acceptably low bleeding risk (eg, colonoscopy) are routinely performed during an OAC interruption due to the fact that a high bleeding risk intervention may be necessary during the procedure (eg, polypectomy). This approach may be preferable when a significant amount of preparation is required (eg, bowel preparation) and may be a more efficient use of healthcare resources by avoiding repeat procedures.

Bridging Anticoagulation Does Not Significantly Reduce Thromboembolic Events

Several observational studies and a meta-analysis have demonstrated consistently low thromboembolism event rates without conclusive benefits from bridging anticoagulation (Table 1).[10-13] Although these methodologically weak studies and expert consensus have served as the basis for guideline recommendations, the consensus is beginning to change based on results from the BRIDGE trial.[4,5,14,15]

BRIDGE was a randomized, double-blind, placebo-controlled trial among patients with atrial fibrillation (n = 1884) requiring OAC interruption for mostly low-risk, ambulatory surgeries or invasive procedures (eg, gastrointestinal endoscopy, cardiac catheterization). Notably, thromboembolism events were rare, and there was no significant difference in thromboembolism events between patients randomized to placebo or bridging with LMWH (0.4% vs 0.3%, respectively; $P = .73$).[14] However, the proportion of patients enrolled with the highest thromboembolic risk (ie, $CHADS_2$ score 5-6 or prior transient ischemic attack and/or stroke) was low, potentially indicating an underestimated benefit in these patients. Major bleeding was significantly reduced in patients forgoing bridging anticoagulation (1.3% vs 3.2%; RR 0.41; 95% confidence interval, 0.20-0.78; $P = .005$), although bleeding occurred more frequently than thromboembolism in both groups.

Even though randomized trials assessing the safety and efficacy of bridging for VTE or MHVs have not been completed, evidence is not entirely lacking.[16,17] A rigorous observational study limited to a VTE cohort (deep vein thrombosis of upper or lower extremity and/or pulmonary embolism) analyzed the effects of bridging in patients with a surgical or invasive procedure-related OAC interruption. Patients were stratified according to the American College of Chest Physicians perioperative guideline risk-stratification schema, and most VTE events (≥93%) occurred more than 12 months prior to OAC interruption.[7] Importantly, the study found a nonsignificant difference in thromboembolism events between patients who were bridged and those who were not (0.0% vs 0.2%, respectively; $P = .56$), a very low overall thromboembolism event rate (0.2%), and a

TABLE 2. **Periprocedural Risk Stratification Determined by Patient-Specific and Procedure-Specific Risk Factors**

	Thromboembolism Risk Factors			Bleeding Risk Factors	
	Indication for Anticoagulation				
Risk Level	**MHV**	**Atrial Fibrillation**	**VTE**	**Patient-Specific**	**Procedure-Specific**
High	Mechanical mitral valve Multiple mechanical valves Mechanical aortic valve with additional risk factors (eg, prior thromboembolism, AF, LVEF <40%)	CHADS2 score ≥5 or CHA2DS2VaSc score ≥7 Stroke, TIA, or systemic embolism within 3 months Prior thromboembolism with short-term interruption of anticoagulation	Severe thrombophilia (eg, protein C/S deficiency, antiphospholipid syndrome) Recent VTE (eg, within 3 months) Prior thromboembolism with short-term interruption of anticoagulation	Prior bleeding event within 3 months Bleeding history with similar procedure or prior bridging Thrombocytopenia Antiplatelet agent use Platelet dysfunction (eg, uremia) Supratherpeutic INR at the time of procedure	Cardiothoracic surgery Neurosurgery Retinal surgery Vascular surgery Urologic surgery (excluding laser lithotripsy)
Low/Moderate	Bileaflet mechanical aortic valve without additional risk factors (eg, prior thromboembolism, AF, LVEF <40%)	CHADS2 score ≤4 or CHA2DS2VaSc score ≤6 Prior TIA/stroke ≥3 months previously	Absence of severe thrombophilia No VTE within previous 3 months	None of above risk factors HAS-BLED score ≤2	Gastrointestinal endoscopy ± biopsy Pacemaker implantation Orthopedic surgery Abdominal surgery Mohs surgery Cataract surgery Dental extraction(s) Angiography

NOTE: $CHADS_2$ = congestive heart failure, hypertension, age >75 years, diabetes mellitus, prior stroke/TIA (2 points); CHA_2DS_2VaSc = congestive heart failure, hypertension, age >75 years (2 points), diabetes mellitus, prior stroke/TIA (2 points), vascular disease, age >65 years, female sex; HAS-BLED score = uncontrolled hypertension, abnormal renal/liver function, prior stroke, prior bleeding or predisposition, labile INRs, elderly (≥65 years), concomitant antiplatelet agent or NSAID use, alcohol or drug use (≥8 drinks/week). Abbreviations: AF, atrial fibrillation; INR, international normalized ratio; LVEF, left ventricular systolic function; MHV, mechanical heart valve; NSAID, nonsteroidal anti-inflammatory drug; TIA, transient ischemic attack; VTE, venous thromboembolism.

lack of correlation between events and risk-stratification category.[17] In other words, all thromboembolic events occurred in the low- and moderate-risk groups, which include patients who do not warrant bridging under current guidelines. Clinically relevant bleeding occurred in 17 (0.9%) of 1812 patients studied. Notably, 15 (2.7%) of 555 patients receiving bridging suffered clinically relevant bleeding as compared with 2 (0.2%) of 1257 patients forgoing bridging anticoagulation.

The Bleeding Risk of Bridging Anticoagulation Often Outweighs the Potential Benefits

The early observational studies on LMWH bridging demonstrated that thromboembolic events are infrequent (0.4%-0.9%), whereas major bleeding events occur up to 7 times more often (0.7%-6.7%).[10-12] The BRIDGE trial demonstrated comparably low thromboembolic events (0.3%). In the patients treated with bridging LMWH, major bleeding (3.2%) occurred 10 times more frequently than thromboembolism.[14] Likewise, in a VTE cohort study, Clark et al.[17] demonstrated "a 17-fold higher risk of bleeding without a significant difference in the rate of recurrent VTE" in patients bridged with heparin as compared with those who were not. Considering that recurrent VTE and major bleeding events have similar case-fatality rates,[18] these increases in major bleeding events without reductions in thromboembolic events unmistakably tip the risk–benefit balance sharply towards an increased risk of harm.

WHEN IS BRIDGING ANTICOAGULATION POTENTIALLY HELPFUL?

Acknowledging the lack of prospective clinical trials assessing bridging for VTE or MHVs and the predominance of patients with low and moderate thromboembolic risk enrolled in BRIDGE, it is plausible that patients with a high thromboembolic risk (eg, mechanical mitral valve, CHA2DS2VaSc score ≥7, VTE occurrence within 3 months) who are at low risk for bleeding might benefit from bridging. However, until randomized controlled trials are completed in these high-risk populations or risk stratification systems are derived and validated, the decision to bridge patients with a perceived high thromboembolic risk remains uncertain. Consideration of the patient-specific and procedure-specific bleeding risk factors (Table 2) should be weighed against the patient-specific and procedure-specific thromboembolic risk factors to derive an individualized risk–benefit assessment.

WHAT SHOULD YOU DO INSTEAD?

First, determine whether periprocedural OAC interruption is necessary for patients on chronic OAC due to atrial fibrillation, VTE, or MHVs. Avoid unwarranted OAC interruption by discussing the need for OAC interruptions with the surgeon or proceduralist, especially if the surgery is associated with a low bleeding risk and the patient has a high thromboembolic risk. When a periprocedural OAC interruption is justified, bridging should be avoided in the majority of patients, especially those

with low to moderate thromboembolic risk or increased bleeding risk according to current risk-stratification schema.[7,15,19]

Periprocedural management of direct oral anticoagulants (DOACs) is different than that of warfarin. The duration of DOAC interruption is determined by the procedural bleeding risk, drug half-life, and a patient's creatinine clearance. Although the pharmacokinetics of DOACs generally allow for brief interruptions (eg, 24-48 hours), longer interruptions (eg, 96-120 hours) are warranted prior to high bleeding risk procedures, when drug half-life is prolonged (ie, dabigatran), and in patients with renal impairment. Parenteral bridging anticoagulation is not recommended during brief DOAC interruptions, and substituting a DOAC in place of LMWH for bridging is not advised. The 2017 American College of Cardiology Expert Consensus Decision Pathway provides periprocedural OAC interruption guidance for atrial fibrillation, with many principles applicable to other OAC indications.[15]

We developed an institutional guideline that provides clinicians a structured approach to bridging OAC that steers them away from inappropriate bridging and helps them make decisions when evidence is lacking. Shared decision-making represents another effective method for well-informed patients and clinicians to arrive at a mutually agreed upon bridging decision.

RECOMMENDATIONS

- Avoid unnecessary periprocedural interruptions of OAC, especially for procedures with a low bleeding risk.
- Avoid the administration of bridging anticoagulation in patients with low to moderate thromboembolic risk during periprocedural OAC interruptions.
- In patients with a high thromboembolic risk, an individualized assessment of the patient-specific and procedure-specific bleeding risks versus the thromboembolic risks is necessary when considering bridging anticoagulation administration.

CONCLUSION

Returning to the opening case, the patient requires an anticoagulation interruption and INR correction prior to surgery. Because the CHA_2DS_2VaSc score of 4 does not categorize him as a high thromboembolic risk, bridging anticoagulation should be avoided. In the majority of patients on OAC, bridging anticoagulation does not reduce thromboembolic events and is associated with increased major bleeding. Unnecessary anticoagulation interruptions should be avoided for procedures associated with low bleeding risk. Bridging should not be administered to the majority of patients requiring a periprocedural anticoagulation interruption.

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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In the Hospital: Series Introduction

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The only real voyage of discovery consists not in seeking new landscapes but in having new eyes.

—Marcel Proust

Hospitals can be complex, challenging, and dehumanizing for both patients and practitioners. In a national survey, up to half of hospitalists were affected by burnout and scored highly on emotional exhaustion and depersonalization scales.[1]

Yet hospitals are also ripe with meaningful stories. In addition to patients' narratives, the stories of multidisciplinary team members who make quality patient care possible reveal that we are bound together in more ways than we realize. Now, we have the opportunity to tell these stories.

This issue of *Journal of Hospital Medicine* introduces a new series: *In the Hospital*. Through selected interviews we explore the day-to-day lives of members of our hospital team. Highlighting the "team" in healthcare has been a longstanding focus of *JHM*, but we also hope that this series will demonstrate how each *individual* we meet with is not only a critical part of how patients receive care but is also an important member of our community.

We invite readers to appreciate the common threads that bind these pieces together. These stories will introduce us to individuals who have discrete and often disparate job descriptions, but all of them care about patients and want the best for them. Some are frustrated with the health care system and the constraints it places on our efficiency. Many of them worry about how to balance the demands of work with the need to be available for their families and friends. Many are trying their best to maintain their humanism, build resilience, and sustain themselves in ways that meet their personal goals for excellence, empathy, and fulfillment.

This series begins with the story of a palliative-care clinical chaplain whose life experience and perspective brings to light issues of resilience, meaning, and purpose. Future stories in this series will include a variety of providers across a spectrum of practice environments. We look forward to engaging you in this journey and welcome feedback and contributions.

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Denah Joseph: "In the Hospital"

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We recently spoke with Denah Joseph, a clinical chaplain who works with the Palliative Care team to provide spiritual services to patients with serious illness. In addition, Denah leads efforts to address burnout among healthcare providers.

Denah, tell us about yourself.

My first career was actually in clinical psychology, but I've been a Palliative Care chaplain for 15 years. I also teach skill-building for providers around burnout and resilience.

What brought you to Palliative Care?

I've lost three sisters and a partner to breast cancer, and my dad died when I was quite young, so I've had a lot of exposure to loss. The other big thread in my life has been my spiritual practice. My father was an Orthodox Jew, but exceptionally ecumenical for his time. His first wife was Irish Catholic, and my father used to go to church, sit, kneel, and say the rosary, and light candles for his Catholic friends. Three hundred nuns from the local diocese all came to my dad's funeral. It was really remarkable.

I've been a practicing Buddhist since I was 19. When I went back to school to become a chaplain I wanted to bring more of my spiritual interest into counseling work, so chaplaincy seemed like a really interesting way to do that.

Tell us more about what a chaplain actually does.

As a field, healthcare chaplaincy is relatively new. The old model was if a person was religious, somebody would arrange for a rabbi or an imam or a priest to come into the hospital and take care of the pastoral needs of that patient. In the last 10 to 15 years, the consensus guidelines for quality patient care now include addressing the spiritual dimension of patients' lives. Instead of relying on volunteers from the community with no quality assurance, it's required that any hospital over 200 beds have spiritual care available. In order to be a board-certified chaplain, you need to be endorsed by a faith community, and have an advanced degree in either Pastoral Counseling or Theology.

Everybody has spiritual needs even if they don't use that word "spiritual." We define it in terms of meaning, relationships, impact on one's life, hope, fears, reconciliation issues, legacy issues, etc. Approximately 80% of patients want their physicians to understand a little bit about their spiritual/existential/emotional world, and only 20% of doctors ask—so there's a really big gap. This can be a 5-minute conversation about who are you, what's important to you, what's the biggest struggle with your illness that is not medically oriented.

Can you share a patient encounter where you learned something?

Recently I cared for a patient whose wish was to survive to see his only son graduate from college. His wife and son both were like, "You've got to hang in there, Dad. You've got to hang in there." He had very advanced pancreatic cancer, and the chances of him making it to graduation were exceedingly small, but nobody was dealing with this.

During the hospitalization, I went to the patient and his wife and I said, "We're all hoping that you're going to make it until the graduation but in the event you don't, would you like to write a letter to your son?" In the Jewish tradition, it is called an *ethical will*. It's the idea of legacy work. Just like you would make a will for your material possessions, an ethical will expresses what you value, what you hope for and dream for your beloved. He wanted to do it. His wife said, "Absolutely not, that's like believing you're not going to make it." He was a very gentle guy. He would generally completely defer to his wife, but this time he said, "No, I want to do this."

So I met with the patient and asked questions like, "What are the things you would hope to be remembered for? What are you most proud of that you want your son to know? What would you want your son to know if he became a father?"

I had him just talk, while I took notes. Later on, I wrote it up on official stationery and gave it to the patient.

What was his reaction when you gave the letter to him?

He started to cry. He said it was perfect. I usually read it to them so they can make edits if they want to. It sort of brings the grief forward when you imagine talking to a beloved that you're leaving behind.

A few days later the patient died in the hospital surrounded by family members.

His wife, who had advocated so strongly against the letter, hugged me. She said, "That letter is the most important thing that happened here in the hospital." I was shocked she said that, I had no idea he even shared it with her.

If people have the opportunity to share what's important to them, particularly generationally, it could address a very deep need to be remembered.

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Reflecting on it, I actually see myself as a healer and all my work is in healing, whether it's working with physicians or working with patients or working with students or working with people in my private practice. It's a theme that runs through everything. It's not a word we hear often enough in medicine.

Why not?

The culture of medicine has lost its roots, in that sense. I hear a lot of people say, "There's nothing we can do medically, so we're just supporting them through this." Supporting people through the experience is often seen as less valuable, but I think, particularly for serious, terminal illness, supporting people is not optional.

Switching gears a bit, tell us about the skill-building and resilience work you've done.

I think if you don't proactively care for the rest of your life then your work life takes over. Although it's pronounced in medicine, it's in all fields. The pace and stress of our contemporary culture can be contrary to well-being in general.

When I first came to UCSF, I saw a culture of silence around stress, anxiety, and burnout. I started reading about burnout and the numbers of people who qualified to be burnt out at any given time, which may be at least 50% and trending upward. It just seemed to me that in any other profession if half the workforce was impaired, somebody would be doing something. I've really become passionate about this in the last couple of years.

So I developed a burnout prevention and resilience skills training class for providers. We work on mindfulness, social connection and support, positive psychology emotions like gratitude, appreciation, self-compassion, and humor, and delve into the sources of meaning in our work.

Based on your work, what would you say are the key stressors in medicine, generally?

Well there's research on the electronic medical record and the increasing focus on metrics and "value-driven medicine," which can lead to reduced connection with patients. I hope that what I'm doing makes some difference, but fundamentally, I believe there needs to be a real commitment on the part of the health system, to understand and make the changes that need to happen.

What is the fundamental problem? How do you define that?

Well I don't think anybody knows. I think that's what we're saying. How can it be that so many people aren't happy in such privileged work? It's not clinical. It's the system. It's yet another flow sheet that you have to fill out; the actual amount of time spent with patients is low. No wonder we get burned out. We're just doing orders all the time and answering phone calls.

It's the loss of interconnectedness.

Yes, it's the loss of connection. That goes back to even why chaplains may not be recognized as adding value. You can't put a metric on connection. You can't say, "I made 5 connections."

Anything else you would like to share?

I don't know how you feel about it, but I feel so grateful to have the opportunity to be in people's lives in the intimate way we get to be and I, especially, get to be in a way sometimes even more than doctors. You get to be there, and you may even want to talk about the things that we were mentioning, but they're asking you about their creatinine and their platelets and their urinary incontinence, so that's what you're having to talk about. I don't have to do that, so I feel like I get the best seat in the house that way.

I think the seriously ill have so much to share and often are wise, particularly the young ones, from having dealt with illness. I'm really interested in that idea of wisdom and how you develop wisdom. Traditionally wisdom is associated with being an elder and having lived a long time and having a lot of experience. I think our work gives us that opportunity. We don't have to necessarily live through everything to develop that kind of wisdom, but just to be with people who are living through these things.

So here I am, almost 70. I'm working harder than I've ever worked in my life. My partner is retired. She's like, "Come on, let's play." She rides bikes, takes the dog out, cooks, reads. But I just can't stop. I think it's because I feel like, what else would I want to be doing with my time? I think that's an amazing thing to be given that gift that I learn from my patients all the time and learn about what's important. Obviously people are different, but it all boils down to relationships in the end.

That's the promise of medicine, and I think that's the great sadness of what's going on with the epidemic of burnout. People lose connection to that.

There is some element to being present in these hard and difficult times that can bring perspective to life; and to know the sadness, in some ways

…is to know the joy.

Thank you, Denah, for sharing your thoughts with us.

A Howling Cause of Pancytopenia

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 15-year-old African American girl presented to the emergency department with 3 days of fever, sore throat, nausea, vomiting, and poor appetite. She reported a 4-week history of fatigue, right hand pain and swelling, and a 6-kilogram weight loss for which she had seen her primary care provider several times. She reported no recent travel, sick contacts, or new medications.

It appears that there are potentially at least 2 separate problems: an acute one (past 3 days) and a more chronic one (past 4 weeks). These 2 problems may be directly related (ie, acute worsening of the more chronic problem), indirectly related (ie, the more chronic problem is leading to increased susceptibility to the acute problem, for instance, an evolving immunodeficiency predisposing to an opportunistic infection), or "true, true, but unrelated." The clinical challenge is to keep one's mind open to each of these potential scenarios and to avoid the tendency to focus on one of the problems and not pay enough attention to the other. Occam's razor likely does not apply here.

Numerous common and typically transient diseases could cause the symptoms of the past 3 days, particularly infectious etiologies such as streptococcal pharyngitis or a viral infection. One cannot forget about these possibilities while contemplating the more worrisome symptoms of the past 4 weeks, especially weight loss in a growing adolescent. Patients may unintentionally lose weight for a variety of reasons, which can be broadly categorized by decreased caloric supply, gastrointestinal losses or malabsorption, and increased caloric demand; these categories are not mutually exclusive.

Lastly, 1 symptom may provide a more specific direction: the right hand pain and swelling of the past 4 weeks. More specifics, including the extent of the hand swelling, other areas of involvement, and the nature of her pain, will be helpful.

Her temperature was 99.5°F, heart rate 100 beats per minute, respiratory rate 18 breaths per minute, oxygen saturation 95% while breathing ambient air, blood pressure 99/56 mmHg, weight 44 kilograms, height 161 centimeters, and body mass index 17. She appeared generally ill and underweight. She had edematous and violaceous eyelids, dry cracked lips, and pharyngeal erythema with ulcerations of the hard palate. She had nontender cervical and inguinal lymphadenopathy. Her abdomen was tender to palpation in the lower quadrants without guarding or rebound; there was no organomegaly. A right knee effusion with overlying warmth was present without redness or decreased range of motion. She also had an enlarged third proximal interphalangeal joint and loss of palpable metacarpal phalangeal joint landmarks on her right hand. She was noted to be using her arms to move her legs when repositioning in bed.

These exam findings clearly point toward a systemic process but not 1 specific diagnosis. The presence of at least 2 inflamed joints points toward rheumatologic/inflammatory or infectious diseases. Localized edema (eyelids and right metacarpal phalangeal joints), oral ulcers, possible myositis, and arthritis point toward a systemic vasculitis (eg, granulomatosis with polyangiitis, Behçet disease). While Kawasaki disease is also a systemic vasculitis, the presence of oral ulcers and generalized lymphadenopathy argues against it. Inflammatory myopathies like polymyositis, and especially juvenile dermatomyositis, fit many aspects of this presentation with the violaceous eyelids and possible myositis, though no other cutaneous stigmata of this disease are evident (eg, no Gottron's papules). Polyarthritis, violaceous eyelids, and possible myositis could be consistent with systemic lupus erythematosus (SLE).

The presence of oral ulcers and arthritis make other systemic inflammatory conditions, such as inflammatory bowel disease with arthritis and autoimmune- or infection-related hepatitis,

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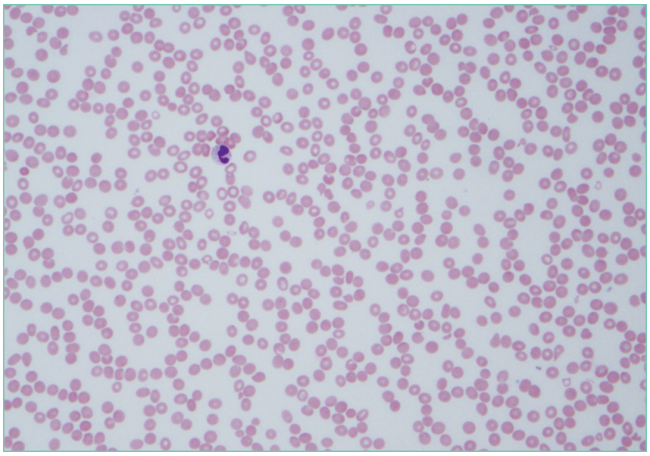

FIG 1. Pathologic findings from peripheral smear: Peripheral smear at presentation (40x) showing decreased density of red blood cells and platelets and only a single granulocyte consistent with pancytopenia.

possible. Infectious etiologies alone or in combination with a rheumatologic process are also possible given fevers and lymphadenopathy. In particular, herpesvirus infections (Epstein-Barr virus [EBV], cytomegalovirus [CMV], herpes simplex virus, or human herpes virus 6), human immunodeficiency virus (HIV), hepatitis C virus (HCV), and syphilis can cause oral ulcers and lymphadenopathy. Other potential infectious etiologies include subacute bacterial endocarditis and disseminated gonococcal infection given the presence of polyarthritis, but these infections are less likely as they do not explain all of the symptoms.

In summary, the differential diagnosis is broad and should be prioritized to consider systemic inflammatory conditions, including autoimmune and infectious (especially viral) syndromes, and initial work-up should focus on these etiologies.

The initial laboratory evaluation was notable for pancytopenia with a white count of 1.9 x 10^9cells/L, absolute neutrophil count of 0.95 x 10^9/L, absolute lymphocyte count of 0.48 x 10^9/L, hemoglobin concentration of 10 g/dL, mean corpuscular volume of 78 fL, and platelet count of 4.1 x 10^9/L (Figure 1). The following infectious studies were sent: hepatitis B virus, HCV, and Parvovirus-B19 serologies, EBV and CMV serologies and polymerase chain reaction studies, HIV antigen and antibody immunoassays, rapid plasma reagin, as well as bacterial blood, urine, and stool cultures. She was started on broad-spectrum antibiotics. The patient's heart rate and blood pressure normalized after receiving a bolus of 20 mL per kilogram of normal saline.

The pancytopenia is obviously notable. It raises the possibility that the oral ulcerations are due to the neutropenia rather than a primary disease manifestation. Other possible causes of pancytopenia include SLE, antiphospholipid antibody syndrome, and related rheumatologic diagnoses, including hemophagocytic lymphohistiocytosis (HLH). Given her age and subacute presentation, secondary forms of HLH seem more likely than primary (genetic) forms, which typically present within the first few years of life. Secondary forms of HLH can occur in association with rheumatic diseases and are then referred to as Macrophage Activation Syndrome (MAS). The most common rheumatologic diseases associated with MAS are systemic juvenile idiopathic arthritis, SLE, and Kawasaki disease. Secondary HLH can also occur with infectious diseases, particularly viral infections such as EBV. It is also important to consider thrombotic thrombocytopenic purpura and other forms of thrombotic microangiopathy, especially if her violaceous eyelids actually represent purpura. The presence of pancytopenia also expands the differential diagnosis to include leukemia, lymphoma, and other oncologic diseases. After obtaining results from pending infectious disease studies, additional diagnostic work-up should include examination of the bone marrow and a peripheral blood smear to evaluate for hemophagocytosis and/or malignancy. Testing for double-stranded DNA antibodies and antinuclear antibodies (ANA) should be sent to evaluate for SLE, and antiphospholipid antibodies should also be checked. Renal function must also be evaluated.

Additional laboratory work-up revealed a reticulocyte count of 0.2%, a positive Coombs immunoglobulin G (IgG) test, haptoglobin less than 80 mg/L, and lactate dehydrogenase (LDH) 25.2 μkat/L (1509 units/L); coagulation studies were normal. Her chemistries showed electrolytes, blood urea nitrogen, and creatinine were within normal limits; her aspartate aminotransferase was 216 units/L, and alanine aminotransferase was 56 units/L. Her spot urine protein-to-creatinine ratio was 1.28. Complement and inflammatory studies showed C3 0.14 g/L (14 mg/dL, normal 83-151 mg/dL), C4 0.05 g/L (5 mg/dL, normal 13-37 mg/dL), erythrocyte sedimentation rate (ESR) 103 mm/hr (normal 0-20 mm/hr), and C-reactive protein (CRP) 3.2 mg/L (normal 0.7-1.7 mg/L). Additional studies showed elevated triglycerides (376 mg/dL), elevated creatine kinase (2437 units/L), and elevated ferritin (22,295.5 ng/mL). An ANA screen and specific autoantibody studies were sent, including antidouble stranded DNA antibody, antiribonucleoprotein antibody, anti-Smith antibody, anti-Ro antibody, and anti-La antibody. A bone marrow biopsy was performed.

The hematologic studies provide a mixed picture. There is evidence of an autoimmune hemolytic anemia (AIHA). Typically, AIHA is associated with reticulocytosis rather than reticulocytopenia. Reticulocytopenia can occur in AIHA, however, because of antibodies directed against erythroid precursors or if 2 processes are occurring simultaneously—ie, AIHA plus bone marrow destructive/failure process. The latter scenario is more likely here. Specifically, the pancytopenia, elevated triglycerides, and extreme hyperferritinemia strongly support the diagnosis of HLH. The very low C3 and C4 suggest a complement-consumptive process, and SLE is the most likely etiology. Proteinuria and Coombs-positive anemia are also features of SLE. The discordance between the ESR (markedly elevated) and CRP (mild elevation) is surprising in the setting of systemic inflam-

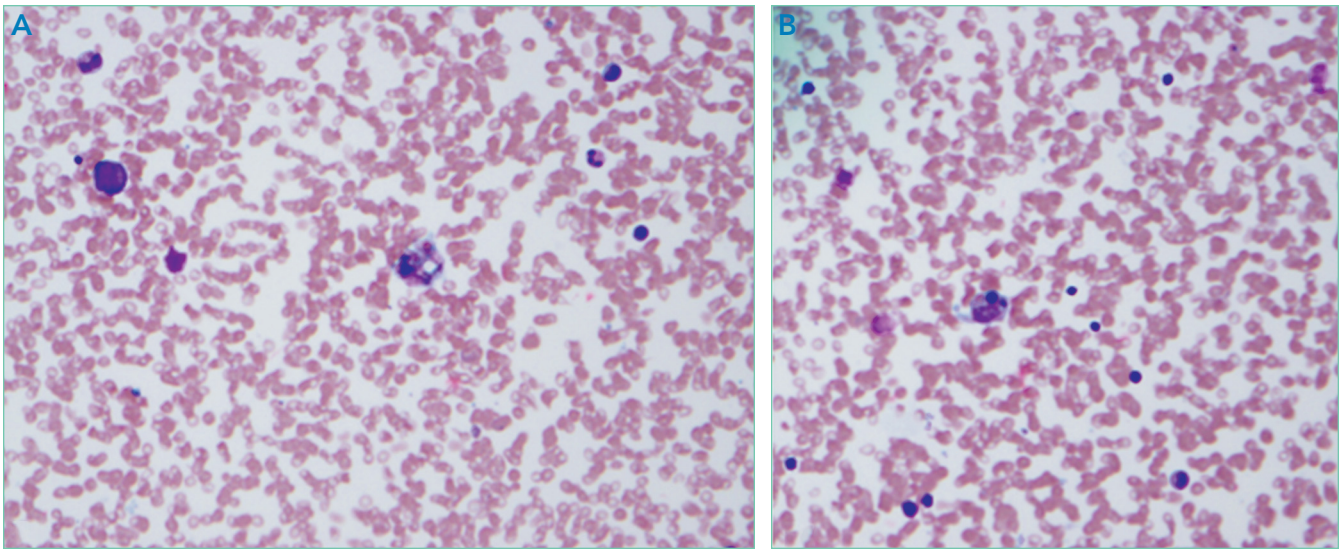

FIG 2. Pathologic findings from bone marrow biopsy: The patient's bone marrow biopsy (40x) shows hemophagocytosis of a lymphocyte (2A) and hemophagocytosis of a red blood cell (2B).

mation. However, her other clinical features are consistent with marked systemic inflammation, and it is important not to dismiss a likely diagnosis simply on the basis of a few incongruous features. At this point, the diagnosis of SLE complicated by secondary HLH is favored, remembering that both these entities can be triggered by a viral infection. Therefore, diligent follow-up of the aforementioned specific autoantibody studies and the bone marrow biopsy is the next logical step, along with the still-pending infectious disease studies.

All of the infectious disease studies returned negative for active infection and were consistent with prior EBV and CMV infections with positive IgG testing. The bone marrow biopsy revealed trilineage hematopoiesis with hemophagocytosis, mild fibrosis, and no blasts (Figure 2). Antibody studies for SLE returned with elevated antidouble stranded DNA antibodies >200,000 IU/L. Reference labs ultimately confirmed the presence of decreased natural killer (NK) cell function, elevated soluble interleukin-2 receptors (IL-2R), and elevated soluble cluster of differentiation 163 (CD163).

These findings are consistent with the diagnosis of SLE complicated by secondary HLH (ie, MAS). It remains possible, but unlikely, that the patient has genetic or familial HLH (fHLH), as this entity is exceedingly rare with distinct underlying genetic aberrations separate from SLE. Ideally, the NK cell function studies would be repeated after the current episode of HLH is controlled and the patient is off of immunosuppressive therapies, but this will likely not be possible given the underlying SLE. Patients with fHLH have reduced or absent NK cell function at baseline (ie, not only during an acute episode of HLH and not because of immunosuppressive medications). Alternatively, one could consider genetic testing for fHLH. The clinical importance of doing this is that patients with fHLH are candidates for bone marrow or stem cell transplantation. There currently is not a published standard of care for the work-up and management of MAS in children with rheumatic disease, so the decision to repeat NK cell function testing and/or genetic testing would be left to the discretion of the treating physician and would depend on the patient's ongoing clinical course.

The patient required red blood cell and platelet transfusions. She received pulse dose intravenous methylprednisolone for treatment of SLE and MAS; she clinically improved within 48 hours of starting steroids. Cyclosporine was added for management of MAS. The patient was transitioned to oral corticosteroids and discharged home. All cell counts normalized within 1 month of discharge. She was weaned off corticosteroids and cyclosporine was discontinued. Her maintenance SLE therapy includes hydroxychloroquine and mycophenolate mofetil.

COMMENTARY

Because the differential diagnosis for new-onset pancytopenia encompasses many diseases across several medical subspecialties, a thorough history and physical exam are necessary to form a tailored clinical approach.[1] The primary causes of pediatric pancytopenia vary depending on geographic location because of the local prevalence of infectious agents and nutritional deficiency patterns. A retrospective study investigating the primary cause of pancytopenia in children without existing malignancy presenting to a US tertiary care hospital found that 64% of cases were due to infection, 28% were due to hematologic disease (most frequently aplastic anemia), and 8% were due to miscellaneous etiologies, including adverse drug reactions and autoimmune diseases.[2] In contrast, the most common cause of pancytopenia in pediatric patients presenting to a tertiary care hospital in India was megaloblastic anemia (28%), followed by infections (21%), acute leukemia (21%), and

TABLE. **American College of Rheumatology Criteria for Classification of Systemic Lupus Erythematosus**[a]

Criterion	Definition
Malar rash	Fixed erythema, flat or raised, over the malar eminence, tending to spare the nasolabial folds.
Discoid rash	Erythematous raised patches with adherent keratotic scaling and follicular plugging; atrophic scarring may occur in older lesions.
Photosensitivity	Skin rash as a result of unusual reaction to sunlight by patient history or physician observation.
Oral ulcers	Oral or nasolabial ulceration, usually painless, observed by physician.
Nonerosive arthritis	Involving 2 or more peripheral joints and characterized by tenderness, swelling, or effusion.
Pleuritis or Pericarditis	Pleuritis: convincing history of pleuritic pain or rubbing heard by a physician or evidence of pleural effusion OR Pericarditis: documented by electrocardiogram or rub, or evidence of pericardial effusion.
Renal disorder	Persistent proteinuria >0.5 grams per day or >3+ if quantification not performed OR Cellular casts: may be red cell, hemoglobin, granular, tubular, or mixed.
Neurologic disorder	Seizures in the absence of offending drugs or known metabolic derangements; eg, uremia, ketoacidosis, or electrolyte imbalance OR Psychosis in the absence of offending drugs or known metabolic derangements; eg, uremia, ketoacidosis, or electrolyte imbalance.
Hematologic disorder	Hemolytic anemia with reticulocytosis, OR Leukopenia <4,000/mm^2 on ≥2 occasions OR Thrombocytopenia <100,000/mm^3 in the absence of offending drugs.
Immunologic disorder	Anti-DNA: antibody to native DNA in abnormal titer OR Anti-Smith: presence of antibody to Smith nuclear antigen OR Positive finding of antiphospholipid antibodies on (a) an abnormal serum level of IgG or IgM anticardiolipin antibodies, (b) a positive test result for lupus anticoagulant by using a standard method, or (c) a false-positive test result for at least 6 months confirmed by *Treponema pallidum* immobilization or fluorescent treponemal antibody absorption test.
Positive antinuclear antibody	An abnormal titer of antinuclear antibody by immunofluorescence or an equivalent assay at any point in time and in the absence of drugs

[a]Adopted from the "1997 Update of the 1982 American College of Rheumatology Revised Criteria for Classification of Systemic Lupus Erythematosus."
NOTE: Abbreviations: IgG, immunoglobulin G; IgM, immunoglobulin M.

aplastic anemia (20%).[3] While clinicians do (and should) consider malignancy as a cause of pancytopenia, there is sparse literature regarding the frequency of pancytopenia associated with the presentations of childhood malignancies.[4] A study of pediatric patients with acute lymphoblastic anemia found that only 11% of newly diagnosed patients had pancytopenia at initial presentation.[4]

There are no official guidelines for the work-up of pediatric pancytopenia from any of the academic societies. Depending on the clinical history, initial laboratory investigation for pediatric pancytopenia may include complete blood cell count with differential, reticulocyte count, peripheral blood smear, complete metabolic panel, hemolysis labs (haptoglobin, LDH, Coombs test) and inflammatory markers (ESR, CRP, fibrinogen). Further investigation to clarify the specific etiology of pancytopenia can be guided by the results of these initial tests.

SLE is an autoimmune disorder characterized by chronic inflammation of multiple organ systems. The name "lupus" (Latin for wolf) became widely used by dermatologists in the 1800s before systemic involvement was realized to describe the destructive facial lesions thought by some to resemble a wolf bite.[5] The American College of Rheumatology (ACR) classification criteria[6] and/or the Systemic Lupus International Collaborating Clinics classification criteria[7] are often used to help make the diagnosis. The ACR criteria are summarized in the Table; an individual is considered to have SLE if 4 or more of the 11 clinical criteria are present.[6] In children, the most common presenting symptoms of SLE are fever, fatigue, weight loss, rash, arthritis, and renal disease.[8] Children with SLE tend to have a more severe phenotype with greater involvement of major organ systems and more rapid accrual of organ damage than adults with SLE, emphasizing the importance of early diagnosis and treatment in this population.[9] As such, severe presenting symptoms may require initiation of immunosuppressive therapies before the patient fully meets diagnostic criteria, provided malignancy and infection can be excluded.

Hematologic abnormalities are present in greater than 70% of pediatric SLE cases.[10,11] The pathogenesis of hematologic

abnormalities in SLE is heterogeneous, involving actions of autoreactive lymphocytes, autoantibodies, and proinflammatory cytokines that can disrupt bone marrow production and cause peripheral blood cell destruction.[12,13] While pancytopenia is common in children with SLE, other coexisting diagnoses should be considered in patients with SLE and pancytopenia. Concurrent diagnoses that can lead to pancytopenia in patients with SLE include infection, pharmacologic side effects, and secondary HLH,[14,15] each of which has differing implications for prognosis and treatment.

Secondary HLH is a severe and often acute complication of systemic inflammatory disorders caused by the proliferation and activation of T cells and macrophages, leading to an enhanced inflammatory state. When HLH occurs in the setting of an underlying autoimmune or autoinflammatory process, it is typically termed MAS. MAS affects an estimated 0.9% to 4.6% of patients with SLE.[16] Early diagnosis and treatment of MAS is important because MAS can be rapidly fatal, with a mortality rate of 8% to 20% in pediatric patients.[17,18] Clinical features of MAS include physical exam findings of fever and splenomegaly as well as laboratory abnormalities, including pancytopenia, elevated ferritin, elevated triglycerides, and low fibrinogen.[18] A bone marrow biopsy showing hemophagocytosis in the absence of malignancy is diagnostic of MAS. Although a bone marrow biopsy is not required to diagnose MAS, it is often obtained to exclude other etiologies of pancytopenia such as malignancy.[19] Specialized diagnostic testing for MAS includes NK cell counts and functional studies, including expression of perforin and granzyme B (NK cell proteins triggering apoptosis in target cells), soluble IL-2R (marker of activated lymphocytes), and CD163 (transmembrane protein of hemophagocytic macrophages). There is no standardized protocol for treating MAS.[20] It is most commonly treated with highdose corticosteroids; additional agents, including cyclosporine and biologic therapies, are also utilized.[16,20]

KEY POINTS

- Children with SLE tend to have greater involvement of major organ systems and more rapid accrual of organ damage than adults with SLE. Therefore, it is sometimes necessary to initiate immunosuppressive therapies before full diagnostic criteria are met, provided that malignancy and infection have been ruled out.
- While pancytopenia is common in pediatric patients with SLE, providers should make sure to consider coexisting diagnoses such as infection and MAS, both of which require different treatment strategies.
- It is important to consider HLH/MAS early in the work-up of pancytopenia, because early diagnosis and treatment improves clinical outcomes. Obtaining a ferritin level can aid in the work-up of pancytopenia because it is both a sensitive and specific marker of HLH/MAS when dramatically elevated.

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Disruptive Physician Behavior: The Importance of Recognition and Intervention and Its Impact on Patient Safety

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Professional misconduct by physicians is a significant problem with negative implications in the healthcare environment and has been termed "disruptive physician behavior" (DPB) in the United States. In recent years, hospitals and healthcare organizations have begun to better understand and formally address DPB, including its management and repercussions. Policy statements by the Joint Commission and the American Medical Association (AMA) have acknowledged that DPB may pose a threat to patient and provider safety. The purpose of this article is to raise awareness about the etiology of disruptive behavior in physicians, describe the consequences and the need for early recognition, and discuss potential interventions. *Journal of Hospital Medicine* 2018;13:210-212. © 2018 Society of Hospital Medicine

Dramatic stories of disruptive physician behavior (DPB) appear occasionally in the news, such as the physician who shot and killed a colleague within hospital confines or the gynecologist who secretly took photographs using a camera disguised as a pen during pelvic examinations. More common in hospitals, however, are incidents of inappropriate behavior that may generate complaints from patients or other providers and at times snowball into administrative or legal challenges.

"Professionalism" is one of the six competencies listed by the Accreditation Council for Graduate Medical Education (ACGME)[1] and the American Board of Medical Specialties. Unfortunately, incidents of disruptive behavior can result in violation of the tenets of professionalism in the healthcare environment. These behaviors fall along a continuum ranging from outwardly aggressive and uncivil to overly passive and insidious. Although these behaviors can occur across all healthcare disciplines and settings and are not just limited to physicians, the behaviors of physicians often have a much greater impact on the healthcare system as a whole because of their positions of relative "power" within the system.[2] Hence, this problem requires greater awareness and education. In this context, the aim of this article is to discuss disruptive behaviors in physicians.

The AMA defines DPB as "personal conduct, verbal or physical that has the potential to negatively affect patient care or the ability to work with other members of the healthcare team."[3] The definition of DPB by the Joint Commission includes "all behaviors that undermine a culture of safety."[4] Both the Joint Commission and the AMA recognize the significance and patient safety implications of such behavior. Policy statements by both these organizations underscore the importance of confronting and remedying these potentially dangerous interpersonal behaviors.

Data regarding the prevalence of DPB have been inconsistent. One study estimated that 3%–5% of physicians demonstrate this behavior,[5] whereas another study reported a DPB prevalence of 97% among physicians and nurses in the workplace.[6] According to a 2004 survey of physician executives, more than 95% of them reported regular encounters of DPB.[7]

The etiology of such disruptive behaviors is multifactorial and complex. Explanations associated with 'nature versus nurture' have ranged from physician psychopathology to unhealthy modeling during training. Both extrinsic and intrinsic factors may also contribute to DPB. External stressors and negative experiences–professional and/or personal–can provoke disruptive behaviors. Overwork, fatigue, strife, and a dysfunctional environment that can arise in both work and home environments can contribute to the development of mental health problems. Stress, burnout, and depression have increasingly become prevalent among physicians and can play a significant role in causing impaired patterns of professional conduct.[8, 9] These mental health problems can cause physicians to acquire maladaptive coping strategies such as substance abuse and drug or alcohol dependence. However, it is important to note that physician impairment and substance abuse are not the most frequent causes of DPB. In fact, fewer than 10% of physician behavior issues have been related to substance abuse.[2, 5]

Intrinsic factors that contribute to DPB include personality traits and disorders, psychiatric diagnoses, and even medical conditions (eg, age and disease-related cognitive impairment).[5] Personality disorders have been implicated in causing

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DPB and constitute varying levels of pathology that may exist in several shades along a continuum. A single individual may fit into multiple different personality disorders (eg, narcissistic, borderline, and antisocial).[10] As a result, making a clear diagnosis is often difficult for mental health professionals. Occasionally, it is simpler to conceptualize DPB in the context of subclinical personality traits, rather than diagnosable personality disorders. Not all these personality traits are pathologic—in fact, some are desirable (Table 1).[10]

Psychiatric disorders such as major depression and bipolar and anxiety disorders may also contribute to DPB.[10] Most of these disorders (except for schizophrenia) are likely as common among physicians as among the general public.[9] An essential clarification is that although DPB can be a manifestation of personality disorders or psychiatric disorders, it does not always stem from underlying psychopathology. Clarifying these distinctions is important for managing the problem and calls for expert professional evaluation in some cases.[10]

A person's behavior is shaped by character, values, perceptions, and attitudes. Individuals who engage in DPB typically lack insight and justify their behaviors as a means to achieve a goal. Disrespectful behavior is rooted, in part, in characteristics such as insecurity, immaturity, and aggressiveness; however, it can also be learned, tolerated, and reinforced in the hierarchical hospital culture.[11]

Other intrinsic factors that may contribute to DPB include lack of emotional intelligence, poor social skills, cultural and ethnic issues, and generation and gender bias.[12] Identifying the root causes of DPB can be challenging due to the complexity of the interaction between the healthcare environment and the key players within it; nevertheless, awareness of the contributing factors and early recognition are important. Those who take on the mantle of leadership within hospitals should be educated in this regard.

TABLE 1. **Personality Traits Associated with Disruptive Physician Behavior**[11]

Maladaptive Traits	Adaptive Traits
Arrogant	Confident
Intimidating, manipulative	Hard-working
Controlling, rigid, inflexible	Motivated
Self-centered, entitled	Persevering
Deceitful, indulges in malicious gossip and pathologic lying	High achieving
Lacks empathy, remorse, and ability to apologize genuinely	Articulate
Lacks self-awareness, insight	Innovative
Fails to self-correct behavior, resists help	Intelligent
Vindictive, blames others, litigious	Focused
Sexually promiscuous	Highly skilled

REPERCUSSIONS OF DISRUPTIVE PHYSICIAN BEHAVIOR

An institution's organizational culture often has an impact on how DPB is addressed. Tolerance of such behavior can have far-reaching consequences. The central tenets of a "culture of safety and respect"–teamwork across disciplines and a blame-free environment in which every member of the healthcare team feels equally empowered to report errors and openly discuss safety issues–would be negatively impacted.

DPB can diminish the quality of care provided, increase the risk of medical errors, and adversely affect patient safety and satisfaction.[11-13] Such behavior can cause erosion of relationships and communication between individuals and contribute to a hostile work environment. For instance, nurses or trainees may be afraid to question a physician because of the fear of getting yelled at or being humiliated. Consequently, improperly written orders may be overlooked or a potentially "wrong-site" surgical procedure may not be questioned for fear of provoking a hostile response.

DPB can increase litigation risk and financial costs to institutions. Provider retention may be adversely affected; valued staff may leave hospitals and need to be replaced, and productivity may suffer. When physicians in training observe how their superiors model disruptive behaviors with impunity, a concerning problem that arises is that DPB becomes normalized in the workplace culture, especially if such behaviors are tolerated and result in a perceived gain.

PROPOSED INTERVENTIONS

Perhaps the initial step in addressing DPB is prevention. Considering the role of external factors, it is necessary to encourage initiatives to foster "whole health" and a peaceful environment in the workplace. Physician health and wellness are key to maintaining professionalism and should be prioritized in the healthcare environment. Individuals should be encouraged to seek professional care when their physical or mental health is compromised.[12] (Table 2)

Confrontation of DPB can be challenging without appropriate infrastructure. Healthcare facilities should have a fair system in place for reliable reporting and monitoring of DPB, including a complaints' verification process, appeals process, and an option for fair hearing.

It is best to initially address the issue in a direct, timely, yet informal manner through counseling or a verbal warning. In several situations, such informal counseling opportunities create a mindful awareness of the problem and the problematic behavior ceases without the need for further action.

When informal intervention is either not appropriate (eg, if the alleged event involved an assault or other illegal behavior) or has already been offered in the past, more formal intervention is required. Institutional progressive disciplinary polices should be in place and adhered to. For example, repeat offenders may be issued written warnings or even temporary suspension of privileges.

Institutional resources such as human resources departments, office of general counsel, office of medical affairs, and the hospital's medical board may be consulted. Some med-

TABLE 2. **Proposed Interventions: What Healthcare Institutions Can Do**[12]

Raise Level of Awareness: Education and Training
Definition of DPB, impact on patient safety, organizational culture
Courses: Sensitivity and diversity training; Communication and team collaboration skills; Stress, anger, conflict management
Organizational Commitment from Leaders
Prioritize "Whole health" of providers
Cultural Transformation: Foster culture of equality, patient safety; have clinical champions to safeguard standards of appropriate behavior
Implement universal disruptive behavior policies and procedures that reinforce "professionalism"
Implement a fair system to report, review, address, monitor DPB
Interventions
Informal–timely verbal discussion, counseling
Formal–courses, coaching, written warning
Program Support–Patient safety/Risk management program, Employee assistance program, Professionalism Committees, Mental health professionals: psychologist, psychiatrist
Disciplinary actions - Internal (Institutional), External (State Medical Board)

ical centers have "employee assistance programs" staffed with clinicians skilled in dealing with DPB. Individuals diagnosed with substance abuse or a mental health disorder may require consultation with mental health professionals.[14]

Special "Professionalism Committees" can be instituted and tasked with investigating complaints and making recommendations for the involvement of resources outside the institution, such as a state medical society.[15]

CONCLUSION

Although the vast majority of physicians are well-behaved, it is important to acknowledge that disruptive behaviors can occur in the healthcare environment. Such behaviors have a major impact on workplace culture and patient safety and must be recognized early. Hospital executives and leaders must ensure that appropriate interventions are undertaken—before the quality of patient care is affected and before lives are endangered.

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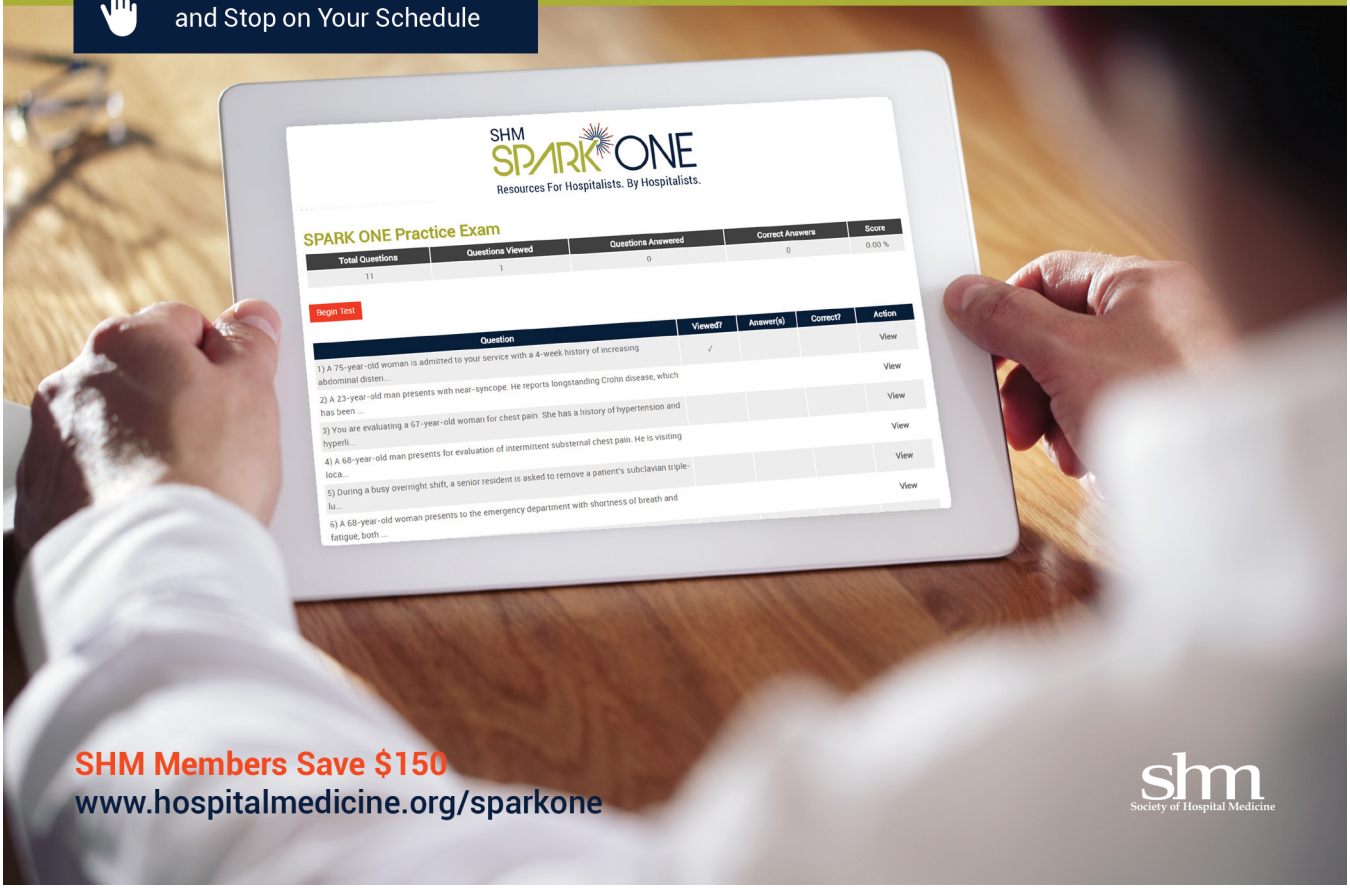

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