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WEBSITE
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EDITORIAL STAFF

Managing Editor
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(240) 221-2471
susanhite@mdedge.com

ART

Creative Director
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PRODUCTION AND MANUFACTURING

Production Manager
Mike Wendt
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mwendt@mdedge.com

CIRCULATION

Subscription Service:
(800) 480-4851
frontline@emscirc.com

PUBLISHING STAFF

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

Director, Business Development
Angela Labrozzi, MBA
(973) 206-8971
Cell (917) 455-6071
alabrozzi@mdedge.com

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PERSPECTIVES IN HOSPITAL MEDICINE

EDITORIALS

Returns to Emergency Department, Observation, or Inpatient Care Within 30 Days After Hospitalization in 4 States, 2009 and 2010 Versus 2013 and 2014

Teryl K. Nuckols, MD, MSHS[1,2], Kathryn R. Fingar, PhD, MPH[3], Marguerite L. Barrett, MS[4], Grant Martsolf, PhD, MPH, RN[5,6], Claudia A. Steiner, MD, MPH[7], Carol Stocks, PhD, RN[7], Pamela L. Owens, PhD[7]

[1]RAND Corporation, Santa Monica, California; [2]Division of General Internal Medicine, Department of Medicine, Cedars-Sinai Hospital, Los Angeles, California; [3]IBM Watson Health, Sacramento, California; [4]M.L. Barrett, Inc., Del Mar, California;[5] RAND Corporation, Pittsburgh, Pennsylvania; [6]University of Pittsburgh School Nursing, Department of Acute and Tertiary Care, Pittsburgh, Pennsylvania; [7]Agency for Healthcare Research and Quality, Rockville, Maryland; Dr. Steiner is now with the Institute for Health Research, Kaiser Permanente, Denver, Colorado.

BACKGROUND: Nationally, readmissions have declined for acute myocardial infarction (AMI) and heart failure (HF) and risen slightly for pneumonia, but less is known about returns to the hospital for observation stays and emergency department (ED) visits.

OBJECTIVE: To describe trends in rates of 30-day, all-cause, unplanned returns to the hospital, including returns for observation stays and ED visits.

DESIGN: By using Healthcare Cost and Utilization Project data, we compared 210,007 index hospitalizations in 2009 and 2010 with 212,833 matched hospitalizations in 2013 and 2014.

SETTING: Two hundred and one hospitals in Georgia, Nebraska, South Carolina, and Tennessee.

PATIENTS: Adults with private insurance, Medicaid, or no insurance and seniors with Medicare who were hospitalized for AMI, HF, and pneumonia.

MEASUREMENTS: Thirty-day hospital return rates for inpatient, observation, and ED visits.

RESULTS: Return rates remained stable among adults with private insurance (15.1% vs 15.3%; $P = .45$) and declined modestly among seniors with Medicare (25.3% vs 25.0%; $P = .04$). Increases in observation and ED visits coincided with declines in readmissions (8.9% vs 8.2% for private insurance and 18.3% vs 16.9% for Medicare, both $P \leq .001$). Return rates rose among patients with Medicaid (31.0% vs 32.1%; $P = .04$) and the uninsured (18.8% vs 20.1%; $P = .004$). Readmissions remained stable (18.7% for Medicaid and 9.5% for uninsured patients, both $P > .75$) while observation and ED visits increased.

CONCLUSIONS: Total returns to the hospital are stable or rising, likely because of growth in observation and ED visits. Hospitalists' efforts to improve the quality and value of hospital care should consider observation and ED care. *Journal of Hospital Medicine* 2018;13:296-303. Published online first November 22, 2017. © 2018 Society of Hospital Medicine

Given the frequency, potential preventability, and costs associated with hospital readmissions, reducing readmissions is a priority in efforts to improve the quality and value of healthcare.[1,2] State and national bodies have created diverse initiatives to facilitate improvements in hospital discharge practices and reduce 30-day readmission rates across payers.[3-5] For example, the Agency for Healthcare Research and Quality (AHRQ) and the Institute for Healthcare Improvement have published tools for improving discharge practices.[6,7] Medicare instituted financial penalties for hospitals with higher-than-expected readmission rates for acute myocardial infarction (AMI), heart failure (HF), and pneumonia in 2012, while private payers and Medicaid programs have established their own policies.[8-13] Furthermore, private payers and Medicaid programs shifted toward capitated and value-based reimbursement models in which readmissions lead to financial losses for hospitals.[14,15] Accordingly, hospitals have implemented diverse interventions to reduce readmissions.[16,17] From 2009 to 2013, 30-day readmissions declined among privately insured adults (from 12.4% to 11.7%), Medicare patients (from 22.0% to 20.0%), and uninsured individuals (11.5% to 11.0%) but climbed among patients with Medicaid (from 19.8% to 20.5%) after index admissions for AMI, HF, pneumonia, or chronic obstructive pulmonary disease.[18]

To date, research, policies, and quality improvement interventions have largely focused on improvements to one aspect of the system of care that provided in the inpatient setting – among older adults with Medicare. Yet, inpatient readmissions may underestimate how often patients return to the hospital because patients can be placed under observation or stabilized and discharged from the emergency department (ED) instead of being readmitted. Observation and ED visits are less costly to payers than inpatient admissions.[19] Thus, information about utilization of inpatient, ob-

***Address for correspondence:** Teryl K. Nuckols, MD, MSHS, RAND Corporation, 1776 Main Street, Santa Monica, CA 90401; Telephone: 310-393-0411; Fax: (310) 260-8159; E-mail: teryl.nuckols@cshs.org

Additional Supporting Information may be found in the online version of this article.

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TABLE 1. **Characteristics of Index Admissions[a] After Matching for AMI, HF, and Pneumonia in 2009 and 2010 versus 2013 and 2014 and Subsequent Revisits Within 30 Days, by Expected Payer at the Index Admission**

	Private, 18-64 Years		Medicare, 65+ Years		Medicaid, 18-64 Years		Uninsured, 18-64 Years	
Characteristic	**2009 and 2010**	**2013 and 2014**	**2009 and 2010**	**2013 and 2014**	**2009 and 2010**	**2013 and 2014**	**2009 and 2010**	**2013 and 2014**
Index admissions, N	35,056	31,171[b]	144,113	149,380[b]	14,575	15,566[b]	16,263	16,716[b]
AMI	13,002	13,324[b]	26,566	29,452[b]	2290	2714[b]	5353	5820[b]
HF	8371	7381[b]	63,659	65,011[b]	5692	6615[b]	5382	5726[b]
Pneumonia	13,683	10,466[b]	53,888	54,917[b]	6593	6237[b]	5528	5170[b]
Variables used in matching procedure								
Patient age, years, % of index admissions								
18-24	1.8	1.5[b]	–	–	3.8	3.4	2.2	2.0
25-34	4.7	4.3[b]	–	–	8.9	8.4	7.7	7.4
35-44	13.5	13.2	–	–	15.9	15.8	20.3	20.2
45-54	32.1	32.4	–	–	33.6	33.8	38.9	39.2
55-64	48.0	48.6	–	–	37.9	38.6	30.9	31.3
65-74	–	–	35.8	35.9	–	–	–	–
75+	–	–	64.2	64.1	–	–	–	–
Dual Medicare and Medicaid enrollment, % of index admissions	–	–	14.2	14.1	–	–	–	–
Male, % of index admissions	59.3	60.8[b]	46.1	46.2	44.5	45.2	63.1	63.6
Comorbidity index, mean	11.6	11.1[b]	20.4	20.4	20.1	20.0	13.3	13.2
Hospital's ratio of observation visits to inpatient stays, 2009 and 2010, mean	0.22	0.22	0.24	0.24	0.23	0.23	0.23	0.23
Returns to hospital, N	5304	4783[b]	36,438	37,280[b]	4516	4993[b]	3064	3356[b]
Type of visit, % of returns[c]								
Inpatient	58.6	53.3[b]	72.2	67.8[b]	60.4	58.3[b]	50.8	47.2[b]
Not inpatient	41.4	46.7[b]	27.8	32.1[b]	39.5	41.8[b]	49.2	52.8[b]
Observation	8.0	11.1[b]	4.7	6.8[b]	6.4	8.5[b]	6.8	9.9[b]
ED	33.4	35.6[b]	23.1	25.3[b]	33.1	33.3	42.4	42.9

[a] Includes records that could be matched and were included in the final analysis; results are weighted for matching.

[b] 2013 and 2014 versus 2009 and 2010, $P < .05$.

[c] Percentage out of total revisits; other percentages are out of total index admissions. The revisit categories are mutually exclusive.

NOTE: Source: AHRQ, Center for Delivery, Organization, and Markets, HCUP, State Inpatient Databases, State Emergency Department Databases, and State Ambulatory Surgery and Services Databases, 4 States, 2009 and 2010 versus 2013 and 2014, weighted matched records. Abbreviations: AHRQ, Agency for Healthcare Research and Quality; AMI, acute myocardial infarction; ED, emergency department; HCUP, Healthcare Cost and Utilization Project; HF, heart failure. –, not applicable.

servation, and ED visits within 30 days of hospital discharge may be more informative than inpatient readmissions alone. However, little is known about trends in returns to the hospital for observation and ED visits and whether such trends vary by payer.

Our objective was to assess whether changes have occurred in rates of total 30-day, all-cause, unplanned returns to the hospital among adults with index admissions for AMI, HF, and pneumonia in which returns to the hospital included inpatient readmissions, observation visits, and ED visits. We also assessed whether changes in the rate of hospital inpatient readmissions coincided with changes in rates of returns for ED or observation visits. To examine the effects of readmission policies implemented by diverse payers and broad changes to the health system following the Affordable Care Act, we compared data from 201 hospitals in 4 states in 2009 and 2010 with data from the same hospitals for 2013 and 2014.

METHODS

Data Sources, Populations, and Study Variables

We used Healthcare Cost and Utilization Project (HCUP) State

TABLE 2. **Principal (First-Listed) Diagnosis at Return to Hospital, by Type of Return Visit and Whether the Index Admission was for AMI, HF, or Pneumonia**

	Percentage of Index Admissions Resulting in a Return Visit					
	Inpatient		Observation		ED	
Condition at the Index Admission and Principal (First-Listed) Diagnosis at the Revisit	2009 and 2010	2013 and 2014	2009 and 2010	2013 and 2014	2009 and 2010	2013 and 2014
AMI, total	11.6	10.7[a]	1.6	2.5[a]	5.4	5.9[a]
Heart failure	2.0	1.9	0.1	0.1[a]	0.2	0.1[a]
Nonspecific chest pain	0.6	0.4[a]	0.7	1.0[a]	0.8	0.9
Other lower respiratory disease	0.1	0.1	<0.1	0.1[a]	0.3	0.3
Complications of surgery or medical care	0.5	0.4[a]	<0.1	<0.1	0.1	0.1
Cardiac dysrhythmias	0.4	0.4	<0.1	0.1[a]	0.1	0.1
Coronary atherosclerosis, other heart disease	0.4	0.3[a]	0.1	0.2[a]	0.1	0.1
HF, total	19.5	18.6[a]	1.3	1.8[a]	6.2	6.9[a]
Congestive heart failure	7.1	6.5[a]	0.2	0.4[a]	0.7	0.7
Hypertension with complications	0.8	0.9[a]	<0.1	<0.1	<0.1	0.1
Cardiac dysrhythmias	0.7	0.6	<0.1	0.1	0.1	0.2
Fluid and electrolyte disorders	0.4	0.4[a]	0.1	0.1	0.1	0.2[a]
Nonspecific chest pain	0.3	0.1[a]	0.2	0.3[a]	0.4	0.4
Other lower respiratory disease	0.1	0.1[a]	<0.1	0.1	0.4	0.5
Pneumonia, total	15.1	14.5[a]	1.0	1.4[a]	6.6	7.0[a]
Pneumonia	2.9	2.6[a]	0.1	0.1	0.4	0.4
Congestive heart failure	1.2	1.2	<0.1	0.1[a]	0.1	0.1
Chronic obstructive pulmonary disease	1.0	0.9[a]	0.1	0.1	0.4	0.4
Other lower respiratory disease	0.2	0.1[a]	<0.1	0.1	0.5	0.5
Nonspecific chest pain	0.1	0.1[a]	0.2	0.2[a]	0.3	0.3

[a]2013 and 2014 versus 2009 and 2010, $P < .05$.

NOTE: The diagnosis categories are mutually exclusive. Conditions are defined according to Clinical Classification Software categories. Conditions shown are those that ranked in the top three reasons for inpatient, observation, or ED visits in 2009 and 2010 or 2013 and 2014 with a sample size of at least 10 patients. Conditions are sorted according to the number of inpatient readmissions in 2009 and 2010. Source: AHRQ, Center for Delivery, Organization, and Markets, HCUP, State Inpatient Databases, State Emergency Department Databases, and State Ambulatory Surgery and Services Databases, 4 States, 2009 and 2010 versus 2013 and 2014, weighted matched records. Abbreviations: AHRQ, Agency for Healthcare Research and Quality; AMI, acute myocardial infarction; ED, emergency department; HCUP, Healthcare Cost and Utilization Project.

Inpatient Databases, State Emergency Department Databases, and State Ambulatory Surgery and Services Databases from Georgia, Nebraska, South Carolina, and Tennessee. These states comprise 7% of the US population and were the only states with data that included all observation and ED visits as well as encrypted patient identification numbers that permitted linkage across facilities and hospitals.[20]

Index admissions for patients aged 18 years and older were eligible if they occurred at nonfederal general medical/surgical hospitals (excluding critical access hospitals) that had at least 1 index admission per target condition per year and at least 5 inpatient, observation, and ED visits for any condition per year.

We classified patients into the following 4 populations by age and insurance coverage: 18 to 64 years with private insurance, 65 years and older with Medicare (excluding younger adults with Medicare), 18 to 64 years with Medicaid, and 18 to 64 years without insurance. We identified patients aged 65 years and older with Medicare by using the primary or secondary expected payer for the index admission. This group included patients who were dually eligible for Medicare and Medicaid. If Medicare was not the primary or secondary payer, we used the primary payer to identify Medicaid, privately insured, and uninsured patients aged 18 to 64 years. None of the states expanded Medicaid coverage during the years studied.

The primary outcome of interest was the rate of having 1 or more all-cause, unplanned return(s) to an acute care hospital within 30 days of discharge after an index admission for AMI, HF, and pneumonia as defined by a modified version of Centers for Medicare & Medicaid Services' readmission metrics.[21,22] We examined total return rates as well as rates for inpatient, observation, and ED care. We also examined the leading diagnoses associated with returns to the hospital. For each index admission, we included only 1 return visit, giving priority to inpatient readmissions, then observation visits, and then ED visits.

The HCUP databases are consistent with the definition of limited data sets under the Health Insurance Portability and Accountability Act Privacy Rule and contain no direct patient

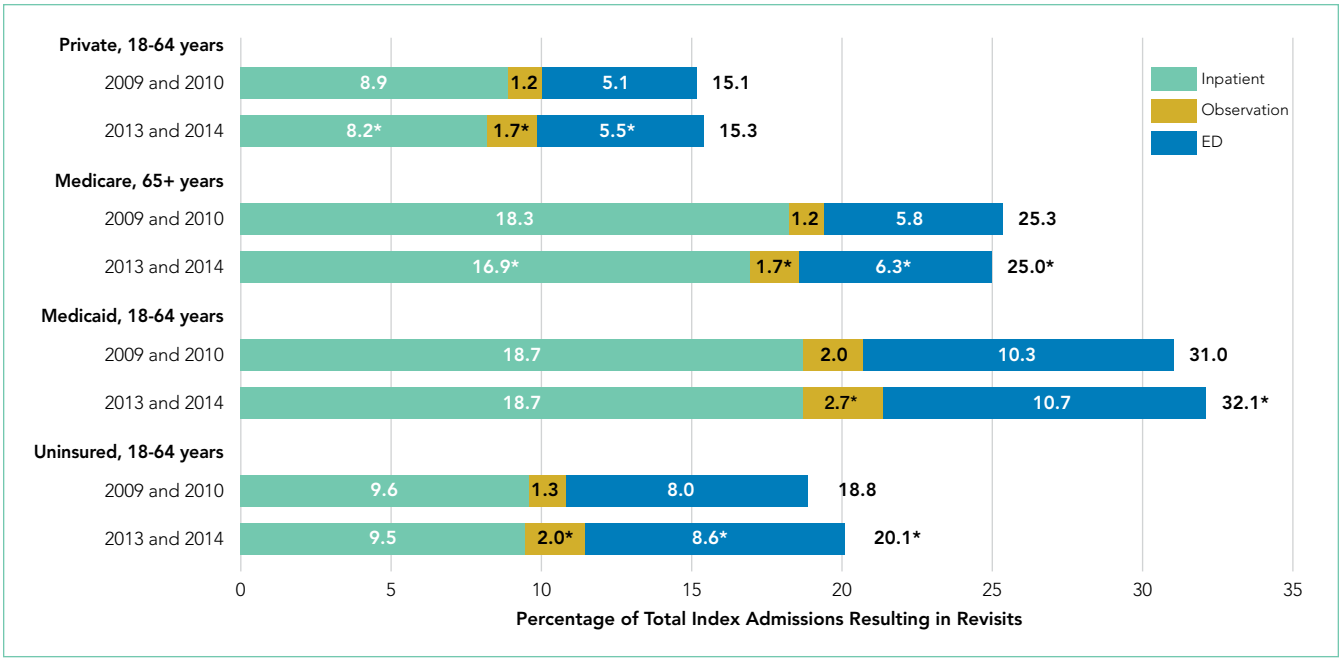

FIG 1. Matched comparison of hospitalizations for acute myocardial infarction, heart failure, and pneumonia combined in 2009 and 2010 versus 2013 and 2014: rates at which patients returned to the hospital within 30 days of discharge, by expected payer. The revisit categories are mutually exclusive and sum to the total. Expected payer was defined at the index admission. The asterisk indicates 2013 and 2014 versus 2009 and 2010, $P < .05$.

NOTE: Source: AHRQ, Center for Delivery, Organization, and Markets, HCUP, State Inpatient Databases, State Emergency Department Databases, and State Ambulatory Surgery and Services Databases, 4 States, 2009 and 2010 versus 2013 and 2014, weighted matched records. Abbreviations: AHRQ, Agency for Healthcare Research and Quality; ED, emergency department; HCUP, Healthcare Cost and Utilization Project.

identifiers. The AHRQ Institutional Review Board considers research using HCUP data to have exempt status.

Statistical Analysis

To compare rates at which patients returned to the hospital during 2 cohort periods (2009 and 2010 vs 2013 and 2014), we used coarsened exact matching, a well-established matching technique for balancing covariates between 2 populations of patients that may be related to the outcome.[23] For observational datasets, coarsened exact matching is preferable to traditional matching because it enables the investigator to assess balance between the 2 populations, select the desired degree of balance, and eliminate observations for which comparable matches cannot be found.

We assembled sets of index admissions in each study period that were similar with respect to payer, primary diagnosis, and other factors. Matching variables included the patient's age group, sex, and Elixhauser Comorbidity Index[24] (in deciles), as well as the hospital's ratio of observation visits relative to inpatient admissions in 2009 and 2010 combined (in quartiles; see supplementary Appendix). For Medicare beneficiaries, we also matched on dual enrollment in Medicaid.

We conducted the matching process separately for each target condition and payer population. First, we grouped index admissions in both periods into strata defined by all possible combinations of the matching variables and allowing one-to-many random matching within strata. We then dropped records in any strata for which there were no records in 1 of the time periods. Finally, we calculated weights based on the size of each stratum. We used these weights to account for the different numbers of index admissions in each stratum between the 2 study periods. For example, if a stratum contained 10 index admissions in 2009 and 2010 combined and 20 in 2013 and 2014 combined, an admission weighed double in the earlier period. After weighting, the index admissions in each period (2009 and 2010; 2013 and 2014) had similar characteristics (Table 1). After matching and weighting, we compared the percentage of index admissions for which patients returned to the hospital and the primary diagnoses at the return visit between the 2 study periods using 2-sided χ^2 tests ($P < .05$). Analyses were conducted by using SAS software (version 9.4; SAS Institute Inc., Cary, NC).

RESULTS

There were 423,503 eligible index admissions for AMI, HF, and pneumonia in the 2 periods combined; 422,840 (99.8%) were successfully matched and included in this analysis. After matching weights were applied, there were few statistically significant differences across the 2 time periods (see Table 1 and supplementary Appendix).

From 2009 and 2010 to 2013 and 2014, the percentage of patients hospitalized for AMI, HF, and pneumonia who had only observation or ED visits when they returned to the hospital increased from 41.4% to 46.7% among patients with private insurance ($P < .001$), from 27.8% to 32.1% among older patients with Medicare ($P < .001$), from 39.5% to 41.8% among patients with Medicaid ($P = .03$), and from 49.2% to 52.8% among patients without insurance

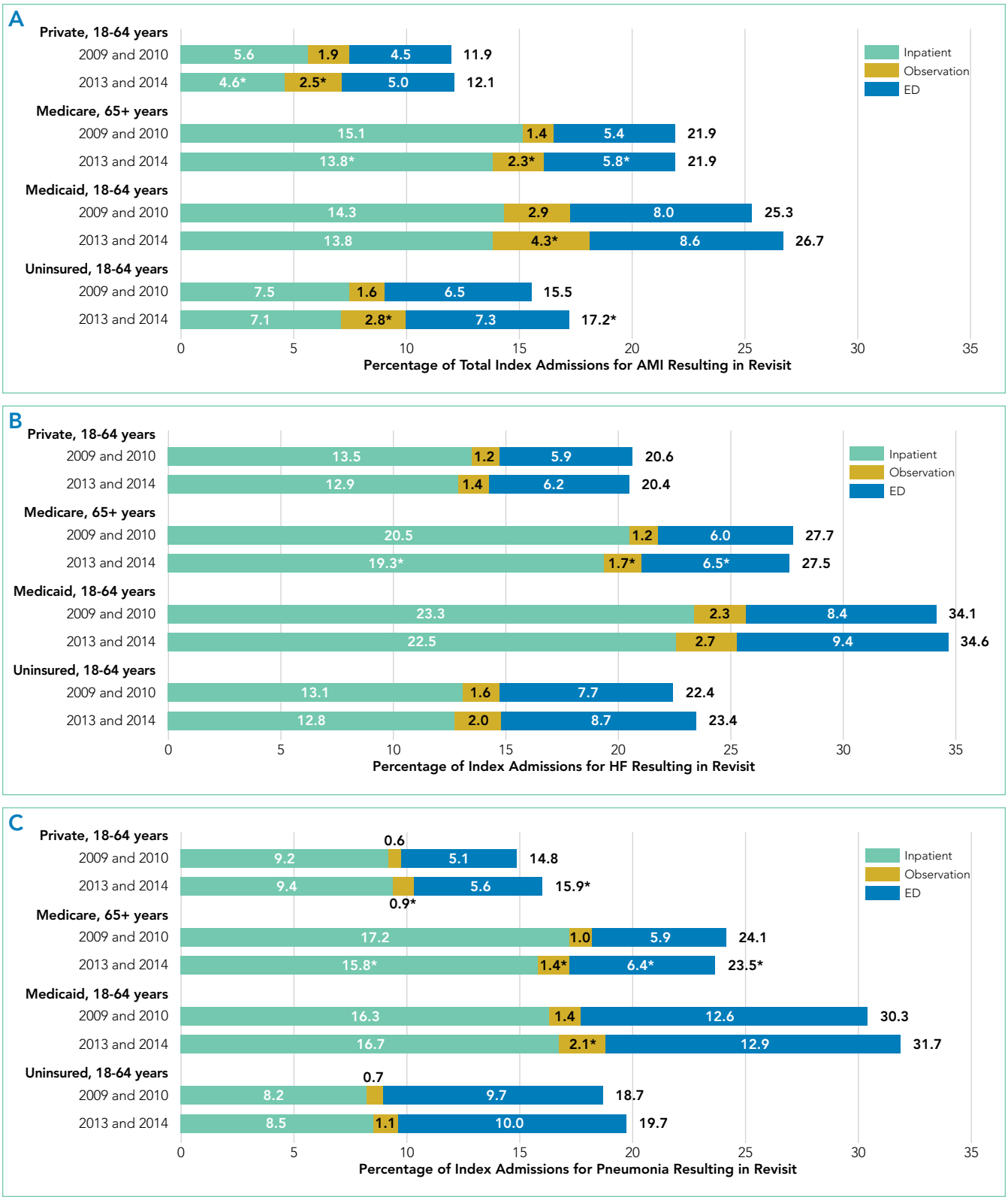

FIG 2. Matched comparison of hospitalizations for (a) AMI (b), HF, and (c) pneumonia individually in 2009 and 2010 versus 2013 and 2014: rates at which patients returned to the hospital within 30 days of discharge, by expected payer. The revisit categories are mutually exclusive and sum to the total. Expected payer was defined at the index admission. The asterisk indicates 2013 and 2014 versus 2009 and 2010, $P < .05$. NOTE: Source: AHRQ, Center for Delivery, Organization, and Markets, HCUP, State Inpatient Databases, State Emergency Department Databases, and State Ambulatory Surgery and Services Databases, 4 States, 2009 and 2010 versus 2013 and 2014, weighted matched records. Abbreviations: AHRQ, Agency for Healthcare Research and Quality; AMI, acute myocardial infarction; ED, emergency department; HCUP, Healthcare Cost and Utilization Project; HF, heart failure.

(*P* = .004; Table 1). The percentage of returns to the hospital for observation increased across all payers (*P* < .001); in 2013 and 2014 combined, observation visits ranged from 6.8% of hospital returns among patients with Medicare to 11.1% among patients with private insurance. The percentage of returns to the hospital for an ED visit increased among patients with private insurance (*P* = .02) and Medicare (*P* < .001); in 2013 and 2014, ED visits ranged from 25.3% of returns to the hospital among patients with Medicare to 42.9% among uninsured patients.

The increases in 30-day observation and ED visits coincided with reductions in inpatient readmissions among patients with private insurance and Medicare and contributed to growth in total returns to the hospital among patients with Medicaid or no insurance (Figure 1). Among privately insured individuals, a decline in inpatient readmissions (from 8.9% to 8.2%; *P* = .001) coincided with increases in observation visits (from 1.2% to 1.7%; *P* < .001) and ED visits (from 5.1% to 5.5%; *P* = .02), leading to a stable rate of approximately 15% at which patients with AMI, HF, or pneumonia returned to the hospital during both periods (*P* = .45). Among Medicare patients, inpatient readmissions declined from 18.3% to 16.9% (*P* < .001), while observation visits and ED visits increased (from 1.2% to 1.7% and 5.8% to 6.3%, respectively; *P* < .001), leading to a small net decrease in total returns to the hospital (25.3% vs 25.0%; *P* = .04). Among Medicaid recipients, inpatient readmissions were unchanged (18.7%; *P* = .93), but an increase in observation visits (from 2.0% to 2.7%; *P* < .001) and a nonsignificant increase in ED visits (from 10.3% to 10.7%; *P* = .26) led to a rise in total revisits (31.0% vs 32.1%; *P* = .04). Among uninsured adults, inpatient readmissions were stable (around 9.5%; *P* = .76), while there was a rise in observation visits (1.3% vs 2.0%; *P* < .001) and ED visits (8.0% vs 8.6%; *P* = .04), yielding an increase in total revisits (18.8% vs 20.1%; *P* = .004).

Figure 2 shows individual differences for each of the 3 target conditions between 2009 and 2010 versus 2013 and 2014 by payer. Overall, rates at which patients returned to the hospital within 30 days remained stable, with 3 exceptions. For patients with private insurance, total returns to the hospital rose for pneumonia (14.8% vs 15.9%; *P* = .02). For seniors with Medicare, total returns to the hospital declined for pneumonia (from 24.1% to 23.5%; *P* = .03). Among the uninsured, total returns to the hospital rose for AMI (15.5% vs 17.2%; *P* = .02).

Patients initially hospitalized for HF and pneumonia who returned to the hospital within 30 days often returned for the same conditions (Table 2). Reasons for returning to the hospital were similar in the 2 periods (2009 and 2010; 2013 and 2014) across the 3 target conditions. However, when patients returned to the hospital in 2013 and 2014 with the same diagnosis as the index admission, they were less likely to be readmitted and more likely to be placed under observation than in 2009 and 2010.

DISCUSSION

Matching index admissions for AMI, HF, or pneumonia in 201 hospitals in 2009 and 2010 with those in 2013 and 2014, we observed that increases in observation and ED visits coincided with reductions in inpatient readmissions among patients with private insurance and Medicare and contributed to growth in total returns to the hospital among patients with Medicaid or no insurance. Among patients with private insurance and Medicare, inpatient readmissions declined significantly for all 3 target conditions, but total returns to the hospital remained constant for AMI and HF, rose for privately insured patients with pneumonia, and declined modestly for Medicare patients with pneumonia. Inpatient readmissions were unchanged for adults aged 18 to 64 years with Medicaid or no insurance, but total returns to the hospital increased significantly, reaching 32% among those with Medicaid.

These findings add to recent literature, which has primarily emphasized inpatient readmissions among Medicare beneficiaries with several exceptions. A prior analysis indicates that readmissions have declined among diverse payer populations nationally.[18] Gerhardt et al[25] found that from 2011 to 2012, all-cause 30-day readmissions declined among fee-for-service (FFS) Medicare beneficiaries following any index admission, while ED revisits remained stable and observation revisits increased slightly. Evaluating the CMS Hospital Readmission Reductions Program (HRRP), Zuckerman et al[17] reported that from 2007 to 2015, inpatient readmissions declined among FFS Medicare beneficiaries aged 65 years and older who were hospitalized with AMI, HF, or pneumonia, while returns to the hospital for observation rose approximately 2%; ED visits were not included. We found that Medicare (FFS and Medicare Advantage) patients with AMI and HF returned to the hospital with the same frequency in 2009 and 2010 as in 2013 and 2014, and those patients with pneumonia returned slightly less often. In aggregate, declines in inpatient readmissions in the 4 states we studied coincided with increases in observation and ED care. Moreover, these shifts occurred not only among Medicare beneficiaries but also among privately insured adults, Medicaid recipients, and the uninsured.

Three factors may have contributed to these apparent shifts from readmissions to observation and ED visits. First, some authors have suggested that hospitals may reduce readmissions by intentionally placing some of the patients who return to the hospital under observation instead of admitting them.[17,26] If true, hospitals with greater declines in readmissions would have larger increases in observation revisits. Zuckerman et al[17] found no correlation among Medicare beneficiaries between hospital-level trends in observation revisits and readmissions, but returns to observation rose more rapidly for AMI, HF, and pneumonia (compared with other conditions) during long term follow-up than during the HRRP implementation period. Other authors have documented that declines in readmissions have been greatest at hospitals with the highest baseline readmission rates,[27,28] and hospitals with lower readmission rates have more observation return visits.[29]

Second, shifts from inpatient readmissions to return visits for observation may reflect unintentional rather than intentional changes in the services provided. Clinical practice patterns are evolving such that patients who present to the hospital for acute

care increasingly are placed under observation or discharged from the ED instead of being admitted, regardless of whether they recently were hospitalized.[30] Inpatient admissions, which are strongly correlated with readmission rates,[28,31] are declining nationally,[32] and both observation and ED visits are rising.[33-35] Although little is known about effects on health outcomes and patient out-of-pocket costs, shifts from inpatient admissions to observation and ED visits reduce costs to payers.[36,37]

Third, instead of substitution, more patients may be returning for lower-acuity conditions that can be treated in the ED or under observation. Hospitals are implementing diverse and multifaceted interventions to reduce readmissions that can involve assessing patient needs and the risk for readmission, educating patients about self-care and risks after discharge, reconciling medication, scheduling follow-up visits, and monitoring patients through telephone calls and home nursing visits.[26,38,39] Although the intent may be to reduce patients' need to return to the hospital, interventions that educate patients about risks after discharge may lower the threshold at which they find symptoms worrisome enough to return. This could increase lower-acuity return visits. We found that reasons for returning were similar in 2009 and 2010 versus 2013 and 2014, but we did not examine acuity of illness at the time of return.

Other areas of concern are the high rates at which Medicaid patients are returning to the hospital and the increases in rates of returns among Medicaid patients and the uninsured. Individuals in these disadvantaged populations may be having difficulty accessing ambulatory care or may be turning to the ED more often for lower acuity problems that arise after discharge. In 3 of the 4 states we studied, 15% to 16% of adults live in poverty and 10% to 30% live in primary care health professional shortage areas.[40,41] Given the implications for patient outcomes and costs, trends among these populations warrant further scrutiny.[42,43]

This analysis has several limitations. Data were from 4 states, but trends in readmissions are similar nationally. From 2010 through 2015, the all-condition readmission rate declined by 8% among Medicare beneficiaries nationally and by 6.1% in South Carolina, 7.4% in Georgia, 8.3% in Nebraska, and 8.7% in Tennessee.[44] We report trends across hospitals and did not examine hospital-level revisits. Therefore, further research is needed to determine whether these findings are related to co-occurring trends, intentional substitution, or other factors.

In conclusion, measuring inpatient readmissions without accounting for return visits to the ED and observation underestimates the rate at which patients return to the hospital following an inpatient hospitalization. Because of growth in observation and ED visits, trends in the total rates at which patients return to the hospital can differ from trends in inpatient readmissions. In the 4 states we studied, total return rates were particularly high and rising among patients with Medicaid and lower, but also rising, among the uninsured. Policy analysts and researchers should investigate the factors contributing to growth in readmissions in these vulnerable populations and determine whether similar trends are occurring nationwide. Hospitalists play critical roles in admitting and discharging inpatients, caring for patients under observation, and implementing quality improvement programs. Irrespective of payer, hospitalists' efforts to improve the quality and value of care should include observation and ED visits as well as inpatient readmissions.

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Caregiver Perspectives on Communication During Hospitalization at an Academic Pediatric Institution: A Qualitative Study

Lauren G. Solan, MD, MEd[1]*, Andrew F. Beck, MD, MPH[1,2], Stephanie A. Shardo, BS[1], Hadley S. Sauers-Ford, MPH[1], Jeffrey M. Simmons, MD, MSc[1], Samir S. Shah, MD, MSCE[1,3], Susan N. Sherman, DPA[4], on behalf of the H2O Study Group

[1]Cincinnati Children's Hospital Medical Center, Division of Hospital Medicine, Cincinnati, Ohio. Lauren G. Solan is now with the University of Rochester Medical Center, Division of Pediatric Hospital Medicine, Rochester, New York. Hadley S. Sauers-Ford is now with UC Davis Health System, Pediatric Telemedicine, Sacramento, California. Stephanie A. Shardo is now with Summa Akron City Hospital, Cooper Cancer Center, Akron, Ohio; [2]Cincinnati Children's Hospital Medical Center, Division of General and Community Pediatrics, Cincinnati, Ohio; [3]Cincinnati Children's Hospital Medical Center, Division of Infectious Diseases, Cincinnati, Ohio; [4]SNS Research, Cincinnati, Ohio.

OBJECTIVE: Communication among those involved in a child's care during hospitalization can mitigate or exacerbate family stress and confusion. As part of a broader qualitative study, we present an in-depth understanding of communication issues experienced by families during their child's hospitalization and during the transition to home.

METHODS: Focus groups and individual interviews stratified by socioeconomic status included caregivers of children recently discharged from a children's hospital after acute illnesses. An open-ended, semistructured question guide designed by investigators included communication-related questions addressing information shared with families from the medical team about discharge, diagnoses, instructions, and care plans. By using an inductive thematic analysis, 4 investigators coded transcripts and resolved differences through consensus.

RESULTS: A total of 61 caregivers across 11 focus groups and 4 individual interviews participated. Participants were 87% female and 46% non-white. Analyses resulted in 3 communication-related themes. The first theme detailed experiences affecting caregiver perceptions of communication between the inpatient medical team and families. The second revealed communication challenges related to the teaching hospital environment, including confusing messages associated with large multidisciplinary teams, aspects of family-centered rounds, and confusion about medical team member roles. The third reflected caregivers' perceptions of communication between providers in and out of the hospital, including types of communication caregivers observed or believed occurred between medical providers.

CONCLUSIONS: Participating caregivers identified various communication concerns and challenges during their child's hospitalization and transition home. Caregiver perspectives can inform strategies to improve experiences, ease challenges inherent to a teaching hospital, and determine which types of communication are most effective. *Journal of Hospital Medicine* 2018;13:304-310. Published online first January 18, 2018. © 2018 Society of Hospital Medicine

Provision of high-quality, high-value medical care hinges upon effective communication. During a hospitalization, critical information is communicated between patients, caregivers, and providers multiple times each day. This can cause inconsistent and misinterpreted messages, leaving ample room for error.[1] The Joint Commission notes that communication failures occurring between medical providers account for ~60% of all sentinel or serious adverse events that result in death or harm to a patient.[2] Communication that occurs between patients and/or their caregivers and medical providers is also critically important. The content and consistency of this communication is highly valued by patients and providers and can affect patient outcomes during hospitalizations and during transitions to home.[3,4] Still, the multifactorial, complex nature of communication in the pediatric inpatient setting is not well understood.[5,6]

During hospitalization, communication happens continuously during both daytime and nighttime hours. It also precedes the particularly fragile period of transition from hospital to home. Studies have shown that nighttime communication between caregivers and medical providers (ie, nurses and physicians), as well as caregivers' perceptions of interactions that occur between nurses and physicians, may be closely linked to that caregiver's satisfaction and perceived quality of care.[6,7] Communication that occurs between inpatient and outpatient providers is also subject to barriers (eg, limited availability for direct communication)[8-12]; studies have shown that patient and/or caregiver satisfaction has also been tied to perceptions of this communication.[13,14] Moreover, a caregiver's ability to understand diagnoses and adhere to postdischarge care plans is intimately tied to communication during the hospitalization and at discharge. Although many improvement efforts have

***Address for correspondence:** Lauren G. Solan, MD, MEd, Division of Pediatric Hospital Medicine, University of Rochester Medical Center, 601 Elmwood Avenue, Box 667, Rochester, NY 14642; Telephone: 585-275-6819; Fax: 585-276-1128; E-mail: lauren_solan@urmc.rochester.edu

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aimed to enhance communication during these vulnerable time periods,[3,15,16] there remains much work to be done.[1,10,12]

The many facets and routes of communication, and the multiple stakeholders involved, make improvement efforts challenging. We believe that more effective communication strategies could result from a deeper understanding of how caregivers view communication successes and challenges during a hospitalization. We see this as key to developing meaningful interventions that are directed towards improving communication and, by extension, patient satisfaction and safety. Here, we sought to extend findings from a broader qualitative study[17] by developing an in-depth understanding of communication issues experienced by families during their child's hospitalization and during the transition to home.

METHODS

Setting

The analyses presented here emerged from the Hospital to Home Outcomes Study (H2O). The first objective of H2O was to explore the caregiver perspective on hospital-to-home transitions. Here, we present the results related to caregiver perspectives of communication, while broader results of our qualitative investigation have been published elsewhere.[17] This objective informed the latter 2 aims of the H2O study, which were to modify an existing nurse-led transitional home visit (THV) program and to study the effectiveness of the modified THV on reutilization and patient-specific outcomes via a randomized control trial. The specifics of the H2O protocol and design have been presented elsewhere.[18]

H2O was approved by the Institutional Review Board at Cincinnati Children's Hospital Medical Center (CCHMC), a free-standing, academic children's hospital with ~600 inpatient beds. This teaching hospital has >800 total medical students, residents, and fellows. Approximately 8000 children are hospitalized annually at CCHMC for general pediatric conditions, with ~85% of such admissions staffed by hospitalists from the Division of Hospital Medicine. The division is composed of >40 providers who devote the majority of their clinical time to the hospital medicine service; 15 additional providers work on the hospital medicine service but have primary clinical responsibilities in another division.

Family-centered rounds (FCR) are the standard of care at CCHMC, involving family members at the bedside to discuss patient care plans and diagnoses with the medical team.[19] On a typical day, a team conducting FCR is composed of 1 attending, 1 fellow, 2 to 3 pediatric residents, 2 to 3 medical students, a charge nurse or bedside nurse, and a pharmacist. Other ancillary staff, such as social workers, care coordinators, nurse practitioners, or dieticians, may also participate on rounds, particularly for children with greater medical complexity.

Population

Caregivers of children discharged with acute medical conditions were eligible for recruitment if they were English-speaking (we did not have access to interpreter services during focus groups/interviews), had a child admitted to 1 of 3 services (hospital medicine, neurology, or neurosurgery), and could attend a focus group within 30 days of the child's discharge. The majority of participants had a child admitted to hospital medicine; however, caregivers with a generally healthy child admitted to either neurology or neurosurgery were eligible to participate in the study.

TABLE 1. **Participant Demographics**

Focus Group and Interview Participants Demographics (N = 61)	
Gender	N (%)
Male	8 (13)
Female	53 (87)
Age range (years)	
18-24	5 (8)
25-34	28 (46)
35-44	22 (36)
45-54	6 (10)
Marital status	
Single	22 (36)
Single, living with partner	8 (13)
Married	24 (39)
Separated, divorced, widowed	7 (11)
Race	
Black or African American	25 (41)
White	33 (54)
Other	3 (5)
Ethnicity	
Non-Hispanic	59 (97)
Hispanic	2 (3)
Socioeconomic status based on census tract	
High socioeconomic status (<15% below poverty level)	27 (44)
Low socioeconomic status (≥15% below poverty level)	34 (56)
Highest level of education completed	
Less than high school	4 (6.5)
High school/GED	31 (51)
2- or 4-year college	18 (29.5)
Graduate education	8 (13)
Currently enrolled in school	12 (20)
Yes	49 (80)
No	
Currently employed[a]	
No	28 (46)
Full-time	22 (36)
Part-time	9 (15)

[a]Data missing from 2 participants.

Study Design

As presented elsewhere,[17,20] we used focus groups and individual in-depth interviews to generate consensus themes about patient and caregiver experiences during the transition from hospital to home. Because there is evidence suggesting that focus group participants are more willing to talk openly when among others of similar backgrounds, we stratified the sample

TABLE 2. **Major Theme 1 and Associated Subthemes**

Major Theme 1: Experiences that Affect Caregiver Perceptions of Communication between the Inpatient Medical Team and Families			
Positive Experiences		**Negative Experiences**	
Feeling like part of the team	"**I thought it was above and beyond family-centric care**, like I felt like **they really took me as the expert on my child** and they were like, 'What do you think?'...You know, I really felt like they actually waited for me to say 'Yeah, he is back to normal and I don't have, you know, a lot of concerns.'" "**They ask you if you think they're ready to be discharged**. So, you don't get sent home in a situation that you're not really ready for."	Feeling left out of the loop	"But **when they shut it [the door], it's like you're in there and they're out there**. And in order for me to get information you have to cross that threshold." "I told them…**I need to know what you're talking about**. Some things I understand, so I won't ask about it, but some things that I don't understand, **I would like you to, you know, to also include me…I'm the parent**… **it's important for me to know where you are getting all this information and how can it help me**."
Nurses as interpreters and navigators	"And **they [nurses] actually would give us suggestions or ask this question**…so you would know who was who and they would make sure…'Now doctor so and so and he's a cardiologist today and… And doctor so and so is your neurologist' and so…the **nurses kind of helped us manage the care plan which was very helpful**." "**When the nurse would come in all by herself...We would basically stop her** and say, 'Hey, they said this in this report, and what does that mean and when can we go home? Or, do the fevers all have to be gone?' And **the nurse would take the time to say exactly what [was] needed**."	Insufficient face time with physicians	"…I was more frustrated. So because **they [physicians] will say they'll come back, but then they don't come back for 24 hours** and stuff like that." "There was one doctor, he was really nice, but he came in [and] I was sleeping. And **I actually woke up to him standing in front of me**… So you're asleep, you're exhausted, and he's like, 'Hi,' and like started talking. **As soon as I opened my eyes, I'm like 'I need more time,' but he told me so much. And like two hours later, I could not remember anything we talked about**."
		Use of medical jargon	"I think **they shouldn't assume that everybody has a strong understanding of medical terms.** I think they should just forget all their training and explain it…" "**If you're not familiar with the medical field, you don't know the terms**."

TABLE 3. **Major Theme 2 and Associated Subthemes**

Major Theme 2: Communication Challenges for Caregivers Related to a Teaching Hospital Environment	
Confusing messages with a large multidisciplinary team	"Well, on one hand like, you know **the guy who did the surgery said to do this, and on the other hand they're [the medical team] saying not to, back and forth**." "I mean I understand it's a teaching hospital, they [residents] have to learn, but **that kind of can get frustrating as a parent**. **We were getting told so many different things** by different people." "And [the primary medical team] seemed to think, 'Oh well, **you know, I think it's this'**--- and that **specialist is like 'No, we don't think it's that**… well there's nothing else we can really do, stop treating the symptoms, you can go and then [the primary medical team] didn't even call the medicines [into the pharmacy] to treat the symptoms."
Perceptions of family-centered rounds	"… **They're talking amongst themselves with you in the room. You're trying to pick out what they're talking about**…They did ask me if I want to join a round in the room, but now I think I would round outside the room because **they are confusing…that's what happens with all the talking.** Everybody talking at one time." "And **that [FCR] we found frustrating as well** because he had headaches and the light and sound bother him and **all of a sudden he would have 15 doctors that were standing in your room asking questions**…I mean the lights are off for a reason…**he's asleep**." "I got ambushed most of the time I was sleeping because [my daughter] would be up all night and I will **get ambushed at 6 in the morning. There would be like 10 to 15 doctors**…And they're like, 'Oh we're just here hun, is this a good time?' And like, I guess, let's just get this, but **it could be a better time if they see me sleeping.**"
Role confusion: who's in charge of the team?	"That was my confusion is there were so many different people. **Like always so many people, who is the doctor, like I don't know**." "**I basically figured out who was the chief of the whole group and I just pulled him to the side and ask him the questions** to see what was going on." "Because **there's nobody really in charge. It's like one big team** and so like one person is not responsible. So **no one takes ownership**."

NOTE: Abbreviation: FCR, family-centered rounds.

by the family's estimated socioeconomic status.[21,22] Socioeconomic status was estimated by identifying the poverty rate in the census tract in which each participant lived. Census tracts, relatively homogeneous areas of ~4000 individuals, have been previously shown to effectively detect socioeconomic gradients.[23-26] Here, we separated participants into 2 socioeconomically distinct groupings (those in census tracts where <15% or ≥15% of the population lived below the federal poverty level).[26] This cut point ensured an equivalent number of eligible participants within each stratum and diversity within our sample.

Data Collection

Caregivers were recruited on the inpatient unit during their child's hospitalization. Participants then returned to CCHMC fa-

TABLE 4. **Major Theme 3 and Associated Subthemes**

Major Theme 3: Caregiver Perceptions of Communication Between Medical Providers	
Communication between inpatient medical providers	"Finally, one doctor came in and said that the test results that they were waiting for would be around four o'clock, we could probably go home around that time …but **I have another doctor come in and say that there was a miscommunication**. The results of her blood test couldn't come back until 10 o'clock that night…So that was kind of…kind of weird for me... Because I'm thinking, **three different times, like three different messages about her test results being back in**…"
	"I guess my nurse switched in between the time at 11 or something…so **the next nurse thought I was still waiting on the medicine** and [child] already had the medicine and like an hour goes by and I'm like standing at the window like waiting for anyone to walk by. And somebody was like, 'do you need help?' And **I'm like, 'can you send my nurse in? I think the first lady left**.'"
Communication between inpatient and outpatient providers	"I wasn't really clear on was **did my primary already know what was happening**, do you know what I mean?...[child] comes in, he gets even worse, he's on a drip, he's on all the stuff…and I'm thinking like, **does he know everything that happened?** Or am I going to call and be like, 'Well he was in the hospital for five days and on the first day…and then he had six other medicines and then now what do I do' and you know or does he already have it? That's what I was unclear on. It's like, **am I just calling any random person and say, hey, let me get some medical advice or does he have the charts, does he have the stuff**?"
	"And because she was so little, we took her to our primary care, our normal doctor…and she read over [the discharge paperwork] so they sent over the right paperwork and the dismissals to her, so **it was necessary that she was informed and it helped out a lot…**"

cilities for the focus group within 30 days of discharge. Though efforts were made to enhance participation by scheduling sessions at multiple sites and during various days and times of the week, 4 sessions yielded just 1 participant; thus, the format for those became an individual interview. Childcare was provided, and participants received a gift card for their participation.

An open-ended, semistructured question guide,[17] developed de novo by the research team, directed the discussion for focus groups and interviews. As data collection progressed, the question guide was adapted to incorporate new issues raised by participants. Questions broadly focused on aspects of the inpatient experience, discharge processes, and healthcare system and family factors thought to be most relevant to patient- and family-centered outcomes. Communication-related questions addressed information shared with families from the medical team about discharge, diagnoses, instructions, and care plans. An experienced moderator and qualitative research methodologist (SNS) used probes to further elucidate responses and expand discussion by participants. Sessions were held in private conference rooms, lasted ~90 minutes, were audiotaped, and were transcribed verbatim. Identifiers were stripped and transcripts were reviewed for accuracy. After conducting 11 focus groups (generally composed of 5-10 participants) and 4 individual interviews, the research team determined that theoretical saturation[27] was achieved, and recruitment was suspended.

Data Analysis

An inductive, thematic approach was used for analysis.[27] Transcripts were independently reviewed by a multidisciplinary team of 4 researchers, including 2 pediatricians (LGS and AFB), a clinical research coordinator (SAS), and a qualitative research methodologist (SNS). The study team identified emerging concepts and themes related to the transition from hospital to home; themes related to communication during hospitalization are presented here.

During the first phase of analysis, investigators independently read transcripts and later convened to identify and define initial concepts and themes. A preliminary codebook was then designed. Investigators continued to review and code transcripts independently, meeting regularly to discuss coding decisions collaboratively, resolving differences through consensus.[28] As patterns in the data became apparent, the codebook was modified iteratively, adding, subtracting, and refining codes as needed and grouping related codes. Results were reviewed with key stakeholders, including parents, inpatient and outpatient pediatricians, and home health nurses, throughout the analytic process.[27,28] Coded data were maintained in an electronic database accessible only to study personnel.

RESULTS

Participants

Sixty-one caregivers of children discharged from CCHMC participated. Participants were 87% female and 46% nonwhite; 42.5% had a 2-year college level of education or greater, and 56% resided in census tracts with ≥15% of residents living in poverty (Table 1). Participant characteristics aligned closely with the demographics of families of children hospitalized at CCHMC.

Resulting Themes

Analyses revealed the following 3 major communication-related themes with associated subthemes: (1) experiences that affect caregiver perceptions of communication between the inpatient medical team and families, (2) communication challenges for caregivers related to a teaching hospital environment, and (3) caregiver perceptions of communication between medical providers. Each theme (and subtheme) is explored below with accompanying verbatim quotes in the narrative and the tables.

Major Theme 1: Experiences that Affect Caregiver Perceptions of Communication Between the Inpatient Medical Team and Families

Experiences during the hospitalization contributed to caregivers' perceptions of their communication with their child's inpatient medical team. There were 5 related subthemes identified. The following 2 subthemes were characterized as positive experiences: (1) feeling like part of the team and (2) nurses as

interpreters and navigators. The following 3 subthemes were characterized as negative: (1) feeling left out of the loop, (2) insufficient face time with physicians, and (3) the use of medical jargon (Table 2). More specifically, participants described feeling more satisfied with their care and the inpatient experience when they felt included and when their input and expertise as a caregiver was valued. They also appreciated how nurses often took the time after FCR or interactions with the medical team to explain and clarify information that was discussed with the patient and their caregiver. For example, 1 participant stated, "Whenever I ask about anything, I just ask the nurse. And if she didn't know, she would find out for me…"

In contrast, some of the negative experiences shared by participants related to feeling excluded from discussions about their child's care. One participant said, "They tell you…as much as they want to tell you. They don't fully inform you on things." Additionally, concerns were voiced about insufficient time for face-to-face discussions with physicians: "I forget what I have to say and it's something really, really important…But now, my doctor is going, you can't get the doctor back." Finally, participants discussed how the use of medical jargon often made it more difficult to understand things, especially for those not in the medical field.

Major Theme 2: Communication Challenges for Caregivers Related to a Teaching Hospital Environment

At a large teaching institution with various trainees and multiple subspecialties, communication challenges were particularly prominent. Three subthemes were related to this theme: (1) confusing messages with a large multidisciplinary team, (2) perceptions of FCR, and (3) role confusion, or who's in charge of the team? (Table 3). Participants described confusing and inconsistent messages arising from the involvement of many medical providers. One stated, "When [the providers] all talk it seems like it don't make sense because [what] one [is] saying is slightly different [from] the other one…and then you'd be like, 'Wait, what?' So it kind of confuses you…" Similarly, the use of FCR was overwhelming for the majority of participants who cited difficulty tracking conversations, feeling "lost" in the crowd of team members, or feeling excluded from the conversation about their child. One participant stated, "But because so many people came in, it can get overwhelming. They come in big groups, like 10 at once." In contrast, some participants had a more favorable view of FCR: "What really blew me away was I came out of the restroom and there is 10 doctors standing around and they very well observed my child. And not only one doctor, but every one of them knew was going on with my kid. It kind of blew me away." Participants felt it was not always clear who was in charge of the medical team. Trying to remember the various roles of all of the team members contributed to this confusion and made asking questions difficult. One participant shared, "I just want the main people…the boss to come in, check the baby out. I don't need all the extra people running around me, keep asking me the same thing on that topic. Send in the main group, the bosses, they know what the problem is and how to fix it."

Major Theme 3: Caregiver Perceptions of Communication Between Medical Providers

Caregivers have a unique vantage point as they witness many interactions between medical providers during their child's hospitalization. Still, they do not generally witness all the interactions between inpatient providers or between inpatient and outpatient providers. This led to variable perceptions of this communication. Specifically, the 2 subthemes described here were (1) communication between inpatient medical providers and (2) communication between inpatient and outpatient providers (Table 4). Caregivers assessed how well (or how poorly) medical providers communicated with each other based upon the consistency of messages they received or interactions they personally experienced or observed. One participant described how the medical team did not appear to be in consensus about when to discharge her child, highlighting the perception that team members did not have a shared understanding of the child's needs: "One of the doctors was…nervous about sending him home. It was just one doctor…the other doctors on her team and everything and the nurses, they were like 'He's fine.'" Others shared concerns related to inadequate handoff and messages not getting passed along shift-to-shift.

Perceptions were not isolated to the inpatient setting. Based on their experiences, caregivers similarly described their sense of how inpatient and outpatient providers were communicating with each other. In some cases, it was clear that good communication, as perceived by the participant, had occurred in situations in which the primary care physician knew "everything" about the hospitalization when they saw the patient in follow-up. One participant described, "We didn't even realize at the time, [the medical team] had actually called our doctor and filled them in on our situation, and we got [to the follow up visit]…He already knew the entire situation." There were others, however, who shared their uncertainty about whether the information exchange about their child's hospitalization had actually occurred. They, therefore, voiced apprehension around who to call for advice after discharge; would their outpatient provider have their child's hospitalization history and be able to properly advise them?

DISCUSSION

Communication during a hospitalization and at transition from hospital to home happens in both formal and informal ways; it is a vital component of appropriate, effective patient care. When done poorly, it has the potential to negatively affect a patient's safety, care, and key outcomes.[2] During a hospitalization, the multifaceted nature of communication and multidisciplinary approach to care provision can create communication challenges and make fixing challenges difficult. In order to more comprehensively move toward mitigation, it is important to gather perspectives of key stakeholders, such as caregivers. Caregivers are an integral part of their child's care during the hospitalization and particularly at home during their child's recovery. They are also a valued member of the team, particularly in this era of family-centered care.[19,29] The perspectives of the caregivers presented here identified both successes and chal-

lenges of their communication experiences with the medical team during their child's hospitalization. These perspectives included experiences affecting perceptions of communication between the inpatient medical team and families; communication related to the teaching hospital environment, including confusing messages associated with large multidisciplinary teams, aspects of FCR, and confusion about medical team member roles; and caregivers' perceptions of communication between providers in and out of the hospital, including types of communication caregivers observed or believed occurred between medical providers. We believe that these qualitative results are crucial to developing better, more targeted interventions to improve communication.

Maintaining a healthy and productive relationship with patients and their caregivers is critical to providing comprehensive and safe patient care. As supported in the literature, we found that when caregivers were included in conversations, they felt appreciated and valued; in addition, when answers were not directly shared by providers or there were lingering questions, nurses often served as "interpreters."[29,30] Indeed, nurses were seen as a critical touchpoint for many participants, individuals that could not only answer questions but also be a trusted source of information. Supporting such a relationship, and helping enhance the relationship between the family and other team members, may be particularly important considering the degree to which a hospitalization can stress a patient, caregiver, and family.[31-34] Developing rapport with families and facilitating relationships with the inclusion of nursing during FCR can be particularly helpful. Though this can be challenging with the many competing priorities of medical providers and the fast-paced, acute nature of inpatient care, making an effort to include nursing staff on rounds can cut down on confusion and assist the family in understanding care plans. This, in turn, can minimize the stress associated with hospitalization and improve the patient and family experience.

While academic institutions' resources and access to subspecialties are often thought to be advantageous, there are other challenges inherent to providing care in such complex environments. Some caregivers cited confusion related to large teams of providers with, to them, indistinguishable roles asking redundant questions. These experiences affected their perceptions of FCR, generally leading to a fixation on its overwhelming aspects. Certain caregivers highlighted that FCR caused them, and their child, to feel overwhelmed and more confused about the plan for the day. It is important to find ways to mitigate these feelings while simultaneously continuing to support the inclusion of caregivers during their child's hospitalization and understanding of care plans. Some initiatives (in addition to including nursing on FCR as discussed above) focus on improving the ways in which providers communicate with families during rounds and throughout the day, seeking to decrease miscommunications and medical errors while also striving for better quality of care and patient/family satisfaction.[35] Other initiatives seek to clarify identities and roles of the often large and confusing medical team. One such example of this is the development of a face sheet tool, which provides families with medical team members' photos and role descriptions. Unaka et al.[36] found that the use of the face sheet tool improved the ability of caregivers to correctly identify providers and their roles. Thinking beyond interventions at the bedside, it is also important to include caregivers on higher level committees within the institution, such as on family advisory boards and/or peer support groups, to inform systems-wide interventions that support the tenants of family-centered care.[29] Efforts such as these are worth trialing in order to improve the patient and family experience and quality of communication.

Multiple studies have evaluated the challenges with ensuring consistent and useful handoffs across the inpatient-to-outpatient transition,[8-10,12] but few have looked at it from the perspective of the caregiver.[13] After leaving the hospital to care for their recovering child, caregivers often feel overwhelmed; they may want, or need, to rely on the support of others in the outpatient environment. This support can be enhanced when outpatient providers are intimately aware of what occurred during the hospitalization; trust erodes if this is not the case. Given the value caregivers place on this communication occurring and occurring well, interventions supporting this communication are critical. Furthermore, as providers, we should also inform families that communication with outpatient providers is happening. Examples of efforts that have worked to improve the quality and consistency of communication with outpatient providers include improving discharge summary documentation, ensuring timely faxing of documentation to outpatient providers, and reliably making phone calls to outpatient providers.[37-39] These types of interventions seek to bridge the gap between inpatient and outpatient care and facilitate a smooth transfer of information in order to provide optimal quality of care and avoid undesired outcomes (eg, emergency department revisits, readmissions, medication errors, etc) and can be adopted by institutions to address the issue of communication between inpatient and outpatient providers.

We acknowledge limitations to our study. This was done at a single academic institution with only English-speaking participants. Thus, our results may not be reflective of caregivers of children cared for in different, more ethnically or linguistically diverse settings. The patient population at CCHMC, however, is diverse both demographically and clinically, which was reflected in the composition of our focus groups and interviews. Additionally, the inclusion of participants who received a nurse home visit after discharge may limit generalizability. However, only 4 participants had a nurse home visit; thus, the overwhelming majority of participants did not receive such an intervention. We also acknowledge that those willing to participate may have differed from nonparticipants, specifically sharing more positive experiences. We believe that our sampling strategy and use of an unbiased, nonhospital affiliated moderator minimized this possibility. Recall bias is possible, as participants were asked to reflect back on a discharge experience occurring in their past. We attempted to minimize this by holding sessions no more than 30 days from the day of discharge. Finally, we present data on caregivers' perception of communication and not directly observed communication

occurrences. Still, we expect that perception is powerful in and of itself, relevant to both outcomes and to interventions.

CONCLUSION

Communication during hospitalization influences how caregivers understand diagnoses and care plans. Communication perceived as effective fosters mutual understandings and positive relationships with the potential to result in better care and improved outcomes. Communication perceived as ineffective negatively affects experiences of patients and their caregivers and can adversely affect patient outcomes. Learning from caregivers' experiences with communication during their child's hospitalization can help identify modifiable factors and inform strategies to improve communication, support families through hospitalization, and facilitate a smooth reentry home.

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Improving Teamwork and Patient Outcomes with Daily Structured Interdisciplinary Bedside Rounds: A Multimethod Evaluation

Robyn Clay-Williams, PhD[1]*, Jennifer Plumb, PhD[2], Georgina M. Luscombe, PhD[3], Catherine Hawke, FFPH[3], Hazel Dalton, PhD[4], Gabriel Shannon, FRACP[3], Julie Johnson, PhD[5]

[1]Centre for Healthcare Resilience & Implementation Science, Australian Institute of Health Innovation, Macquarie University, Sydney, New South Wales, Australia; [2]Australian Commission on Safety and Quality in Health Care, Sydney, New South Wales, Australia; [3]The School of Rural Health, Sydney Medical School, The University of Sydney, Orange, New South Wales, Australia; [4]Faculty of Health and Medicine, The University of Newcastle, Newcastle, New South Wales, Australia; [5]Department of Surgery, Center for Healthcare Studies, Institute for Public Health and Medicine, Feinberg School of Medicine, Northwestern University, Chicago, Illinois.

BACKGROUND: Previous research has shown that interdisciplinary ward rounds have the potential to improve team functioning and patient outcomes.

DESIGN: A convergent parallel multimethod approach to evaluate a hospital interdisciplinary ward round intervention and ward restructure.

SETTING: An acute medical unit in a large tertiary care hospital in regional Australia.

PARTICIPANTS: Thirty-two clinicians and inpatients aged 15 years and above, with acute episode of care, discharged during the year prior and the year of the intervention.

INTERVENTION: A daily structured interdisciplinary bedside round combined with a ward restructure.

MEASUREMENTS: Qualitative measures included contextual factors and measures of change and experiences of clinicians. Quantitative measures included length of stay (LOS), monthly "calls for clinical review,'" and cost of care delivery.

RESULTS: Clinicians reported improved teamwork, communication, and understanding between and within the clinical professions, and between clinicians and patients, after the intervention implementation. There was no statistically significant difference between the intervention and control wards in the change in LOS over time (Wald $\chi^2 = 1.05$; degrees of freedom [df] = 1; $P = .31$), but a statistically significant interaction for cost of stay, with a drop in cost over time, was observed in the intervention group, and an increase was observed in the control wards (Wald $\chi^2 = 6.34$; df = 1; $P = .012$). The medical wards and control wards differed significantly in how the number of monthly "calls for clinical review" changed from prestructured interdisciplinary bedside round (SIBR) to during SIBR (F (1,44) = 12.18; $P = .001$).

CONCLUSIONS: Multimethod evaluations are necessary to provide insight into the contextual factors that contribute to a successful intervention and improved clinical outcomes. *Journal of Hospital Medicine* 2018;13:311-317. © 2018 Society of Hospital Medicine

Evidence has emerged over the last decade of the importance of the front line patient care team in improving quality and safety of patient care.[1-3] Improving collaboration and workflow is thought to increase reliability of care delivery.[1] One promising method to improve collaboration is the interdisciplinary ward round (IDR), whereby medical, nursing, and allied health staff attend ward rounds together. IDRs have been shown to reduce the average cost and length of hospital stay,[4,5] although a recent systematic review found inconsistent improvements across studies.[6] Using the term "interdisciplinary," however, does not necessarily imply the inclusion of all disciplines necessary for patient care. The challenge of conducting interdisciplinary rounds is considerable in today's busy clinical environment: health professionals who are spread across multiple locations within the hospital, and who have competing hospital responsibilities and priorities, must come together at the same time and for a set period each day. A survey with respondents from Australia, the United States, and Canada found that only 65% of rounds labelled "interdisciplinary" included a physician.[7]

While IDRs are not new, structured IDRs involve the purposeful inclusion of all disciplinary groups relevant to a patient's care, alongside a checklist tool to aid comprehensive but concise daily assessment of progress and treatment planning. Novel, structured IDR interventions have been tested recently in various settings, resulting in improved teamwork, hospital

***Address for correspondence:** Robyn Clay-Williams, PhD, Centre for Healthcare Resilience & Implementation Science, Australian Institute of Health Innovation, Macquarie University, Level 6, 75 Talavera Road, Sydney NSW 2109, Australia; Telephone: 02-9850-2438; Fax: 02-9850-2499; E-mail: robyn.clay-williams@mq.edu.au

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performance, and patient outcomes in the US, including the Structured Interdisciplinary Bedside Round (SIBR) model.[8-12]

The aim of this study was to assess the impact of the new structure and the associated practice changes on interprofessional working and a set of key patient and hospital outcome measures. As part of the intervention, the hospital established an Acute Medical Unit (AMU) based on the Accountable Care Unit model.[13]

METHODS

Description of the Intervention

The AMU brought together 2 existing medical wards, a general medical ward and a 48-hour turnaround Medical Assessment Unit (MAU), into 1 geographical location with 26 beds. Prior to the merger, the MAU and general medical ward had separate and distinct cultures and workflows. The MAU was staffed with experienced nurses; nurses worked within a patient allocation model, the workload was shared, and relationships were collegial. In contrast, the medical ward was more typical of the remainder of the hospital: nurses had a heavy workload, managed a large group of longer-term complex patients, and they used a team-based nursing model of care in which senior nurses supervised junior staff. It was decided that because of the seniority of the MAU staff, they should be in charge of the combined AMU, and the patient allocation model of care would be used to facilitate SIBR.

Consultants, junior doctors, nurses, and allied health professionals (including a pharmacist, physiotherapist, occupational therapist, and social worker) were geographically aligned to the new ward, allowing them to participate as a team in daily structured ward rounds. Rounds are scheduled at the same time each day to enable family participation. The ward round is coordinated by a registrar or intern, with input from patient, family, nursing staff, pharmacy, allied health, and other doctors (intern, registrar, and consultant) based on the unit. The patient load is distributed between 2 rounds: 1 scheduled for 10 AM and the other for 11 AM each weekday.

Data Collection Strategy

The study was set in an AMU in a large tertiary care hospital in regional Australia and used a convergent parallel multimethod approach[14] to evaluate the implementation and effect of SIBR in the AMU. The study population consisted of 32 clinicians employed at the study hospital: (1) the leadership team involved in the development and implementation of the intervention and (2) members of clinical staff who were part of the AMU team.

Qualitative Data

Qualitative measures consisted of semistructured interviews. We utilized multiple strategies to recruit interviewees, including a snowball technique, criterion sampling,[15] and emergent sampling, so that we could seek the views of both the leadership team responsible for the implementation and "frontline" clinical staff whose daily work was directly affected by it. Everyone who was initially recruited agreed to be interviewed, and additional frontline staff asked to be interviewed once they realized that we were asking about how staff experienced the changes in practice.

The research team developed a semistructured interview guide based on an understanding of the merger of the 2 units as well as an understanding of changes in practice of the rounds (provided in Appendix 1). The questions were pilot tested on a separate unit and revised. Questions were structured into 5 topic areas: planning and implementation of AMU/SIBR model, changes in work practices because of the new model, team functioning, job satisfaction, and perceived impact of the new model on patients and families. All interviews were audio-recorded and transcribed verbatim for analysis.

Quantitative Data

Quantitative data were collected on patient outcome measures: length of stay (LOS), discharge date and time, mode of separation (including death), primary diagnostic category, total hospital stay cost and "clinical response calls," and patient demographic data (age, gender, and Patient Clinical Complexity Level [PCCL]). The PCCL is a standard measure used in Australian public inpatient facilities and is calculated for each episode of care.[16] It measures the cumulative effect of a patient's complications and/or comorbidities and takes an integer value between 0 (no clinical complexity effect) and 4 (catastrophic clinical complexity effect).

Data regarding LOS, diagnosis (Australian Refined Diagnosis Related Groups [AR-DRG], version 7), discharge date, and mode of separation (including death) were obtained from the New South Wales Ministry of Health's Health Information Exchange for patients discharged during the year prior to the intervention through 1 year after the implementation of the intervention. The total hospital stay cost for these individuals was obtained from the local Health Service Organizational Performance Management unit. Inclusion criteria were inpatients aged over 15 years experiencing acute episodes of care; patients with a primary diagnostic category of mental diseases and disorders were excluded. LOS was calculated based on ward stay. AMU data were compared with the remaining hospital ward data (the control group). Data on "clinical response calls" per month per ward were also obtained for the 12 months prior to intervention and the 12 months of the intervention.

Analysis

Qualitative Analysis

Qualitative data analysis consisted of a hybrid form of textual analysis, combining inductive and deductive logics.[17,18] Initially, 3 researchers (J.P., J.J., and R.C.W.) independently coded the interview data inductively to identify themes. Discrepancies were resolved through discussion until consensus was reached. Then, to further facilitate analysis, the researchers deductively imposed a matrix categorization, consisting of 4 a priori categories: context/conditions, practices/processes, professional interactions, and consequences.[19,20] Additional a priori categories were used to sort the themes further in terms of experiences prior to, during, and following implementation of the intervention. To compare changes in those different time periods, we wanted to know what themes were related to implementation and whether those themes continued to be applicable to sustainability of the changes.

Quantitative analysis. Distribution of continuous data was examined by using the one-sample Kolmogorov-Smirnov test. We compared pre-SIBR (baseline) measures using the Student t test for normally distributed data, the Mann-Whitney U z test for nonparametric data (denoted as M-W U z), and χ^2 tests for categorical data. Changes in monthly "clinical response calls" between the AMU and the control wards over time were explored by using analysis of variance (ANOVA). Changes in LOS and cost of stay from the year prior to the intervention to the first year of the intervention were analyzed by using generalized linear models, which are a form of linear regression. Factors, or independent variables, included in the models were time period (before or during intervention), ward (AMU or control), an interaction term (time by ward), patient age, gender, primary diagnosis (major diagnostic categories of the AR-DRG version 7.0), and acuity (PCCL). The estimated marginal means for cost of stay for the 12-month period prior to the intervention and for the first 12 months of the intervention were produced. All statistical analyses were performed by using IBM SPSS version 21 (IBM Corp., Armonk, New York) and with alpha set at $P < .05$.

RESULTS

Qualitative Evaluation of the Intervention

Participants.

Three researchers (RCW, JP, and JJ) conducted in-person, semistructured interviews with 32 clinicians (9 male, 23 female) during a 3-day period. The duration of the interviews ranged from 19 minutes to 68 minutes. Participants consisted of 8 doctors, 18 nurses, 5 allied health professionals, and an administrator. Ten of the participants were involved in the leadership group that drove the planning and implementation of SIBR and the AMU.

Themes

Below, we present the most prominent themes to emerge from our analysis of the interviews. Each theme is a type of postintervention change perceived by all participants. We assigned these themes to 1 of 4 deductively imposed, theoretically driven categories (context and conditions of work, processes and practices, professional relationships, and consequences). In the context and conditions of work category, the most prominent theme was changes to the physical and cultural work environment, while in the processes and practices category, the most prominent theme was efficiency of workflow. In the professional relationships category, the most common theme was improved interprofessional communication, and in the consequences of change category, emphasis on person-centered care was the most prominent theme. Table 1 delineates the category, theme, and illustrative quotes (additional quotes are available in Supplemental Table 1 in the online version of this article.

Context and Conditions of Work

The physical and cultural work environment changed substantially with the intervention. Participants often expressed their understanding of the changes by reflecting on how things were different (for better or worse) between the AMU and places they had previously worked, or other parts of the hospital where they still worked, at the time of interview. In a positive sense, these differences primarily related to a greater level of organization and structure in the AMU. In a negative sense, some nurses perceived a loss of ownership of work and a loss of a collegial sense of belonging, which they had felt on a previous ward. Some staff also expressed concern about implementing a model that originated from another hospital and potential underresourcing. The interviews revealed that a further, unanticipated challenge for the nursing staff was to resolve an industrial relations problem: how to integrate a new rounding model without sacrificing hard-won conditions of work, such as designated and protected time for breaks (Australia has a more structured, unionized nursing workforce than in countries like the US; effort was made to synchronize SIBR with nursing breaks, but local agreements needed to be made about not taking a break in the middle of a round should the timing be delayed). However, leaders reported that by emphasizing the benefits of SIBR to the patient, they were successful in achieving greater flexibility and buy-in among staff.

Practices and Processes

Participants perceived postintervention work processes to be more efficient. A primary example was a near-universal approval of the time saved from not "chasing" other professionals now that they were predictably available on the ward. More timely decision-making was thought to result from this predicted availability and associated improvements in communication.

The SIBR enforced a workflow on all staff, who felt there was less flexibility to work autonomously (doctors) or according to patients' needs (nurses). More junior staff expressed anxiety about delayed completion of discharge-related administrative tasks because of the midday completion of the round. Allied health professionals who had commitments in other areas of the hospital often faced a dilemma about how to prioritize SIBR attendance and activities on other wards. This was managed differently depending on the specific allied health profession and the individuals within that profession.

Professional Interactions

In terms of interprofessional dynamics on the AMU, the implementation of SIBR resulted in a shift in power between the doctors and the nurses. In the old ward, doctors largely controlled the timing of medical rounding processes. In the new AMU, doctors had to relinquish some control over the timing of personal workflow to comply with the requirements of SIBR. Furthermore, there was evidence that this had some impact on traditional hierarchical models of communication and created a more level playing field, as nonmedical professionals felt more empowered to voice their thoughts during and outside of rounds.

The rounds provided much greater visibility of the "big picture" and each profession's role within it; this allowed each clinician to adjust their work to fit in and take account of others. The process was not instantaneous, and trust developed over

TABLE 1. **Category, Theme, and Illustrative Quotes**

CATEGORY	THEME	ILLUSTRATIVE QUOTES
Conditions and context of work	Greater level of organisation and structure post-implementation	"I previously worked in rehab and it was a very stressful area and a lot that was - nothing was organised or structured. So it's a big relief for me to come onto a ward where those things are available." (Admin, Interview #23)
	Perceived loss of ownership and sense of belonging post-intervention	"We were not happy … because we're not prepared to join them … we didn't have prior get together or meet these people that we are going to work with" (Nurse, Interview #17)
	Implementing a model from elsewhere	"[Emory], for instance, has two consultants on for that same number of patients. Two consultants would be great. That would make it a lot easier …" (Leader, Interview #1)
	Potential under resourcing post-intervention	"One of the logistical difficulties [is that] we weren't set up, so we had to do ad hoc projector and whatnot. [We didn't have] that equipment - I think because of the short timeframe … The acquisition of equipment … involves dollars and cents" (Leader, Interview #12)
	Maintaining conditions of work post-intervention	"The other thing was lining it up with the nursing breaks, so that's one of the big differences compared with America; we've got a much more structured, unionised nursing workforce, so we had to fully respect their ability to have their breaks. (Doctor, Interview #21)
	Staff were accepting when changes were seen to benefit the patient	"[after implementation] the ward had started to get to the point where people said 'I'll have my break to fit in with the ward round.'" (Doctor, Interview #21).
Practices and processes	Improved efficiency post-intervention	"[you spend] less time chasing people and [get] very clear directions [about the plan for the patient]" (Doctor, Interview #29)
	Less flexibility and autonomy post-intervention	"Nothing stopped the SIBR. It was like the train." (Nurse, Interview #19)
	SIBR had priority over other administrative tasks	"You've got a couple of hours. You've got to do the whole lot, plus do your pills, your washes and all the other work kind of thing. Sometimes still the permanent staff still have trouble getting their work done around SIBR" (Nurse, Interview #11)
	Allied health professionals had to meet other hospital commitments	"Now I'm far less flexible because I know that I have to be here between 10:00 and 12:00 whereas before I could say well I know there's three hours work here, I'll come and do it in the afternoon…" (Allied Health, Interview #13)
Professional interactions	Improved interprofessional communication post-intervention	"everyone is there at the same time on the same page and you get a really good chance to be heard by people from other disciplines, what your concerns are and their specialty … I think the relationship between the disciplines [now] is really, really good." (Nurse, Interview #14)
	Improved interprofessional trust postintervention	"…it's been great having … the pharmacist there. He'll pick up on things that as juniors we haven't got the knowledge or the nous to pick up on … it makes life easier." (Doctor, Interview #8)
	Clinicians adjusted their work to fit in post-intervention	"I think it's got advantages not necessarily for the [senior doctors] at all, that most of the advantages are in fact for the patient, the nursing staff and the junior staff. [As a senior doctor, you've got to change your roster, you've got to change the way you used to do business." (Leader, Interview #21)
	Power shifted to a more level playing field post-intervention	"I think sometimes in some hospital systems you can get this is the doctors, this the nurses, the doctor will say what happens and the nurse doesn't question, but this is more a case of we're all working together for the patient. It's not just doctors and nurses, it's allied health, it's everyone; it's everyone together." (Nurse, Interview #9)
	Poorer interdepartmental relationships	"So basically it's meant that at 7:00 in the morning, the pharmacist comes here first, and that they are committed to those two wards until 1:00, and then at 1:00 that person goes to the dispensary. Now, that's meant elsewhere in the hospital that that slightly reduced pharmaceutical support for some other parts of the hospital." (Doctor, Interview #21)

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a period of weeks. Better communication meant fewer misunderstandings, and workload dropped.

The participation of allied health professionals in the round enhanced clinician interprofessional skills and knowledge. The more inclusive approach facilitated greater trust between clinical disciplines and a development of increased confidence among nursing, allied health, and administrative professionals.

In contrast to the positive impacts of the new model of care on communication and relationships within the AMU, interdepartmental relationships were seen to have suffered. The processes and practices of the new AMU are different to those in the other hospital departments, resulting in some isolation of the unit and difficulties interacting with other areas of the hospital. For example, the trade-offs that allied health professionals made to participate in SIBR often came at the expense of other units or departments.

Consequences

All interviewees lauded the benefits of the SIBR intervention for patients. Patients were perceived to be better informed and more respected, and they benefited from greater perceived timeliness of treatment and discharge, easier access to doctors, better continuity of treatment and outcomes, improved nurse knowledge of their circumstances, and fewer gaps in their care. Clinicians spoke directly to the patient during SIBR, rather than consulting with professional colleagues over the patient's head. Some staff felt that doctors were now thinking of patients as "people" rather than "a set of symptoms." Nurses discovered that informed patients are easier to manage.

Staff members were prepared to compromise on their own needs in the interests of the patient. The emphasis on the patient during rounds resulted in improved advocacy behaviors

TABLE 1. **Category, Theme, and Illustrative Quotes (continued)**

CATEGORY	THEME	ILLUSTRATIVE QUOTES
Consequences	Patients perceived to be better informed and more respected	"The patients also tell you they're not getting mixed messages. The junior coming and telling them one thing. Then the consultant coming in, in the evening, and telling them something totally different." (Leader, Interview #1)
	Patients perceived to benefit from greater perceived timeliness of treatment and discharge	"From a patient flow and a bed management point of view, yes, we have seen a decreased length of stay of the patients in the acute medical ward." (Leader, Interview #12)
	Patients perceived to have better continuity of treatment and outcomes	"It's amazing how many [allied health] referrals I pick up just by being there and listening to what the doctors are saying … it's really good because we're not missing out on the people that would - that we probably would normally have fallen through the gaps" (Allied Health, Interview #16)
	Improved nurse knowledge of patients' circumstances, fewer gaps in care	"You actually get to communicate with the doctor and the patient at the same time, so you're involving the patient, which helps. Because sometimes the patient won't tell the nurse something but will tell the doctor something or vice versa, whereas with the whole team there, everyone hears everything about the patient." (Nurse, Interview #30)
	Patients were 'humanised'	"From the point of view of the doctors the issue of how the doctors relate to the patients is very important now; they're no longer a set of a symptoms in a bed, it's Mr Smith and it's all very personalised. (Nurse, Interview #34)
	Informed patients are less work	"Because they know what's going on, they don't ring the bell as often … if you go to another medical ward you would never hear the bell stop, it would just go all day, all day, all day. Here it's quiet for an hour sometimes." (Nurse, Interview #14)
	Staff members prepared to compromise on own needs for the patient	"So in terms of lunch breaks and morning tea breaks, they've definitely suffered, they've gone down to non-existent, which is something I'm still happy to do because at the end of the day you're here for the patients and you can see the benefits that it does have." (Allied Health, Interview #2)
	Improved advocacy behaviours of clinicians	"I get to be much more of an advocate, because I get the opportunity to bring up concerns in front of a team who have the abilities to make changes …" (Nurse, Interview #14)
	Nurses more empowered	"They're not just giving Clexane because they're reading up on the medication now. They're actually saying to the patient I'm giving you Clexane because this is going to help prevent you from developing any blood clots or anything until you're more mobile and that. It's also saying in that report they're not very mobile. They're not on a DVT prophylaxis, should they be?" (Leader, Interview #31)
	Easier access to doctors for patients' family members	"I think families loved it … They knew when the doctors and teams were going to be around, they knew they could find out in plain English what was going to happen, and they knew they had a plan, even if it's 'we don't know'." (Doctor, Interview # 20)

of clinicians. The nurses became more empowered and able to show greater initiative. Families appeared to find it much easier to access the doctors and obtain information about the patient, resulting in less distress and a greater sense of control and trust in the process.

Quantitative Evaluation of the Intervention

Hospital Outcomes

In the 12 months prior to the intervention, patients in the AMU were significantly older, more likely to be male, had greater complexity/comorbidity, and had longer LOS than the control wards ($P < .001$; see Table 2). However, there were no significant differences in cost of care at baseline ($P = .43$).

Patient demographics did not change over time within either the AMU or control wards. However, there were significant increases in Patient Clinical Complexity Level (PCCL) ratings for both the AMU (44.7% to 40.3%; P<0.05) and the control wards (65.2% to 61.6%; $P < .001$). There was not a statistically significant shift over time in median LoS on the ward prior to (2.16 days, IQR 3.07) and during SIBR in the AMU (2.15 days; IQR 3.28), while LoS increased in the control (pre-SIBR: 1.67, 2.34; during SIBR 1.73, 2.40; M-W U z = -2.46, $P = .014$). Mortality rates were stable across time for both the AMU (pre-SIBR 2.6% [95% confidence interval {CI}, 1.9-3.5]; during SIBR 2.8% [95% CI, 2.1-3.7]) and the control (pre-SIBR 1.3% [95% CI, 1.0-1.5]; during SIBR 1.2% [95% CI, 1.0-1.4]).

The total number of "clinical response calls" or "flags" per month dropped significantly from pre-SIBR to during SIBR for the AMU from a mean of 63.1 (standard deviation 15.1) to 31.5 (10.8), but remained relatively stable in the control (pre-SIBR 72.5 [17.6]; during SIBR 74.0 [28.3]), and this difference was statistically significant ($F(1,44) = 9.03$; $P = .004$). There was no change in monthly "red flags" or "rapid response calls" over time (AMU: 10.5 [3.6] to 9.1 [4.7]; control: 40.3 [11.7] to 41.8 [10.8]). The change in total "clinical response calls" over time was attributable to the "yellow flags" or the decline in "calls for clinical review" in the AMU (from 52.6 [13.5] to 22.4 [9.2]). The average monthly "yellow flags" remained stable in the control (pre-SIBR 32.2 [11.6]; during SIBR 32.3 [22.4]). The AMU and the control wards differed significantly in how the number of monthly "calls for clinical review" changed from pre-SIBR to during SIBR ($F(1,44) = 12.18$; $P = .001$).

The 2 main outcome measures, LOS and costs, were analyzed to determine whether changes over time differed between the AMU and the control wards after accounting for age, gender, and PCCL. There was no statistically significant difference between the AMU and control wards in terms of change in LOS over time (Wald $\chi^2 = 1.05$; degrees of freedom [df] = 1; $P = .31$).

TABLE 2. **Intervention Patient and Economic Outcomes**

Patient Outcomes					
PCCL rating: No complications/ comorbidity	*N*	*% (n)*	*N*	*% (n)*	*P Value*
AMU	1,551	44.7 (693)	1,651	40.3 (666)	.01
Control	7,111	65.2 (4,636)	7,795	61.6 (4,805)	<.001
Ward LoS in days	*N*	*median (IQR)*	*N*	median (IQR)	*P Value*
AMU	2,303	2.16 (3.07)	2,495	2.15 (3.28)	.63
Control	8,704	1.67 (2.34)	9,265	1.73 (2.40)	.01
Economic Outcome					
Costs $K	*N*	*median (IQR)*	*N*	*median (IQR)*	*P Value*
AMU	1,551	4.94 (6.89)	*1,410*	4.64 (6.00)	.10
Control	7,111	4.81 (5.93)	*6,529*	5.67 (6.63)	<.001
Adjusted costs $K[a]		*mean (SE)*		*mean (SE)*	
AMU	1,551	6.18 (0.46)	1,410	4.53 (0.48)	[b]
Control	7,111	9.53 (0.21)	6,529	9.70 (0.22)	

Control = remaining hospital wards. Abbreviations: AMU, Acute Medical Unit IQR, interquartile range; LoS, length of stay; PCCL, Patient Clinical Complexity Level: 0 = no complication or comorbidity; 1 = minor; 2 = moderate; 3 = severe; 4 = catastrophic complication or comorbidity; SE, Standard Error; Costs are in AUD.

Data are based on hospital stays, with the exception of LoS which is based on ward level stays.

[a]adjusted costs are estimated marginal means adjusting for patient age, gender, PCCL and primary diagnosis; [b]indicates statistically significant interaction between time and group (intervention vs control wards) at $P < .05$.

There was a statistically significant interaction for cost of stay, indicating that ward types differed in how they changed over time (with a drop in cost over time observed in the AMU and an increase observed in the control) (Wald $\chi^2 = 6.34$; df = 1; $P = .012$.

DISCUSSION

We report on the implementation of an AMU model of care, including the reorganization of a nursing unit, implementation of IDR, and geographical localization. Our study design allowed a more comprehensive assessment of the implementation of system redesign to include provider perceptions and clinical outcomes.

The 2 very different cultures of the old wards that were combined into the AMU, as well as the fact that the teams had not previously worked together, made the merger of the 2 wards difficult. Historically, the 2 teams had worked in very different ways, and this created barriers to implementation. The SIBR also demanded new ways of working closely with other disciplines, which disrupted older clinical cultures and relationships. While organizational culture is often discussed, and even measured, the full impact of cultural factors when making workplace changes is frequently underestimated.[21] The development of a new culture takes time, and it can lag organizational structural changes by months or even years.[22] As our interviewees expressed, often emotionally, there was a sense of loss during the merger of the 2 units. While this is a potential consequence of any large organizational change, it could be addressed during the planning stages, prior to implementation, by acknowledging and perhaps honoring what is being left behind. It is safe to assume that future units implementing the rounding intervention will not fully realize commensurate levels of culture change until well after the structural and process changes are finalized, and only then if explicit effort is made to engender cultural change.

Overall, however, the interviewees perceived that the SIBR intervention led to improved teamwork and team functioning. These improvements were thought to benefit task performance and patient safety. Our study is consistent with other research in the literature that reported that greater staff empowerment and commitment is associated with interdisciplinary patient care interventions in front line caregiving teams.[23,24] The perception of a more equal nurse-physician relationship resulted in improved job satisfaction, better interprofessional relationships, and perceived improvements in patient care. A flatter power gradient across professions and increased interdisciplinary teamwork has been shown to be associated with improved patient outcomes.[25,26]

Changes to clinician workflow can significantly impact the introduction of new models of care. A mandated time each day for structured rounds meant less flexibility in workflow for clinicians and made greater demands on their time management and communication skills. Furthermore, the need for human resource negotiations with nurse representatives was an unexpected component of successfully introducing the changes to workflow. Once the benefits of saved time and better communication became evident, changes to workflow were generally accepted. These challenges can be managed if stakeholders are engaged and supportive of the changes.[13]

Finally, our findings emphasize the importance of combining qualitative and quantitative data when evaluating an intervention. In this case, the qualitative outcomes that include "intangible" positive effects, such as cultural change and improved staff understanding of one another's roles, might encourage us to continue with the SIBR intervention, which would allow more time to see if the trend of reduced LOS identified in the statistical analysis would translate to a significant effect over time.

We are unable to identify which aspects of the intervention led to the greatest impact on our outcomes. A recent study found that interdisciplinary rounds had no impact on patients' perceptions of shared decision-making or care satisfaction.[27] Although our findings indicated many potential benefits for patients, we were not able to interview patients or their carers to confirm these findings. In addition, we do not have any patient-centered outcomes, which would be important to consider in future work. Although our data on clinical response calls might be seen as a proxy for adverse events, we do not have data on adverse events or errors, and these are important to consider in future work. Finally, our findings are based on data from a single institution.

CONCLUSIONS

While there were some criticisms, participants expressed overwhelmingly positive reactions to the SIBR. The biggest reported benefit was perceived improved communication and understanding between and within the clinical professions, and between clinicians and patients. Improved communication was perceived to have fostered improved teamwork and team functioning, with most respondents feeling that they were a valued part of the new team. Improved teamwork was thought to contribute to improved task performance and led interviewees to perceive a higher level of patient safety. This research highlights the need for multimethod evaluations that address contextual factors as well as clinical outcomes.

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Hospitalist Perspective of Interactions with Medicine Subspecialty Consult Services

Traci N. Adams, MD[1]*, Joanna Bonsall, MD[2], Daniel Hunt, MD[2], Alberto Puig, MD[3], Jeremy B. Richards, MD[4], Liyang Yu, MS[5], Jakob I. McSparron, MD[6], Nainesh Shah, MD[7], Jonathan Weissler, MD[1], Eli M. Miloslavsky, MD[8]

[1]Division of Pulmonary and Critical Care Medicine, University of Texas Southwestern Medical Center, Dallas, Texas; [2]Department of Medicine, Emory University, Atlanta, Georgia; [3]Department of Medicine, Massachusetts General Hospital, Boston, Massachusetts; [4]Division of Pulmonary, Critical Care, and Sleep Medicine, Medical University of South Carolina, Charleston, South Carolina; [5]Division of Internal Medicine, Massachusetts General Hospital, Boston, Massachusetts; [6]Division of Pulmonary, Critical Care, and Sleep Medicine, Beth Israel Deaconess Medical Center, Boston, Massachusetts; [7]Department of Medicine, University of Texas Southwestern Medical Center, Dallas, Texas; [8]Division of Rheumatology, Allergy, and Immunology, Massachusetts General Hospital, Boston, Massachusetts.

BACKGROUND: Medicine subspecialty consultation is becoming increasingly important in inpatient medicine.

OBJECTIVE: We conducted a survey study in which we examined hospitalist practices and attitudes regarding medicine subspecialty consultation.

DESIGN AND SETTING: The survey instrument was developed by the authors based on prior literature and administered online anonymously to hospitalists at 4 academic medical centers in the United States.

MEASUREMENTS: The survey evaluated 4 domains: (1) current consultation practices, (2) preferences regarding consultation, (3) barriers to and facilitating factors of effective consultation, and (4) a comparison between hospitalist–fellow and hospitalist–subspecialty attending interactions.

RESULTS: One hundred twenty-two of 261 hospitalists (46.7%) responded. The majority of hospitalists interacted with fellows during consultation. Of those, 90.9% reported that in-person communication occurred during less than half of consultations, and 64.4% perceived pushback at least "sometimes" in their consult interactions. Participants viewed consultation as an important learning experience, preferred direct communication with the consulting service, and were interested in more teaching during consultation. The survey identified a number of barriers to and facilitating factors of an effective hospitalist–consultant interaction, which impacted both hospitalist learning and patient care. Hospitalists reported more positive experiences when interacting with subspecialty attendings compared to fellows with regard to multiple aspects of the consultation.

CONCLUSION: The hospitalist–consultant interaction is viewed as important for both hospitalist learning and patient care. Multiple barriers and facilitating factors impact the interaction, many of which are amenable to intervention. *Journal of Hospital Medicine* 2018;13:318-323. Published online first November 22, 2017. ©2018 Society of Hospital Medicine

Hospitalist physicians care for an increasing proportion of general medicine inpatients and request a significant share of all subspecialty consultations.[1] Subspecialty consultation in inpatient care is increasing,[2,3] and effective hospitalist–consulting service interactions may affect team communication, patient care, and hospitalist learning. Therefore, enhancing hospitalist–consulting service interactions may have a broad-reaching, positive impact. Researchers in previous studies have explored resident–fellow consult interactions in the inpatient and emergency department settings as well as attending-to-attending consultation in the outpatient setting.[4-7] However, to our knowledge, hospitalist–consulting team interactions have not been previously described. In academic medical centers, hospitalists are attending physicians who interact with both fellows (supervised by attending consultants) and directly with subspecialty attendings. Therefore, the exploration of the hospitalist–consultant interaction requires an evaluation of hospitalist–fellow and hospitalist–subspecialty attending interactions. The hospitalist–fellow interaction in particular is unique because it represents an unusual dynamic, in which an attending physician is primarily communicating with a trainee when requesting assistance with patient care.[8] In order to explore hospitalist–consultant interactions (herein, the term "consultant" includes both fellow and attending consultants), we conducted a survey study in which we examine hospitalist practices and attitudes regarding consultation, with a specific focus on hospitalist consultation with internal medicine subspecialty consult services. In addition, we compared fellow–hospitalist and attending–

***Address for correspondence:** Traci N. Adams, MD, UT Southwestern Medical Center, 5323 Harry Hines Blvd, Dallas, TX 75219; Telephone: 832-428-8135; Fax 214-645-6272; E-mail: tnfadams@gmail.com

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hospitalist interactions and explored barriers to and facilitating factors of an effective hospitalist–consultant relationship.

METHODS

Survey Development

The survey instrument was developed by the authors based on findings of prior studies in which researchers examined consultation.[2-6,9-16] The survey contained 31 questions (supplementary Appendix A) and evaluated 4 domains of the use of medical subspecialty consultation in direct patient care: (1) current consultation practices, (2) preferences regarding consultants, (3) barriers to and facilitating factors of effective consultation (both with respect to hospitalist learning and patient care), and (4) a comparison between hospitalist–fellow and hospitalist–subspecialty attending interactions. An evaluation of current consultation practices included a focus on communication methods (eg, in person, over the phone, through paging, or notes) because these have been found to be important during consultation.[5,6,9,15,16] In order to explore hospitalist preferences regarding consult interactions and investigate perceptions of barriers to and facilitating factors of effective consultation, questions were developed based on previous literature, including our qualitative work examining resident–fellow interactions during consultation.[4-6,9,12] We compared hospitalist consultation experiences among attending and fellow consultants because the interaction in which an attending hospitalist physician is primarily communicating with a trainee may differ from a consultation between a hospitalist attending and a subspecialty attending.[8] Participants were asked to exclude their experiences when working on teaching services, during which students or housestaff often interact with consultants. The survey was cognitively tested with both hospitalist and non-hospitalist attending physicians not participating in the study and was revised by the authors using an iterative approach.

Study Participants

Hospitalist attending physicians at University of Texas Southwestern (UTSW) Medical Center, Emory University School of Medicine, Massachusetts General Hospital (MGH), and the Medical University of South Carolina (MUSC) were eligible to participate in the study. Consult team structures at each institution were composed of either a subspecialist-attending-only or a fellow-and-subspecialty-attending team. Fellows at all institutions are supervised by a subspecialty attending when performing consultations. Respondents who self-identified as nurse practitioners or physician assistants were excluded from the analysis. Hospitalists employed by the Veterans Affairs hospital system were also excluded. The study was approved by the institutional review boards of UTSW, Emory, MUSC, and MGH.

The survey was anonymous and administered to all hospitalists at participating institutions via a web-based survey tool (Qualtrics, Provo, UT). Participants were eligible to enter a raffle for a $500 gift card, and completion of the survey was not required for entry into the raffle.

TABLE 1. **Participant Baseline Data**

Characteristics	N (%)
Gender	
Male	63 (51.6)
Female	59 (48.4)
Age (mean +/- SD)	37.7 +/- 7.9
Primary practice site	
Academic medical center	105 (86.1)
Community nonteaching hospital	2 (1.6)
Community teaching hospital	14 (11.5)
Years worked as a hospitalist (mean +/- SD)	5.6 +/- 5.0
Years worked in current institution (mean +/- SD)	3.6 +/- 2.9
Percentage of daytime shifts (mean +/- SD)	74.1+/- 35.1
Percentage of time on teaching services (mean +/- SD)	19.2 +/- 25.1
Percentage of time on direct patient care (mean +/- SD)	70.5 +/- 34.0
Use of consult services over time	
Increased a lot	9 (7.4)
Increased a little	38 (31.1)
No change	38 (31.1)
Decreased a little	30 (24.6)
Decreased a lot	7 (5.7)
Total consults per shift	
0-1	48 (39.3)
2-3	62 (50.8)
4-5	8 (6.6)
>5	2 (1.6)
Medical subspecialty consults per shift (mean +/- SD)	2.9 +/- 2.4
Most common reason for requesting consultation	
Assistance with diagnosis	26 (21.3)
Assistance with treatment	49 (40.2)
Request a procedure	22 (18.0)
Patient request	4 (3.3)
Discharge planning	0 (0)

Statistics

Results were summarized using the mean with standard deviation for continuous variables and the frequency with percentage for categorical variables after excluding missing values. All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC). A 2-sided *P* value of ≤.05 was considered statistically significant.

RESULTS

Of a possible 261 respondents, 122 (46.7%) participated in the survey. Missing values for survey responses ranged from 0% to 21.3%, with a mean of 15.2%. Demographic characteristics are shown in Table 1. Respondents had a mean age of 37.7 years and had worked as attending hospitalists for an average of 5.6 years. The majority of respondents (86.1%) practiced in aca-

TABLE 2. **Hospitalist Consultation Practices**

Practices	N	Never	Sometimes	About Half the Time	Most of the Time	Always
Consults performed by fellow with attending supervision	102	4 (3.9%)	5 (4.9%)	10 (9.8%)	53 (52%)	30 (29.4%)
Hospitalist speaks with consultant to request consult in person	97	25 (25.8%)	59 (60.8%)	10 (10.3%)	3 (3.1%)	0 (0%)
Hospitalist speaks with consultant to request consult over the phone	101	3 (3%)	12 (11.9%)	9 (8.9%)	46 (45.5%)	31 (30.7%)
Hospitalist speaks with consultant to request consult by page only	96	46 (47.9%)	34 (35.4%)	3 (3.1%)	8 (8.3%)	5 (5.2%)
Consultant communicates with hospitalist after evaluating patient in person	99	24 (24.2%)	66 (66.7%)	9 (9.1%)	0 (%)	0 (%)
Consultant communicates with hospitalist after evaluating patient over the phone	103	2 (1.9%)	38 (36.9%)	25 (24.3%)	34 (33%)	4 (3.9%)
Consultant communicates with hospitalist after evaluating patient by page only	100	14 (14%)	71 (71%)	10 (10%)	5 (5%)	0 (0%)
Percentage of consults where hospitalists learned from interactions with consultant	102	1 (1%)	43 (42.2%)	37 (36.3%)	17 (16.7%)	4 (3.9%)

demic medical centers, with the remaining working in satellite community hospitals. Respondents reported working daytime shifts 74.1% of the time on average and being on inpatient, direct-care services without house-staff 70.5% of the time.

Current Consultation Practices

Current consultation practices and descriptions of hospitalist–consultant communication are shown in Table 2. Forty percent of respondents requested 0-1 consults per day, while 51.7% requested 2-3 per day. The most common reasons for requesting a consultation were assistance with treatment (48.5%), assistance with diagnosis (25.7%), and request for a procedure (21.8%). When asked whether the frequency of consultation is changing, slightly more hospitalists felt that their personal use of consultation was increasing as compared to those who felt that it was decreasing (38.5% vs 30.3%, respectively).

An exploration of communication practices during consultation revealed that hospitalists most often interacted with fellows rather than attending physicians (81.4%). However, even when a fellow performs a consult and communicates with a hospitalist, a subspecialty attending is involved in the care of the patient, although he or she may not communicate directly with the hospitalist. Respondents indicated that they most often communicated a consult request to the consultant by phone (76.2%). Pushback from consultants (defined as perceived reluctance or resistance to perform the consult for any reason) was perceived as common, with 64.4% of hospitalists indicating that they experience pushback at least "sometimes" (3 on a 5-point Likert scale) and 22.1% reporting that pushback was "frequent" or occurred "most of the time". Follow-up interactions (defined as communication of recommendations after the consultant evaluated the patient) infrequently occurred through in-person communication, with 90.9% reporting that this occurred in less than half of consultations. Communication by phone was most common, with 61.2% reporting that it occurred at least half the time, and 86% of respondents reported that communication by paging only occurred at least "sometimes". Consultation was commonly seen as a valuable educational experience, with 56.9% of hospitalists indicating that they learned from at least half of consults.

Hospitalist Preferences

Eighty-six percent of respondents agreed that consultants should be required to communicate their recommendations either in person or over the phone. Eighty-three percent of hospitalists agreed that they would like to receive more teaching from the consulting services, and 74.0% agreed that consultants should attempt to teach hospitalists during consult interactions regardless of whether the hospitalist initiates the teaching–learning interaction.

Barriers to and Facilitating Factors of Effective Consultation

Participants reported that multiple factors affected patient care and their own learning during inpatient consultation (Figure 1). Consultant pushback, high hospitalist clinical workload, a perception that consultants had limited time, and minimal in-person interactions were all seen as factors that negatively affected the consult interaction. These generally affected both learning and patient care. Conversely, working on an interesting clinical case, more hospitalist free time, positive interaction with the consultant, and having previously worked with the consultant positively affected both learning and patient care (Figure 1).

Fellow Versus Attending Interactions

Respondents indicated that interacting directly with the consult attending was superior to hospitalist–fellow interactions in all aspects of care but particularly with respect to pushback, confidence in recommendations, professionalism, and hospitalist learning (Figure 2).

DISCUSSION

To our knowledge, this is the first study to describe hospitalist attending practices, attitudes, and perceptions of internal medicine subspecialty consultation. Our findings, which focus

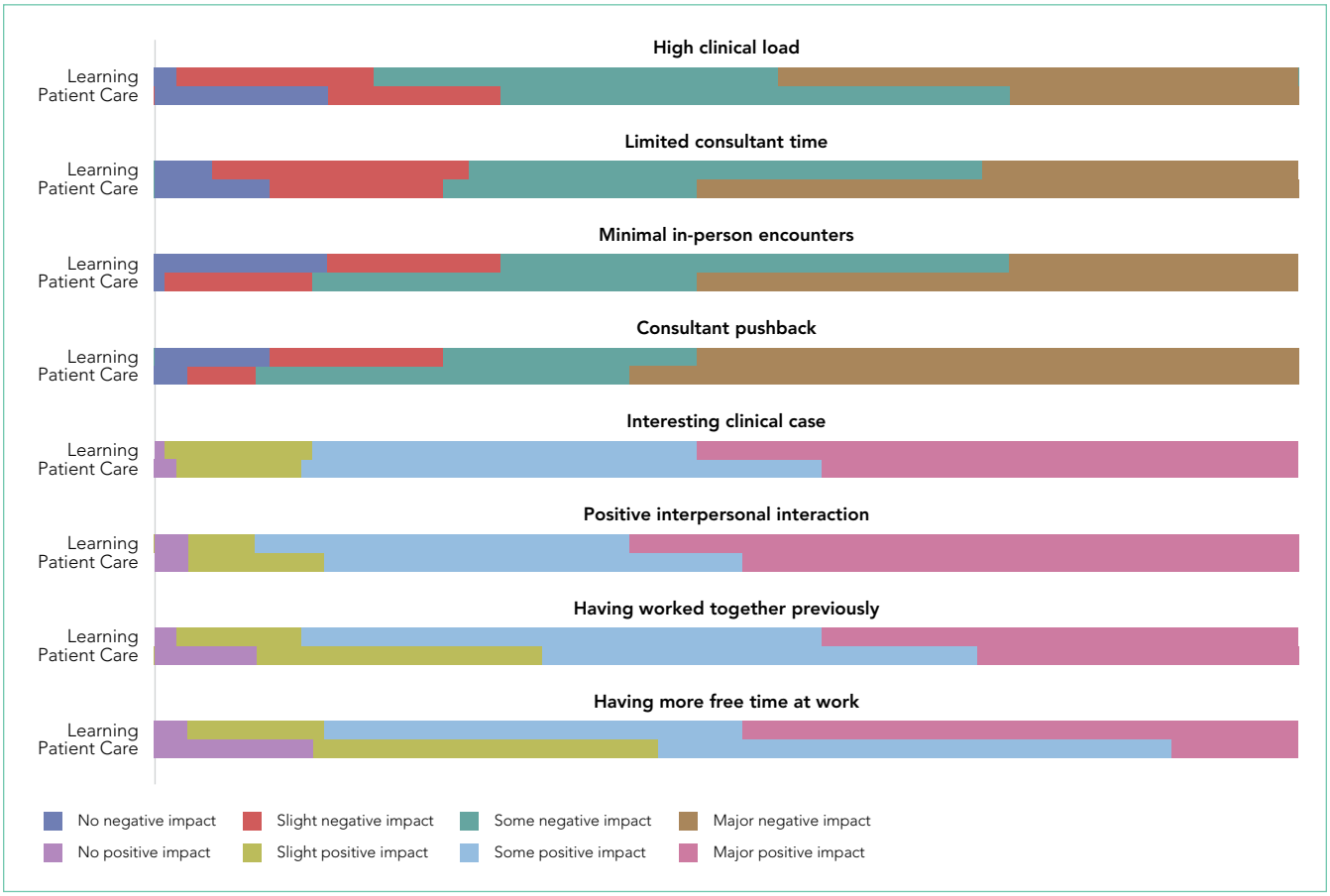

FIG 1. Barriers to and facilitating factors of patient care and hospitalist learning.

on the interaction between hospitalists and internal medicine subspecialty attendings and fellows, outline the hospitalist perspective on consultant interactions and identify a number of factors that are amenable to intervention. We found that hospitalists perceive the consult interaction to be important for patient care and a valuable opportunity for their own learning. In-person communication was seen as an important component of effective consultation but was reported to occur in a minority of consultations. We demonstrate that hospitalist–subspecialty attending consult interactions are perceived more positively than hospitalist–fellow interactions. Finally, we describe barriers and facilitating factors that may inform future interventions targeting this important interaction.

Effective communication between consultants and the primary team is critical for both patient care and teaching interactions.[4-7] Pushback on consultation was reported to be the most significant barrier to hospitalist learning and had a major impact on patient care. Because hospitalists are attending physicians, we hypothesized that they may perceive pushback from fellows less frequently than residents.[4] However, in our study, hospitalists reported pushback to be relatively frequent in their daily practice. Moreover, hospitalists reported a strong preference for in-person interactions with consultants, but our study demonstrated that such interactions are relatively infrequent. Researchers in studies of resident–fellow consult interactions have noted similar findings, suggesting that hospitalists and internal medicine residents face similar challenges during consultation.[4-6] Hospitalists reported that positive interpersonal interactions and personal familiarity with the consultant positively affected the consult interaction. Most importantly, these effects were perceived to affect both hospitalist learning and patient care, suggesting the importance of interpersonal interactions in consultative medicine.

In an era of increasing clinical workload, the consult interaction represents an important workplace-based learning opportunity.[4] Centered on a consult question, the hospitalist–consultant interaction embodies a teachable moment and can be an efficient opportunity to learn because both parties are familiar with the patient. Indeed, survey respondents reported that they frequently learned from consultation, and there was a strong preference for more teaching from consultants in this setting. However, the hospitalist–fellow consult interaction is unique because attending hospitalists are frequently communicating with fellow trainees, which could limit fellows' confidence in their role as teachers and hospitalists' perception of their role as learners. Our study identifies a number of barriers and facilitating factors (including communication, pushback, familiarity, and clinical workload) that affect the hospitalist–consultant teaching interaction and may be amenable to intervention.

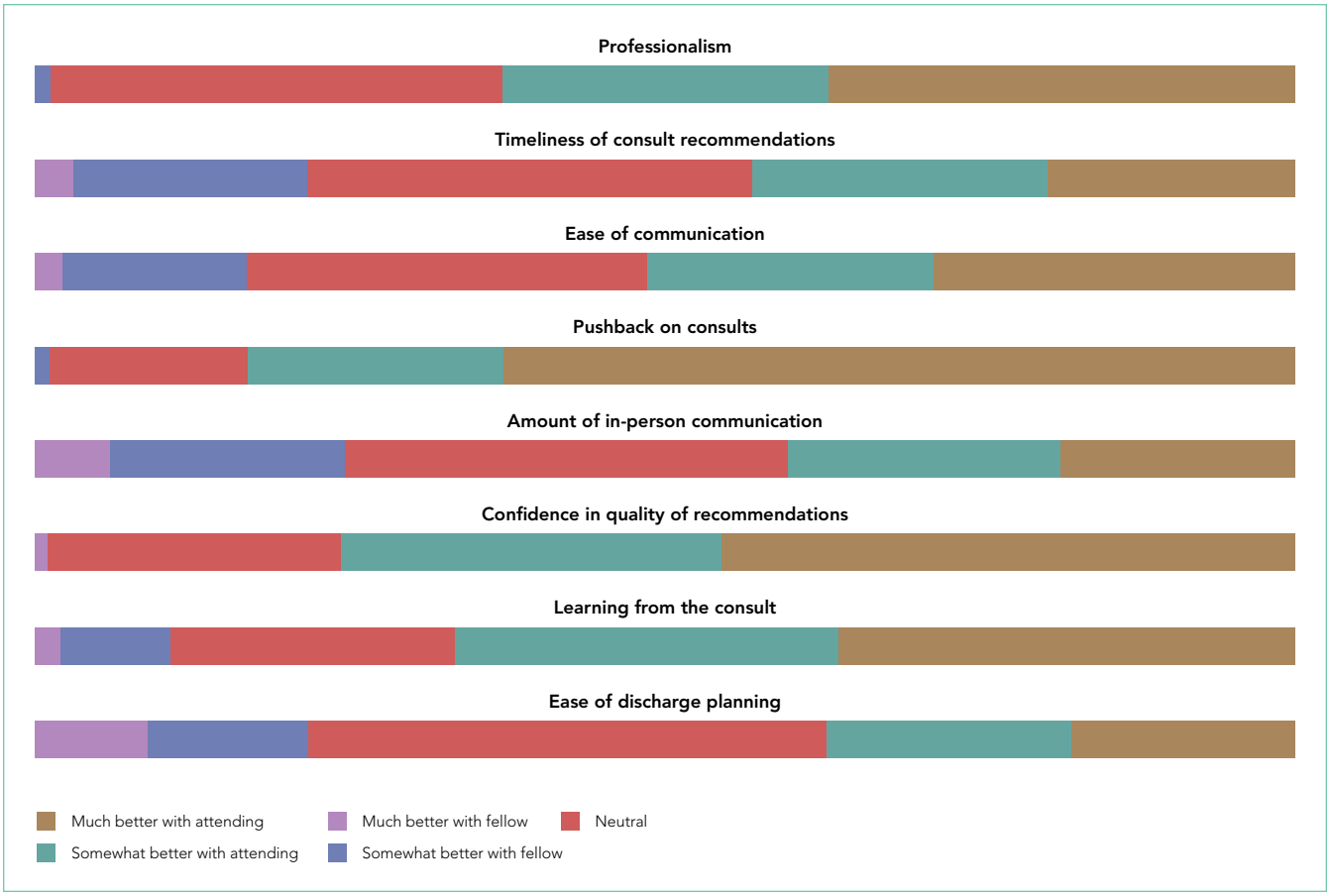

FIG 2. Hospitalist preferences with respect to consult fellows and consult attending physicians.

Hospitalists expressed a consistent preference for interacting with attending subspecialists compared to clinical fellows during consultation. Preference for interaction with attendings was strongest in the areas of pushback, confidence in recommendations, professionalism, and learning from consultation. Some of the factors that relate to consult service structure and fellow experience, such as timeliness of consultation and confidence in recommendations, may not be amenable to intervention. For instance, fellows must first see and then staff the consult with their attending prior to leaving formal recommendations, which makes their communication less timely than that of attending physicians, when they are the primary consultant. However, aspects of the hospitalist–consultant interaction (such as professionalism, ease of communication, and pushback) should not be affected by the difference in experience between fellows and attending physicians. The reasons for such perceptions deserve further exploration; however, differences in incentive structures, workload, and communication skills between fellows and attending consultants may be potential explanations.

Our findings suggest that interventions aimed at enhancing hospitalist–consultant interactions focus on enhancing direct communication and teaching while limiting the perception of pushback. A number of interventions that are primarily focused on instituting a systematic approach to requesting consultation have shown an improvement in resident and medical student consult communication[17,18] as well as resident–fellow teaching interactions.[9] However, it is not clear whether these interventions would be effective given that hospitalists have more experience communicating with consultants than trainees. Given the unique nature of the hospitalist–consultant interaction, multiple barriers may need to be addressed in order to have a significant impact. Efforts to increase direct communication, such as a mechanism for hospitalists to make and request in-person or direct verbal communication about a particular consultation during the consult request, can help consultants prioritize direct communication with hospitalists for specific patients. Familiarizing fellows with hospitalist workflow and the locations of hospitalist workrooms also may promote in-person communication. Fellowship training can focus on enhancing fellow teaching and communication skills,[19-22] particularly as they relate to hospitalists. Fellows in particular may benefit because the hospitalist–fellow teaching interaction may be bidirectional, with hospitalists having expertise in systems practice and quality efforts that can inform fellows' practice. Furthermore, interacting with hospitalists is an opportunity for fellows to practice professional interactions, which will be critical to their careers. Increasing familiarity between fellows and hospitalists through joint events may also serve to enhance the interaction. Finally, enabling hospitalists to provide feedback to fellows stands to benefit both parties because multisource

feedback is an important tool in assessing trainee competence and improving performance.[23] However, we should note that because our study focused on hospitalist perceptions, an exploration of subspecialty fellows' and attendings' perceptions of the hospitalist–consultant interaction would provide additional, important data for shaping interventions.

Strengths of our study include the inclusion of multiple study sites, which may increase generalizability; however, our study has several limitations. The incomplete response rate reduces both generalizability and statistical power and may have created selection or nonresponder bias. However, low response rates occur commonly when surveying medical professionals, and our results are consistent with many prior hospitalist survey studies.[24-26] Further, we conducted our study at a single time point; therefore, we could not evaluate the effect of fellow experience on hospitalist perceptions. However, we conducted our study in the second half of the academic year, when fellows had already gained considerable experience in the consultation setting. We did not capture participants' institutional affiliations; therefore, a subgroup analysis by institution could not be performed. Additionally, our study reflects hospitalist perception rather than objectively measured communication practices between hospitalists and consultants, and it does not include the perspective of subspecialists. The specific needs of nurse practitioners and physicians' assistants, who were excluded from this study, should also be evaluated in future research. Lastly, this is a hypothesis-generating study and should be replicated in a national cohort.

CONCLUSION

The hospitalists represented in our sample population perceived the consult interaction to be important for patient care and a valuable opportunity for their own learning. Participants expressed that they would like to increase direct communication with consultants and enhance consultant–hospitalist teaching interactions. Multiple barriers to effective hospitalist–consultant interactions (including communication, pushback, and hospitalist–consultant familiarity) are amenable to intervention.

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The Epidemiology and Clinical Associations of Portal Vein Thrombosis in Hospitalized Patients With Cirrhosis: A Nationwide Analysis From the National Inpatient Sample

Shawn L. Shah, MD[1], Joseph C. Anderson, MD[2,3], Joseph J. Shatzel, MD[4], Arifa Toor, MD[5], Rolland C. Dickson, MD[5]*

[1]Division of Gastroenterology and Hepatology, NewYork-Presbyterian/Weill Cornell Medical Center, New York, New York; [2]White River Junction Veterans Affairs Medical Center, White River Junction, Vermont; [3]Geisel School of Medicine, Dartmouth-Hitchcock Medical Center, Dartmouth University, Hanover, New Hampshire; [4]Division of Hematology and Medical Oncology, Oregon Health and Science University, Portland, Oregon; [5]Division of Gastroenterology and Hepatology, Mayo Clinic, Phoenix, Arizona.

Portal vein thrombosis (PVT) is thought to be rare in the general population and is most commonly found among patients with cirrhosis.[1-3] The risk of developing PVT in patients with cirrhosis has been correlated with the severity of hepatic impairment.[4,5] There is a lack of national-level data on the epidemiology of PVT and its related outcomes in the inpatient setting. The aim of our study was to describe the prevalence of PVT in hospitalized patients with cirrhosis in the United States. Using the National Inpatient Sample (NIS) database, we described the differences in hepatic decompensation, length of stay, in-hospital mortality, and total charges between patients with cirrhosis with PVT and those without.

METHODS

This study was performed using the 2012 NIS to assess the relationship between PVT and cirrhosis-related outcomes. The NIS has been used reliably to make national estimates of healthcare utilization and estimate disease burden, charges, and outcomes.[6] All admissions with either a primary or secondary discharge diagnosis of an *International Classification of Diseases, 9th Revision–Clinical Modification* (ICD-9-CM) code for PVT (452) and cirrhosis (571.2, 571.5, and 571.6) were identified from the NIS and correlated with age, gender, inpatient length of stay, in-hospital mortality, total charges, and commonly associated diagnoses. Complications of cirrhosis, such as hepatic encephalopathy (572.2), abdominal ascites (789.5), and gastrointestinal bleeding (456 and 456.2), were also identified. Data were assessed using IBM Statistical Package for the Social Sciences Statistics version 19.0 (Chicago, IL). Statistical significance was defined as a P value < .05.

RESULTS

There were 7,296,968 total unweighted admissions in the 2012 NIS, which included 113,766 (1.6%) inpatient admissions for cirrhosis, with 61,867 for nonalcoholic cirrhosis, 49,698 for alcoholic cirrhosis, and 2202 for biliary cirrhosis. The prevalence of PVT among all inpatient admissions was 0.07% (n = 5046) and 1.8% (n = 2046) in patients with cirrhosis (P < .001). On univariate analysis, patients who had a diagnosis of both cirrhosis and PVT had higher proportions of hepatic encephalopathy (22.5% vs 17.7%; P < .00001) as well as gastrointestinal bleeding (11.6% vs 5.7%; P < .00001) as compared with patients with cirrhosis without PVT (Figure). Furthermore, patients with both cirrhosis and PVT incurred a greater average length of stay than did patients with cirrhosis and no PVT (7.7 vs 5.9 days, respectively; P < .05) and in-hospital mortality (9.5 vs 6%, respectively; P < .05). The median cost of an admission of a patient with cirrhosis and PVT was $39,934 as compared to $28,040 for an admission of a patient with cirrhosis without PVT (P < .05).

DISCUSSION

We found that hospitalized patients with concurrent diagnoses of cirrhosis and PVT had longer hospital length of stay, higher mean hospital charges, and a higher proportion of cirrhosis-related complications. Our study represents the largest examination of hospitalized patients with cirrhosis and PVT to date and contributes to the evolving understanding of PVT in end-

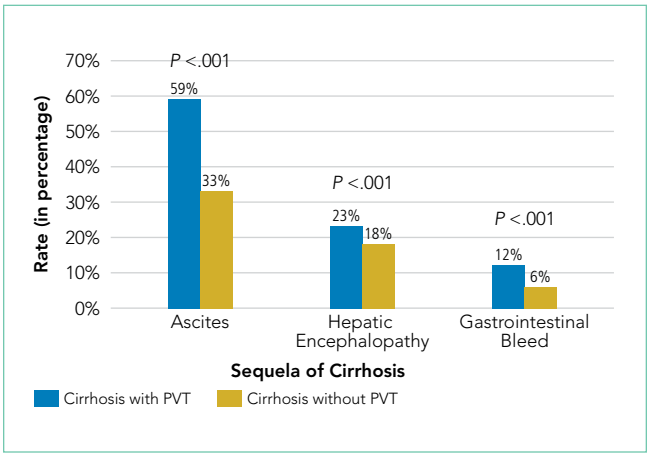

FIG. Primary outcome comparing rates of hepatic decompensation between admissions for patients with cirrhosis with PVT and those without.

***Address for correspondence:** Rolland C. Dickson, MD, 5777 East Mayo Boulevard, Phoenix, AZ, 85064; Telephone: 480-301-6990; Fax: 480-342-1569; E-mail: Dickson.Rolland1@mayo.edu

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stage liver disease. The relationship between cirrhotic complications and PVT may be independent, but the 2 have similar underlying etiologic processes. Thus, given our findings, intervening to address the underlying factors leading to microvascular and/or PVT or mitigating the propagation of PVT in patients with cirrhosis may be beneficial to reducing morbidity and mortality in these patients. In addition, the prevalence of PVT in the overall hospitalized patient population in our study (0.07%) was similar to the 0.05% to 0.5% previously described in a US autopsy series, which should decrease the likelihood that PVT was missed in the cirrhotic population, which is more likely to have inpatient ultrasound imaging.[2] Our study is limited by its retrospective nature, dependency on ICD-9-CM codes for extracting data, and lack of clinical, physical exam, and laboratory results to allow for the calculation of a model for the end-stage liver disease and Child-Pugh score. Also, the study was not designed to evaluate causation, and it is possible that patients with more severe cirrhosis were more likely to be diagnosed with PVT. Further prospective studies directed not only toward the mechanism and treatment of both micro- and macrovascular thrombosis but also at examining the prevention of PVT and attendant benefits are greatly needed.

Disclosures: The authors have nothing to disclose. The contents of this work do not represent the views of the Department of Veterans Affairs or the United States Government.

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Days of Therapy Avoided: A Novel Method for Measuring the Impact of an Antimicrobial Stewardship Program to Stop Antibiotics

Siddhant Datta, MD[1], Mary Staicu, PharmD[2], Mary Lourdes Brundige, PharmD[2], Youssef Soliman, MD[3], Maryrose Laguio-Vila, MD[4]*

[1]*Department of Infectious Diseases, Washington University, St. Louis, Missouri;* [2]*Department of Pharmacy, Rochester General Hospital, Rochester, New York;* [3]*Department of Internal Medicine, Rochester General Hospital, Rochester, New York;* [4]*Department of Infectious Diseases, Rochester General Hospital, Rochester, New York.*

A proposed metric to quantify the impact of an antimicrobial stewardship program (ASP) is using changes in the antibiotic days of therapy (DOT) per 1000 patient-days, which is the total number of days any dose of an antibiotic is administered during a specified time period, standardized by the number of patient-days.[1] Although DOT is useful for comparing antibiotic use among hospitals or time periods, this metric is a composite result of an ASP's often multifaceted approach to improving antibiotic use. Thus, DOT provides a loose estimate of the direct impact of specific ASP activities and does not quantify the amount of antibiotics directly avoided or direct cost savings on the patient level. To ameliorate this, we reviewed our institution's ASP prospective audit and feedback (PAF) and applied a novel metric, days of therapy avoided (DOTA), to calculate the number of antibiotic days avoided that directly result from our ASP's actions targeting antibiotic stoppage. From DOTA, we also calculate attributable cost savings.

METHODS

As approved by the institutional review board, this was a retrospective chart review of electronic records performed at Rochester General Hospital (RGH) in Rochester, New York, a 528-bed, acute-care, community teaching hospital. The RGH ASP began in 2012 with 1 infectious diseases physician and 2 infectious diseases pharmacists, who conducted daily verbal and/or written PAF progress notes within the electronic medical record. In 2013, the ASP team developed a database to document PAF activities. The variables and definitions used are summarized in the Table. When no planned length of therapy (LOT) was documented, an LOT range (based on national guidelines or, when unavailable, local practices) for the documented infection was assumed.[2-9] This database was used to collect records on patients who received written ASP recommendations for no infection (NI) or therapy complete (TC; Table) antibiotic stoppage between January 2013 and December 2016. Only written and accepted interventions (changes occurring within 48 hours of the ASP note) were included in the data set.

To quantify the direct impact of PAF, DOTA (Table) was calculated. Antibiotic costs avoided were calculated by multiplying the average wholesale price (AWP) per day (range: $0.44-$534; mean: $67.85) by DOTA. This calculation was done twice under 2 assumptions: that PAF led to the prevention of (1) 1 more day of antibiotic prescription and (2) the remainder of the documented or assumed LOT.

RESULTS

Over 4 years, the ASP made 1594 interventions to stop antibiotics. Accepted interventions totaled 1151 (72%): 513 (44.5%) for NI and 638 (55.4%) for TC, involving 431 and 575 unique patients, respectively. Nearly half (45.8%) of the NI interventions targeted asymptomatic bacteriuria, whereas respiratory tract infections were the most common (42.2%) indication for the TC intervention.

Under the most conservative assumption that each accepted PAF recommendation avoided 1 day of unnecessary antibiotics, we estimated a total of 1151 DOTA; 690 (59.9%) were intravenous antibiotics. The average DOT on which the PAF note was written was 3.07 ± 1.69 for NI and 6.38 ± 2.73 for TC. A planned LOT was documented for only 36.7% of the courses. On the basis of documented or assumed LOT, we estimate that the NI and TC interventions led to between 1077 and 2826 DOTA and between 397 and 1598 DOTA, respectively. Potential fluoroquinolone DOTA ranged from 300 to 1126; for third- and fourth-generation cephalosporins, there were 314 to 1017 DOTA.

Using the conservative estimate of 1151 DOTA, the costs avoided totaled $16,700, which includes $10,700 for intravenous antibiotics. When the AWP per day of each antibiotic was applied to the remaining LOTs avoided, the maximum potential cost savings was $67,100. Additional cost savings may have been realized if indirect expenses, such as pharmacy preparation and nursing administration time or costs of medical supplies, were evaluated.

CONCLUSION

We investigated DOTA as a measure of the direct patient-level and intervention-specific impact of an ASP's PAF. DOTA may be useful for ASPs with limited access to an electronic record or electronically generated DOT reports because DOTA and

***Address for correspondence:** Maryrose Laguio-Vila, MD, 1425 Portland Avenue, Box 246, Rochester, NY 14621; Telephone: 585-922-4003; Fax: 585-922-5168; E-mail: maryrose.laguiovila@rochesterregional.org

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TABLE. **ASP Database, Variables, Standards, and Definitions**

Database Variables
Antibiotic name and/or route
Infectious indication
DOT on which ASP note written
Planned DOT by primary team
Planned LOT Standards if not Documented by Primary Team
Uncomplicated urinary tract: 3-7 days
Skin and soft tissue: 7-14 days
Intraabdominal: 7-10 days
Respiratory tract: 5-10 days
Bloodstream: 10-14 days
Unknown and/or empiric: 3-10 days
Clostridium difficile: 10-14 days
Definitions for Antibiotic Stoppage Indications Resulting from ASP Review
NI: antibiotics prescribed but not clinically indicated
TC: antibiotics prescribed for a specific infectious cause, but documented planned LOT was longer than recommended by guidelines, and there were no objective signs of continued infection
Definition for Antibiotics DOTA
Difference between DOT on which the ASP recommendation was accepted subtracted from the planned, documented LOT or standard LOT range when not documented

NOTE: Abbreviations: ASP, antibiotic stewardship program; DOTA, days of therapy avoided; LOT, length of therapy; NI, no infection; TC, therapy complete.

cost savings can be tracked manually and prospectively with each accepted intervention. DOTA can also help ASPs identify which clinical conditions are responsible for the most antibiotic overuse, and thus may benefit from the development of clinical treatment guidelines. We found that the highest yield areas for DOTA were targeting asymptomatic bacteriuria (NI) and respiratory infections (TC). In doing so, these have also succeeded in reducing high-risk, broad-spectrum antimicrobials, such as fluoroquinolones and advanced-generation cephalosporins. Further research is needed to assess if DOTA correlates with other ASP metrics and clinical outcomes; however, current evidence supports that reducing unnecessary antibiotic use is fundamental to reducing antibiotic resistance and adverse events.[10]

The limitations of measuring DOTA include time consumption, particularly if not collected prospectively. However, we make several conclusions. ASP PAF stopping antibiotics was well accepted and reduced antibiotic use. Second, calculating DOTA requires little technology and only knowledge of the planned LOT and drug costs. DOTA also identifies which infectious indications to focus PAF efforts on and gain the greatest impact. Overall, DOTA is a simple, useful, and promising measurement of the direct antibiotic and economic impacts of specific ASP PAF and warrants further investigation as an ASP metric.

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When are Oral Antibiotics a Safe and Effective Choice for Bacterial Bloodstream Infections? An Evidence-Based Narrative Review

Andrew J. Hale, MD[1,2*], Graham M. Snyder, MD, SM[3,4], John W. Ahern, PharmD[5,6], George Eliopoulos, MD[3,4], Daniel N. Ricotta, MD[4,7], W. Kemper Alston, MD, MPH[1,2]

[1]Department of Infectious Diseases,University of Vermont Medical Center, Burlington, Vermont; [2]Department of Medicine, Larner College of Medicine at the University of Vermont, Burlington, Vermont; [3]Infectious Diseases, Beth Israel Deaconess Medical Center, Boston, Massachusetts; [4]Department of Medicine, Harvard Medical School, Boston, Massachusetts; [5]Department of Pharmacy, University of Vermont Medical Center, Burlington, Vermont; [6]Larner College of Medicine at the University of Vermont, Burlington, Vermont; [7]Hospitalist, Beth Israel Medical Center, Boston, Massachusetts.

Bacterial bloodstream infections (BSIs) are a major cause of morbidity and mortality in the United States. Traditionally, BSIs have been managed with intravenous antimicrobials. However, whether intravenous antimicrobials are necessary for the entirety of the treatment course in BSIs, especially for uncomplicated episodes, is a more controversial matter. Patients that are clinically stable, without signs of shock, or have been stabilized after an initial septic presentation, may be appropriate candidates for treatment of BSIs with oral antimicrobials. There are risks and costs associated with extended courses of intravenous agents, such as the necessity for long-term intravenous catheters, which entail risks for procedural complications, secondary infections, and thrombosis. Oral antimicrobial therapy for bacterial BSIs offers several potential benefits. When selected appropriately, oral antibiotics offer lower cost, fewer side effects, promote antimicrobial stewardship, and are easier for patients. The decision to use oral versus intravenous antibiotics must consider the characteristics of the pathogen, the patient, and the drug. In this narrative review, the authors highlight areas where oral therapy is a safe and effective choice to treat bloodstream infection, and offer guidance and cautions to clinicians managing patients experiencing BSI. *Journal of Hospital Medicine* 2018;13:328-335. Published online first February 27, 2018. © 2018 Society of Hospital Medicine

Bacterial bloodstream infections (BSIs) are a major cause of morbidity and mortality in the United States. Approximately 600,000 BSI cases occur annually, resulting in 85,000 deaths,[1] at a cost exceeding $1 billion.[2] Traditionally, BSIs have been managed with intravenous antimicrobials, which rapidly achieve therapeutic blood concentrations, and are viewed as more potent than oral alternatives. Indeed, for acutely ill patients with bacteremia and sepsis, timely intravenous antimicrobials are lifesaving.[3]

However, whether intravenous antimicrobials are essential for the entire treatment course in BSIs, particularly for uncomplicated episodes, is controversial. Patients that are clinically stable or have been stabilized after an initial septic presentation may be appropriate candidates for treatment with oral antimicrobials. There are costs and risks associated with extended courses of intravenous agents, such as the necessity for long-term intravenous catheters, which entail risks for procedural complications, secondary infections, and thrombosis. A prospective study of 192 peripherally inserted central catheter (PICC) episodes reported an overall complication rate of 30.2%, including central line-associated BSIs (CLABSI) or venous thrombosis.[4] Other studies also identified high rates of thrombosis[5] and PICC-related CLABSI, particularly in patients with malignancy, where sepsis-related complications approach 25%.[6] Additionally, appropriate care of indwelling catheters requires significant financial and healthcare resources.

Oral antimicrobial therapy for bacterial BSIs offers several potential benefits. Direct economic and healthcare workforce savings are expected to be significant, and procedural and catheter-related complications would be eliminated.[7] Moreover, oral therapy provides antimicrobial stewardship by reducing the use of broad-spectrum intravenous agents.[8] Recent infectious disease "Choosing Wisely" initiatives recommend clinicians "prefer oral formulations of highly bioavailable antimicrobials whenever possible",[9] and this approach is supported by the Centers for Disease Control and Prevention antibiotic stewardship program.[10] However, the expected savings and benefits of oral therapy would be lost should they be less effective and result in treatment failure or relapse of the primary BSI. Pathogen susceptibility, gastrointestinal absorption, oral bioavailability, patient tolerability, and adherence with therapy need to be carefully considered before choosing oral antimicrobials. Thus, oral antimicrobial therapy for BSI should be utilized in carefully selected circumstances.

In this narrative review, we highlight areas where oral therapy is safe and effective in treating bloodstream infections, as well

***Address for Correspondence:** Andrew Hale, MD, University of Vermont Medical Center, Infectious Disease Unit, 111 Colchester Avenue, Mailstop 115 SM2. Burlington, VT 05401; Telephone: 802-847-2264; Fax: 802-847-5322; E-mail: Andrew.Hale@UVMhealth.org

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TABLE 1. **Penetration of Select Oral Antimicrobials to Tissue Sites**[7,44]

Antimicrobial	Bloodstream Bioavailability	Lung	Liver	Urinary Tract	Prostate	Bone	GI	Skin	Bile	CSF	Synovial
Ciprofloxacin	70%	++	+++	+++	+++	+++	+++	+++	+++	+	+++
Levofloxacin	99%	+++	+++	+++	+++	+++	+++	+++	+++	+	+++
Moxifloxacin	90%	+++	+++	+++	+++	+++	+++	+++	+++	+	+++
Trimethoprim-Sulfamethoxazole	90%	++	++	+++	++	++	++	+++	++	+	++
Doxycycline	95%	++	++	++	++	++	++	++	++	+	++
Minocycline	95%	++	++	++	++	++	++	++	++	+	++
Linezolid	99%	+++	++	+++	++	++	++	+++	++	++	++
Metronidazole	90%	++	+++	++	++	++	++	++	++	++	++
Clindamycin	90%	++	++	++	++	++	++	++	++	+	++
Ampicillin	50%	+	++	++	+	++	++	++	++	++	+
Penicillin V	50%	++	++	++	+	++	++	++	++	++	+
Amoxicillin	85%	+	++	++	+	++	++	++	++	++	+
Cephalexin	60%	++	++	++	++	++	++	++	++	+	++

+++ Tissue concentrations equal to or higher than serum concentrations

++ Tissue concentrations at least 50% of the serum concentrations

\+ Tissue concentrations less than 50% of the serum concentrations

Bioavailability represents the percentage of the dose that reaches systemic circulation. Tissue penetration reflects the drug movement from the vascular to the interstitial and intracellular compartments of a particular body site. Drugs passively diffuse through fenestrated capillaries into the interstitial compartment of most tissues. However, some tissue sites (eg, the brain and prostate) contain nonfenestrated capillaries and/or active transport pumps that prevent entry or remove the drug. Tissue concentrations are methodologically dependent on the various techniques used in their quantification, and, in some body sites, are influenced by the presence or absence of inflammation (eg, brain tissue). Thus, the values presented here are best approximations.

as offer guidance to clinicians managing patients experiencing BSI. Given the lack of robust clinical trials on this subject, the evidence for performing a systematic review was insufficient. Thus, the articles and recommendations cited in this review were selected based on the authors' experiences to represent the best available evidence.

INFECTION SOURCE CONTROL

Diagnosing the source of a patient's BSI is vital to successful treatment for 2 reasons. First, without achieving source control, antimicrobial therapy of any sort is more likely to fail.[7] For example, patients with *Staphylococcus aureus* abscess and persistently positive blood cultures despite intravenous antimicrobials require drainage. Similarly, patients with a CLABSI typically benefit from removal of the foreign body.[11] Second, particular oral antibiotics have different penetration levels into various tissues (Table 1).[12] For instance, if a patient has meningitis due to *Streptococcus pneumoniae* with concurrent BSI, doxycycline would be an inferior choice, despite having good bioavailability and achieving high blood concentrations, because it poorly penetrates the central nervous system. An oral regimen must adequately penetrate the source of infection.

PATHOGEN AND ANTIMICROBIAL FACTORS

Several important factors regarding the BSI pathogen should be considered when deciding on oral versus intravenous therapy, as follows: 1) organism speciation and susceptibilities should be available; 2) the pathogen should be susceptible to an oral antimicrobial with high bioavailability that achieves adequate blood and source-tissue concentrations; 3) the candidate antibiotic should have a high barrier to acquired resistance for the pathogen. For example, although *S. aureus* is often susceptible to rifampin, it has a low genetic barrier to resistance; thus, rifampin monotherapy is not recommended; and 4) the selected agent should generally be well-tolerated and have an acceptable safety profile. Table 2 summarizes the characteristics of several key antibiotics.

PATIENT FACTORS

Although the causative pathogen may be susceptible to an oral antibiotic with favorable pharmacokinetics, several patient factors need to be considered. The patient should: 1) have no allergies or intolerances to the selected agent; 2) be physically able to swallow the medication or have a working gastric or jejunal tube in place, as well as have no significant impairment in gastrointestinal absorption; 3) have a history of adherence to oral therapy, particularly if the regimen is dosed multiple times per day, and should be appropriately educated and able to demonstrate understanding of the importance of adherence; 4) take no other medications that may significantly interact with the antibiotic; and 5) be able to immediately access the oral agent upon discharge from the hospital. Some medical facilities are able to provide new medications to the patient before discharge, ensuring availability of oral antibiotic therapy as an

TABLE 2. **Selected Oral Antibiotics**

Antibiotic	Typical Oral Dose[a]	Dietary Interaction	Notable Side Effects	Approx. Cost per Day[b]
Ciprofloxacin	500–750 mg BID	Decreased by concurrent calcium/magnesium/aluminum intake. Take 2 hours before or 6 hours after intake of antacids, dairy, or calcium-fortified food.	Black Box Warning: potentially irreversible serious adverse reactions include tendinitis, tendon rupture, peripheral neuropathy, and CNS effects QTc interval prolongation Hypoglycemia	$10.90
Levofloxacin	500–750 mg daily			$24.61
Moxifloxacin	400 mg daily	No recommendations		$26.77
Linezolid	600 mg BID	Concurrent ingestion of foods rich in certain amino acids (eg, tyramine) such as red wine or aged cheese can precipitate hypertensive crisis	Myelosuppression Serotonin syndrome (avoid other proserotonergic drugs) Peripheral/optic neuropathy	$366.00
Metronidazole	500 mg TID	No recommendations	Black Box Warning: possibly carcinogenic (based on animal data) Disulfiram reaction with alcohol use Neurotoxicity	$4.02
Trimethoprim-sulfamethoxazole	160 mg/800 mg (DS tablet) 1–2 tablets BID	No recommendations	Hypersensitivity to sulfa-drugs Blood dyscrasias Severe dermatologic reactions Hyperkalemia	$2.18
Clindamycin	300–450 mg QID	Take with food	Black Box Warning: Risk for severe *C. difficile* infection Gastrointestinal upset Large pill with unpleasant taste	$9.52
Doxycycline	100 mg BID	Decreased by concurrent calcium and/or high-fat foods and high gastric pH. Avoid taking with antacids, dairy, or calcium-fortified food.	Photosensitivity Esophagitis if not taken with water	$12.30
Minocycline		No recommendations	Photosensitivity Esophagitis if not taken with water Autoimmune syndromes Hyperpigmentation Vertigo	$6.79
Most β-lactams such as ampicillin or dicloxacillin	Not typically recommended for BSI	Penicillin should be taken on an empty stomach	N/A	N/A
Amoxicillin	1g TID	No recommendations	Hypersensitivity Rash	$2.98
Cephalexin	Not typically recommended for BSI	N/A	N/A	N/A

White denotes best evidence for treating select BSIs.

Light yellow denotes antimicrobials with a good bioavailability profile, but minimal data for use in BSI.

Dark yellow denotes antimicrobials with a poor bioavailability profile; these are included to highlight the risks of using such agents for BSI.

[a]Assuming normal renal function. Unless bioavailability is 100%, the doses recommended here, in the context of treating BSI, are often higher than for other indications, given the need to achieve adequate blood concentrations. Doses adapted from reference 44.

[b]Cost per day based on the 2017 average wholesale price (AWP). AWP refers to the average price pharmacies pay for drugs from their wholesale distributors. The price that patients pay will vary depending upon prescription markups and insurance coverage, although in most instances, AWP would be the bare minimum.

outpatient.[13] 6) Finally, the patient should be available for close follow-up. Table 3 summarizes the patient factors to consider.

EVIDENCE REGARDING BLOODSTREAM INFECTIONS DUE TO GRAM-NEGATIVE RODS

BSIs due to gram-negative rods (GNRs) are common and cause significant morbidity and mortality. GNRs represent a broad and diverse array of pathogens. We focus on the *Enterobacteriaceae* family and *Pseudomonas aeruginosa*, because they are frequently encountered in clinical practice.[1]

Gram-Negative Rods, *Enterobacteriaceae* Family

The *Enterobacteriaceae* family includes *Escherichia coli*, *Klebsiella*, *Salmonella*, *Proteus*, *Enterobacter*, *Serratia*, and *Citrobacter* species. The range of illnesses caused by *Enterobacteriaceae* is as diverse as the family, encompassing most body sites.

TABLE 3. **Checklist for Using an Oral Antibiotic for Bloodstream Infection**

Bacterial/Antimicrobial Factors	
[ ]	Speciation and susceptibilities are available
[ ]	Susceptibilities indicate an oral antibiotic is effective against the pathogen
[ ]	Oral agent is highly bioavailable
[ ]	Oral agent has a low acquired-resistance potential for the given pathogen
[ ]	Oral agent is well-tolerated and has an acceptable safety profile for the patient (Table 2)
[ ]	No serious drug–drug interactions between the selected agent and other medications
Patient Factors	
[ ]	No allergies or intolerances to the selected agent
[ ]	No impaired gastrointestinal absorption
[ ]	Hemodynamically stable
[ ]	Minimal compliance concerns
[ ]	Patient has received appropriate education and demonstrated understanding regarding importance of compliance
[ ]	Dietary interactions considered (Table 2)
[ ]	Underlying source of bloodstream infection identified and controlled
[ ]	Upon discharge, patient has access to the oral agent
[ ]	• The pharmacy has the agent available
[ ]	• The patient is able to get medication from pharmacy before the next dose is due
[ ]	• Medication copay at the pharmacy is affordable
[ ]	Available for follow-up

Although most *Enterobacteriaceae* are intrinsically susceptible to antibiotics, there is potential for significant multi-drug resistance. Of particular recent concern has been the emergence of *Enterobacteriaceae* that produce extended-spectrum β-lactamases (ESBL) and even carbapenem-resistant strains.[14]

However, *Enterobacteriaceae* species susceptible to oral antimicrobials are often suitable candidates for oral BSI therapy. Among 106 patients with GNR BSI treated with a highly bioavailable oral antibiotic (eg, levofloxacin), the treatment failure rate was only 2% (versus 14% when an antimicrobial with only moderate or low bioavailability was selected).[15] Oral treatment of *Enterobacteriaceae* BSIs secondary to urinary tract infection has been best studied. A prospective randomized, controlled trial evaluated oral versus intravenous ciprofloxacin amongst 141 patients with severe pyelonephritis or complicated urinary tract infections, in which the rate of bacteremia was 38%.[16] Notably, patients with obstruction or renal abscess were excluded from the trial. No significant differences in microbiological failure or unsatisfactory clinical responses were found between the IV and oral treatment groups. Additionally, a Cochrane review reported that oral antibiotic therapy is no less effective than intravenous therapy for severe UTI, although data on BSI frequency were not provided.[17]

Resistance to fluoroquinolones such as ciprofloxacin has been identified as a risk factor for GNR BSI oral treatment failure, highlighting the importance of confirming susceptibilities before committing to an oral treatment plan.[18,19] Even ESBL *Enterobacteriaceae* can be considered for treatment with fluoroquinolones if susceptibilities allow.[20]

The ideal duration of therapy for GNR BSI is an area of active research. A recent retrospective trial showed no difference in all-cause mortality or recurrent BSI in GNR BSI treated for 8 versus 15 days.[21] A recent meta-analysis suggested that 7 days of therapy was noninferior to a longer duration therapy (10–14 days) for pyelonephritis, in which a subset was bacteremic.[22] However, another trial reported that short course therapy for GNR BSI (<7 days) is associated with higher risk of treatment failure.[22] Further data are needed.

Gram-Negative Rods, *Pseudomonas aeruginosa*

Pseudomonas aeruginosa is a common pathogen, intrinsically resistant to many antimicrobials, and readily develops antimicrobial resistance during therapy. Fluoroquinolones (such as ciprofloxacin, levofloxacin, and delafloxacin) are the only currently available oral agents with antipseudomonal activity. However, fluoroquinolones may not achieve blood concentrations appropriate for *P. aeruginosa* treatment at standard doses, while higher dose regimens may be associated with increased risk for undesirable side effects.[24,25] Currently, given the minimal trial data comparing oral versus intravenous therapy for *P. aeruginosa* BSIs, and multiple studies indicating increased mortality when *P. aeruginosa* is treated inappropriately,[26,27] we prefer a conservative approach and consider oral therapy a less-preferred option.

EVIDENCE REGARDING BLOODSTREAM INFECTIONS DUE TO GRAM-POSITIVE COCCI

The majority of bloodstream infections in the United States, and the resultant morbidity and mortality, are from gram-positive cocci (GPCs) such as *Staphylococcus*, *Streptococcus*, and *Enterococcus* species.[1]

Gram-Positive Cocci, *Streptococcus pneumoniae*

Of the approximately 900,000 annual cases of *S. pneumoniae* infection in the United States, approximately 40,000 are complicated by BSI, with 70% of those cases being secondary to pneumococcal pneumonia.[28] In studies on patients with pneumococcal pneumonia, bacteremic cases generally fare worse than those without bacteremia.[29,30] However, several trials demonstrated comparable outcomes in the setting of bacteremic pneumococcal pneumonia when switched early (within 3 days) from intravenous to oral antibiotics to complete a 7-day course.[31,32] Before pneumococcal penicillin resistance became widespread, oral penicillin was shown to be effective, and remains an option for susceptible strains.[33] It is worth noting, however, that other trials have shown a mortality benefit from treating bacteremic pneumococcal pneumonia initially with dual-therapy including a β-lactam and macrolide such as azithromycin. This observation highlights the importance

of knowing the final susceptibility data prior to consolidating to monotherapy with an oral agent, and that macrolides may have beneficial anti-inflammatory effects, though further research is needed.[34,35]

Although the evidence for treating bacteremic pneumococcal pneumonia using a highly active and absorbable oral agent is fairly robust, *S. pneumoniae* BSI secondary to other sites of infection sites is less well studied and may require a more conservative approach.

Gram-Positive Cocci, β-hemolytic Streptococcus species

β-Hemolytic *Streptococci* include groups A to H, of which groups A (*S. pyogenes*) and B (*S. agalactiae*) are the most commonly implicated in BSIs.[36] Group A *Streptococcus* (GAS) is classically associated with streptococcal pharyngitis and Group B *Streptococcus* (GBS) is associated with postpartum endometritis and neonatal meningitis, though both are virulent organisms with a potential to cause invasive infection throughout the body and in all age-groups. Up to 14% of GAS and 41% GBS BSIs have no clear source;[37,38] given these are skin pathogens, such scenarios likely represent invasion via microabrasion. As β-hemolytic streptococcal BSI is often observed in the context of necrotizing skin and soft tissue infections, surgical source control is particularly important.[39] GAS remains exquisitely susceptible to penicillin, and intravenous penicillin remains the mainstay for invasive disease; GBS has higher penicillin resistance rates than GAS.[40] Clindamycin should be added when there is concern for severe disease or toxic shock.[41] Unfortunately, oral penicillin is poorly bioavailable (approximately 50%), and there has been recent concern regarding inducible clindamycin resistance in GAS.[42] Thus, oral penicillin V and/or clindamycin is a potentially risky strategy, with no clinical trials supporting this approach; however, they may be reasonable options in selected patients with source control and stable hemodynamics. Amoxicillin has high bioavailability (85%) and may be effective; however, there is lack of supporting data. Highly bioavailable agents such as levofloxacin and linezolid have GAS and GBS activity[43] and might be expected to produce satisfactory outcomes. Because no clinical trials have compared these agents with intravenous therapy for BSI, caution is advised. Although bacteriostatic against *Staphylococcus*, linezolid is bactericidal against *Streptococcus*.[44] Fluoroquinolone resistance amongst β-hemolytic *Streptococcus* is rare (approximately 0.5%) but does occur.[45]

Gram-Positive Cocci, *Staphylococcus* Species

Staphylococcus species include *S. aureus* (including methicillin susceptible and resistant strains: MSSA and MRSA, respectively) and coagulase-negative species, which include organisms such as *S. epidermidis*. *S. aureus* is the most common cause of BSI mortality in the United States,[1] with mortality rates estimated at 20%–40% per episode.[46] Infectious disease consultation has been associated with decreased mortality and is recommended.[47] The guidelines of the Infectious Diseases Society of America for the treatment of MRSA recommend the use of parenteral agents for BSI.[48] It is important to consider if a patient with *S. aureus* BSI has infective endocarditis.

Oral antibiotic therapy for *S. aureus* BSI is not currently standard practice. Although trimethoprim-sulfamethoxazole (TMP-SMX) has favorable pharmacokinetics and case series of using it successfully for BSI exist,[49] TMP-SMX showed inferior outcomes in a randomized trial comparing oral TMP-SMX with intravenous vancomycin in a series of 101 *S. aureus* infections.[50] This observation has been replicated.[51] Data on doxycycline or clindamycin for *S. aureus* BSI are limited, and IDSA guidelines advise against their use in this setting because they are predominantly bacteriostatic.[48] Linezolid has favorable pharmacokinetics, with approximately 100% bioavailability, and *S. aureus* resistance to linezolid is rare.[52] Several randomized trials have compared oral linezolid with intravenous vancomycin for *S. aureus* BSI; for instance, Stevens et al. randomized 460 patients with *S. aureus* infection (of whom 18% had BSI) to linezolid versus vancomycin and observed similar clinical cure rates.[53] A pooled analysis showed oral linezolid was noninferior to vancomycin specifically for *S. aureus* BSI.[54] However, long-term use is often limited by hematologic toxicity, peripheral or optic neuropathy (which can be permanent), and induced serotonin syndrome. Additionally, linezolid is bacteriostatic, not bactericidal against *S. aureus*. Using oral linezolid as a first-line option for *S. aureus* BSI would not be recommended; however, it may be used as a second-line treatment option in selected cases. Tedizolid has similar pharmacokinetics and spectrum of activity with fewer side effects; however, clinical data on its use for *S. aureus* BSI are lacking.[55] Fluoroquinolones such as levofloxacin and the newer agent delafloxacin have activity against *S. aureus*, including MRSA, but on-treatment emergence of fluoroquinolone resistance is a concern, and data on delafloxacin for BSI are lacking.[56,57] Older literature suggested the combination of ciprofloxacin and rifampin was effective against right-sided *S. aureus* endocarditis,[58] and other oral fluoroquinolone-rifamycin combinations have also been found to be effective[59] However, this approach is currently not a standard therapy, nor is it widely used. Decisions on the duration of therapy for *S. aureus* BSI should be made in conjunction with an infectious diseases specialist; 14 days is currently regarded as a minimum.[47,48]

Published data regarding oral treatment of coagulase-negative *Staphylococcus* (CoNS) BSI are limited. Most CoNS bacteremia and up to 80% *Staphylococcus epidermidis* bacteremia represent blood culture contamination, though true infection from CoNS is not uncommon, particularly in patients with indwelling catheters.[60] An exception is the CoNS species *Staphylococcus lugdunensis*, which is more virulent, and bacteremia with this organism usually warrants antibiotics. Oral antimicrobial therapy is currently not a standard treatment practice for CoNS BSI that is felt to represent true infection; however, linezolid has been successfully used in case series.[61]

Gram-Positive Cocci, *Enterococcus*

E. faecium and *E. faecalis* are commonly implicated in BSI.[1] Similar to *S. aureus*, infective endocarditis must be ruled out when treating enterococcus BSI; a scoring system has been

proposed to assist in deciding if such patients require echocardiography.[62] Intravenous ampicillin is a preferred, highly effective agent for enterococci treatment when the organism is susceptible.[44] However, oral ampicillin has poor bioavailability (50%), and data for its use in BSI are lacking. For susceptible strains, amoxicillin has comparable efficacy for enterococci and enhanced bioavailability (85%); high dose oral amoxicillin could be considered, but there is minimal clinical trial data to support this approach. Fluoroquinolones exhibit only modest activity against enterococci and would be an inferior choice for BSI.[63] Although often sensitive to oral tetracyclines, data on their use in enterococcal BSI are insufficient. Nitrofurantoin can be used for susceptible enterococcal urinary tract infection; however, it does not achieve high blood concentrations and should not be used for BSI.

There is significant data comparing oral linezolid with intravenous daptomycin for vancomycin-resistant enterococci (VRE) BSI. In a systematic review including 10 trials using 30-day all-cause mortality as the primary outcome, patients treated with daptomycin demonstrated higher odds of death (OR 1.61, 95% CI 1.08–2.40) compared with those treated with linezolid.[64] However, more recent data suggested that higher daptomycin doses than those used in these earlier trials resulted in improved VRE BSI outcomes.[65] A subsequent study reported that VRE BSI treatment with linezolid is associated with significantly higher treatment failure and mortality compared with daptomycin therapy.[66] Further research is needed, but should the side-effect profile of linezolid be tolerable, it remains an effective option for oral treatment of enterococcal BSIs.

EVIDENCE REGARDING ANAEROBIC BACTERIAL BLOOD STREAM INFECTION

Anaerobic bacteria include *Bacteroides*, *Prevotella*, *Porphyromonas*, *Fusobacterium*, *Peptostreptococcus*, *Veillonella*, and *Clostridium*. Anaerobes account for approximately 4% of bacterial BSIs, and are often seen in the context of polymicrobial infection.[67] Given that anaerobes are difficult to recover, and that antimicrobial resistance testing is more labor intensive, antibiotic therapy choices are often made empirically.[67] Unfortunately, antibiotic resistance amongst anaerobes is increasing.[68] However, metronidazole remains highly active against a majority of anaerobes, with only a handful of treatment failures reported,[69] and has a highly favorable pharmacokinetic profile for oral treatment. Oral metronidazole remains an effective choice for many anaerobic BSIs. Considering the polymicrobial nature of many anaerobic infections, source control is important, and concomitant GNR infection must be ruled out before using metronidazole monotherapy.

Clindamycin has significant anaerobic activity, but *Bacteroides* resistance has increased significantly in recent years, as high as 26%-44%.[70] Amoxicillin-clavulanate has good anaerobic coverage, but bioavailability of clavulanate is limited (50%), making it inferior for BSI. Bioavailability is also limited for cephalosporins with anaerobic activity, such as cefuroxime. Moxifloxacin is a fluoroquinolone with some anaerobic coverage and a good oral pharmacokinetic profile, but *Bacteroides* resistance can be as high as 50%, making it a risky empiric choice.[68]

CONCLUSIONS

Bacterial BSIs are common and result in significant morbidity and mortality, with high associated healthcare costs. Although BSIs are traditionally treated with intravenous antimicrobials, many BSIs can be safely and effectively cured using oral antibiotics. When appropriately selected, oral antibiotics offer lower costs, fewer side effects, promote antimicrobial stewardship, and are easier for patients. Ultimately, the decision to use oral versus intravenous antibiotics must consider the characteristics of the pathogen, patient, and drug.

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Shorter Versus Longer Courses of Antibiotics for Infection in Hospitalized Patients: A Systematic Review and Meta-Analysis

Stephanie Royer, MD[1,2,3]*, Kimberley M. DeMerle, MD[1], Robert P. Dickson, MD[1], Hallie C. Prescott, MD, MSc[1,4]

[1]*Department of Internal Medicine, University of Michigan, Ann Arbor, Michigan;* [2]*Division of Hospital Medicine, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio;* [3]*Department of Internal Medicine, University of Cincinnati, Cincinnati, Ohio;* [4]*Veterans Affairs Center for Clinical Management Research, Veterans Affairs Ann Arbor Healthcare System, Ann Arbor, Michigan.*

BACKGROUND: Infection is a leading cause of hospitalization with high morbidity and mortality, but there are limited data to guide the duration of antibiotic therapy.

PURPOSE: Systematic review to compare outcomes of shorter versus longer antibiotic courses among hospitalized adults and adolescents.

DATA SOURCES: MEDLINE and Embase databases, 1990-2017.

STUDY SELECTION: Inclusion criteria were human randomized controlled trials (RCTs) in English comparing a prespecified short course of antibiotics to a longer course for treatment of infection in hospitalized adults and adolescents aged 12 years and older.

DATA EXTRACTION: Two authors independently extracted study characteristics, methods of statistical analysis, outcomes, and risk of bias.

DATA SYNTHESIS: Of 5187 unique citations identified, 19 RCTs comprising 2867 patients met our inclusion criteria, including the following: 9 noninferiority trials, 1 superiority design trial, and 9 pilot studies. Across 13 studies evaluating 1727 patients, no significant difference in clinical efficacy was observed (d = 1.6% [95% confidence interval (CI), −1.0%-4.2%]). No significant difference was detected in microbiologic cure (8 studies, d = 1.2% [95% CI, −4.1%-6.4%]), short-term mortality (8 studies, d = 0.3% [95% CI, −1.2%-1.8%]), longer-term mortality (3 studies, d = −0.4% [95% CI, −6.3%-5.5%]), or recurrence (10 studies, d = 2.1% [95% CI, −1.2%-5.3%]). Heterogeneity across studies was not significant for any of the primary outcomes.

CONCLUSIONS: Based on the available literature, shorter courses of antibiotics can be safely utilized in hospitalized patients with common infections, including pneumonia, urinary tract infection, and intra-abdominal infection, to achieve clinical and microbiologic resolution without adverse effects on mortality or recurrence. *Journal of Hospital Medicine* 2018;13:336-342. Published online first January 25, 2018. © 2018 Society of Hospital Medicine

Acute infections are a leading cause of hospitalization and are associated with high cost, morbidity, and mortality.[1] There is a growing body of literature to support shorter antibiotic courses to treat several different infection types.[2-6] This is because longer treatment courses promote the emergence of multidrug resistant (MDR) organisms,[7-9] microbiome perturbation,[10] and *Clostridium difficile* infection (CDI).[11] They are also associated with more drug side effects, longer hospitalizations, and increased costs.

Despite increasing support for shorter treatment courses, inpatient prescribing practice varies widely, and redundant antibiotic therapy is common.[12-14] Furthermore, aside from ventilator-associated pneumonia (VAP),[15,16] prior systematic reviews of antibiotic duration have typically included outpatient and pediatric patients,[3-6,17-19] for whom the risk of treatment failure may be lower.

Given the potential for harm with inappropriate antibiotic treatment duration and the variation in current clinical practice, we sought to systematically review clinical trials comparing shorter versus longer antibiotic courses in adolescents and adults hospitalized for acute infection. We focused on common sites of infection in hospitalized patients, including pulmonary, bloodstream, soft tissue, intra-abdominal, and urinary.[20,21] We hypothesized that shorter courses would be sufficient to cure infection and associated with lower costs and fewer complications. Because we hypothesized that shorter durations would be sufficient regardless of clinical course, we focused on studies in which the short course of antibiotics was specified at study onset, not determined by clinical improvement or biomarkers. We analyzed all infection types together because current sepsis treatment guidelines place little emphasis on infection site.[22] In contrast to prior reviews, we focused exclusively on adult and adolescent inpatients because the risks of a too-short treatment duration may be lower in pediatric and outpatient populations.

***Address for correspondence:** Stephanie Royer, MD, 3333 Burnet Ave, MLC 3024; Telephone: 513-636-5148; Fax: 513-803-9245; E-mail: Stephanie.Royer@cchmc.org

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METHODS

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.[23] The review was registered on the Prospero database.[24]

Information Sources and Search Strategy

We performed serial literature searches for articles in English comparing shorter versus longer antibiotics courses in hospitalized patients. We searched MEDLINE via PubMed and Embase (January 1, 1990, to July 1, 2017). We used Boolean operators, Boolean logic, and controlled vocabulary (eg, Medical Subject Heading [MeSH] terms) for each key word. We identified published randomized controlled trials (RCTs) of conditions of interest (MeSH terms: "bacteremia," "sepsis," "pneumonia," "pyelonephritis," "intra-abdominal infection," "cellulitis," "soft tissue infection") that compared differing lengths of antibiotic treatment (keywords: "time factors," "duration," "long course," "short course") and evaluated outcomes (key words: "mortality," "recurrence," "secondary infections"). We hand searched references of included citations. The full search strategy is presented in supplementary Appendix 1.

Study Eligibility and Selection Criteria

To meet criteria for inclusion, a study had to (1) be an RCT; (2) involve an adult or adolescent population age ≥12 years (or report outcomes separately for such patients); (3) involve an inpatient population (or report outcomes separately for inpatients); (4) stipulate a short course of antibiotics per protocol prior to randomization and not determined by clinical response, change in biomarkers, or physician discretion; (5) compare the short course to a longer course of antibiotics, which could be determined either per protocol or by some other measure; and (6) involve antibiotics given to treat infection, not as prophylaxis.

Two authors (SR and HCP) independently reviewed the title and/or abstracts of all articles identified by the search strategy. We calculated interrater agreement with a kappa coefficient. Both authors (SR and HCP) independently reviewed the full text of each article selected for possible inclusion by either author. Disagreement regarding eligibility was adjudicated by discussion.

Data Abstraction

Two authors (SR and HCP) independently abstracted study methodology, definitions, and outcomes for each study using a standardized abstraction tool (see supplementary Appendix 2).

Study Quality

We assessed article quality using the Cochrane Collaboration's tool,[25] which evaluates 6 domains of possible bias, including sequence generation, concealment, blinding, and incomplete or selective outcome reporting. The tool is a 6-point scale, with 6 being the best score. It is recommended for assessing bias because it evaluates randomization and allocation concealment, which are not included in other tools.[26] We did not exclude studies based on quality but considered studies with scores of 5-6 to have a low overall risk of bias.

Study Outcomes and Statistical Analysis

Our primary outcomes were clinical cure, microbiologic cure, mortality, and infection recurrence. Secondary outcomes were secondary MDR infection, cost, and length of stay (LOS). We conducted all analyses with Stata MP version 14 (StataCorp, College Station, TX). For each outcome, we reported the difference (95% confidence interval [CI]) between treatment arms as the rate in the short course arm minus the rate in the long course arm, consistent with the typical presentation of noninferiority data. When not reported in a study, we calculated risk difference and 95% CI using reported patient-level data. Positive values for risk difference favor the short course arm for favorable outcomes (ie, clinical and microbiologic cure) and the long course arm for adverse outcomes (ie, mortality and recurrence). A meta-analysis was used to pool risk differences across all studies for primary outcomes and for clinical cure in the community-acquired pneumonia (CAP) subgroup. We also present results as odds ratios and risk ratios in the online supplement. All meta-analyses used random effects models, as described by DerSimonian and Laird,[27,28] with variance estimates of heterogeneity taken from the Mantel-Haenszel fixed effects model. We investigated heterogeneity between studies using the $\chi 2$ I^2 statistic. We considered a $P < .1$ to indicate statistically significant heterogeneity and classified heterogeneity as low, moderate, or high on the basis of an I2 of 25%, 50%, or 75%, respectively. We used funnel plots to assess for publication bias.

RESULTS

Search Results

We identified 5187 unique citations, of which 110 underwent full-text review (Figure 1). Reviewer agreement for selection of title and/or abstracts for full evaluation was 99.1% (kappa = 0.71). Nineteen RCTs with a total of 2867 patients met inclusion criteria and were included in the analysis.[29-47]

Characteristics of Included Studies

Publication years ranged from 1991 to 2015 (Table). Study populations were primarily from Europe (n = 9) or the United States (n = 5). Pneumonia was the most common infection studied, with 3 studies evaluating VAP and 9 studies evaluating CAP. There were also 3 studies of intra-abdominal infections, 2 studies of urinary tract infections (UTIs), 1 study of typhoid fever, and 1 study of hospital-acquired infection of unknown origin. No studies of bacteremia or soft tissue infections met inclusion criteria. Short courses of antibiotics ranged from 1 to 8 days, while long courses ranged from 3 to 15 days.

Common study outcomes included clinical cure or efficacy (composite of symptom cure and improvement; n = 13), infection recurrence (n = 10), mortality (n = 9), microbiologic cure (n = 8), and LOS (n = 7; supplementary Table 1).

Nine studies were pilot studies, 1 was a traditional superiority design study, and 9 were noninferiority studies with a prespecified limit of equivalence of either 10% (n = 7) or 15% (n = 2).

TABLE. **Characteristics of Included Studies**

Author	Year	Country	Number of Patients[a]	Patient Location	Infection Type	Short Course Antibiotic	Short Course Duration (days)	Long Course Antibiotic	Long Course Duration (days)	Primary Outcome	Study Design
Bohte et al.[29]	1995	Netherlands	104	Ward	CAP	Azithromycin	5	Erythromycin or benzylpenicillin	10 or 5 days past last fever	Clinical cure by day 21	Superiority
Capellier et al.[30]	2012	France	225	ICU	VAP	Beta-lactam, aminoglycoside	8	Beta-lactam, aminoglycoside	15	Clinical cure at day 21	Non-inferiority
Chastre et al.[31]	2003	France	401	ICU	VAP	Beta-lactam, aminoglycoside or fluoroquinolone	8	Beta-lactam, aminoglycoside or fluoroquinolone	15	All-cause mortality at day 28, documented recurrence, antibiotic free days	Non-inferiority
Chaudhry et al.[32]	2000	Pakistan	50	Ward	SBP	Cefoperazone	5	Cefoperazone	10	Infection-related and hospitalization mortality[b]	Pilot
Darouiche et al.[33]	2014	USA	55	Ward	CA-UTI	Physician discretion[c]	5	Physician discretion[c]	10	Clinical cure at end of therapy (day 5 or 10)	Non-inferiority
deGier et al.[34]	1995	Netherlands	34	Ward	c-UTI	Fleroxacin	7	Fleroxacin	14	Microbiologic cure 4 to 6 weeks post therapy[b]	Pilot
Dunbar et al.[35]	2003	USA	162	Ward, outpatient	CAP	Levofloxacin	5	Levofloxacin	10	Clinical success at posttherapy (7-14 days after last antibiotics)	Non-inferiority
Gasem et al.[36]	2003	Indonesia	55	Ward	Enteric fever	Ciprofloxacin	7	Chloramphenicol	14	Clinical cure at day 7	Pilot
Kollef et al.[37]	2012	International	167	ICU	VAP	Doripenem	7	Imipenem-cilastatin	10	Clinical cure at end of therapy (day 10)	Non-inferiority
Kuzman et al.[38]	2005	International	171	Ward	CAP	Azithromycin	4-7	Cefuroxime	8-11	Clinical efficacy at posttreatment (day 10-14)	Pilot
Leophonte et al.[39]	2002	France	244	Ward	CAP	Ceftriaxone	5	Ceftriaxone	10	Apyrexia and no further antibiotics at day 10	Non-inferiority
Rizzato et al.[40]	1995	Italy	40	Ward	CAP	Azithromycin	3	Clarithromycin	8+	Clinical cure at day 10[b]	Pilot
Runyon et al.[41]	1991	USA	90	Ward	SBP	Cefotaxime	5	Cefotaxime	10	Hospitalization and all-cause mortality[b]	Non-inferiority
Sawyer et al.[42]	2015	USA-Canada	517	Ward	Complicated intra-abdominal infection	Physician discretion[d]	4	Physician discretion[d]	2 days after resolution of SIRS, maximum 10 days	Composite mortality, surgical-site infection, recurrent intra-abdominal infection	Non-inferiority
Scawn et al.[43]	2012	UK	46	ICU	Hospital-acquired infection of unknown origin	Meropenem, teicoplanin	2	Meropenem, teicoplanin	7	Composite mortality and need for further antibiotics	Pilot
Schonwald et al.[44]	1994	Croatia	142	Ward	CAP	Azithromycin	3	Roxithromycin	10	Clinical cure at day 14	Pilot
Schonwald et al.[45]	1999	Croatia	98	Ward	CAP	Azithromycin	1	Azithromycin	3	Clinical cure at day 10 to 14	Pilot
Siegel et al.[46]	1999	USA	46	Ward	CAP	Cefuroxime	7	Cefuroxime	10	Clinical cure at day 10 to 14	Pilot
Zhao et al.[47]	2014	China	220	Ward	CAP	Levofloxacin	5	Levofloxacin	7+	Overall efficacy at 7 to 14 days post therapy	Non-inferiority

[a] Number of patients included in primary outcome and/or subset of patients hospitalized.

[b] Primary outcome(s) not specified; outcome(s) discussed first and/or most extensively considered to be primary outcome(s).

[c] Standard choices oral fluoroquinolone and amoxicillin; aztreonam and vancomycin used in patients unable to tolerate oral antibiotics; antibiotic choice based on prior sensitivities if available.

[d] Acceptable if consistent with Surgical Infection Society and Infectious Diseases Society of America guidelines.

NOTE: Abbreviations: CAP, community-acquired pneumonia; CA-UTI, catheter-associated urinary tract infection; c-UTI, complicated urinary tract infection; ICU, intensive care unit; SBP, spontaneous bacterial peritonitis; SIRS, systemic inflammatory response syndrome; UK, United Kingdom; USA, United States of America; VAP, ventilator-associated pneumonia.

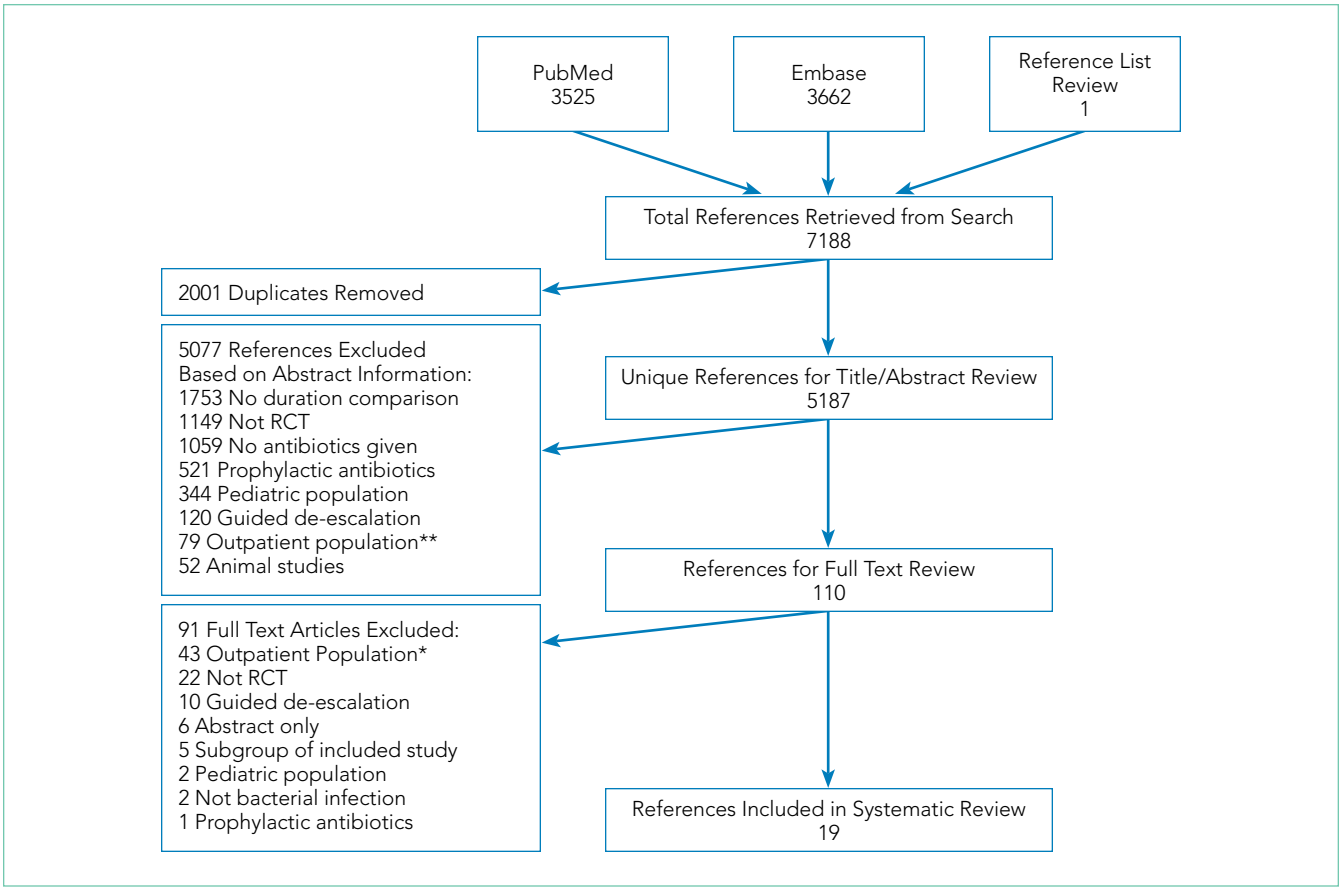

FIG 1. Flow diagram for literature review and study selection. NOTE: **All 79 of these articles included an outpatient-only population. *Twenty-six of these 43 articles were excluded after full-text review because the population contained both inpatients and outpatients but did not provide separate outcomes for the inpatient subgroup. Seventeen articles contained an outpatient-only population. Abbreviation: RCT, randomized controlled trial.

Clinical Cure and Efficacy

Thirteen studies of 1727 patients evaluated clinical cure and efficacy (Figure 2).[29,30,33,35-40,44-47] The overall risk difference was d = 1.6% (95% CI, −1.0%-4.2%), and the pooled odds ratio was 1.11 (95% CI, 0.85-1.45; supplementary Table 2). There was no heterogeneity between studies (I^2 = 0%, P = .55). Five of 6 studies with a noninferiority design met their prespecified margin, while 1 study of VAP failed to meet the 15% noninferiority margin (d = −11.2% [95% CI, −26.3%-3.8%]).[37]

Nine studies of 1225 patients evaluated clinical cure and efficacy in CAP (supplementary Figure 1).[29,35,38-40,44-47] The overall risk difference was d = 2.4% (95% CI, −0.7%-5.5%). There was no heterogeneity between studies (I^2 = 0%, P = .45).

Microbiologic Cure

Eight studies of 366 patients evaluated microbiologic cure (supplementary Figure 2).[32-34,36,38,40,41,47] The overall risk difference was d = 1.2% (95% CI, −4.1%-6.4%). There was no statistically significant heterogeneity between studies (I^2 = 13.3%, P = .33).

Mortality

Eight studies of 1740 patients evaluated short-term mortality (in hospital to 45 days; Figure 2),[30-32,37,39,41,43] while 3 studies of 654 patients evaluated longer-term mortality (60 to 180 days; supplementary Figure 3).[30,31,33] The overall risk difference was d = 0.3% (95% CI, −1.2%-1.8%) for short-term mortality and d = −0.4% (95% CI, −6.3%-5.5%) for longer-term mortality. There was no heterogeneity between studies for either short-term (I^2 = 0.0%, P = .66) or longer-term mortality (I^2 = 0.0%, P = .69).

Infection Recurrence

Ten studies of 1554 patients evaluated infection recurrence (Figure 2).[30-34,40-42,45,46] The overall risk difference was d = 2.1% (95% CI, −1.2%-5.3%). There was no statistically significant heterogeneity between studies (I^2 = 21.0%, P = .25). Two of the 3 studies with noninferiority design (both evaluating intra-abdominal infections) met their prespecified margins.[41,42] In Chastre et al.,[31] the overall population (d = 3.0%; 95% CI, −5.8%-11.7%) and the subgroup with VAP due to nonfermenting gram-negative bacilli (NF-GNB; d = 15.2%; 95% CI, −0.9%-31.4%) failed to meet the 10% noninferiority margin.

Secondary Outcomes

Three studies[30,31,42] of 286 patients (with VAP or intra-abdominal infection) evaluated the emergence of MDR organisms. The overall risk difference was d = −9.0% (95% CI, −19.1%-1.1%; P = .081). There was no statistically significant

heterogeneity between studies (I^2 = 7.6%, P = .34).

Seven studies examined LOS—3 in the intensive care unit (ICU)[30,31,43] and 4 on the wards[32,36,40,41]—none of which found significant differences between treatment arms. Across 3 studies of 672 patients, the weighted average for ICU LOS was 23.6 days in the short arm versus 22.2 days in the long arm. Across 4 studies of 235 patients, the weighted average for hospital LOS was 23.3 days in the short arm versus 29.7 days in the long arm. This difference was driven by a 1991 study[41] of spontaneous bacterial peritonitis (SBP), in which the average LOS was 37 days and 50 days in the short- and long-course arms, respectively.

Three studies[32,41,43] of 186 total patients (with SBP or hospital-acquired infection of unknown origin) examined the cost of antibiotics. The weighted average cost savings for shorter courses in 2016 US dollars[48] was $265.19.

Three studies[30,33,43] of 618 patients evaluated cases of CDI, during 10-, 30-, and 180-day total follow-up. The overall risk difference was d = 0.7% (95% CI, −1.3%-2.8%), with no statistically significant heterogeneity between studies (I^2 = 0%, P = .97).

Study Quality

Included studies scored 2-5 on the Cochrane Collaboration Risk of Bias Tool (supplementary Figure 4). Four studies had an overall low risk of bias,[36,37,43,46] while 15 had a moderate to high risk of bias (supplementary Table 3).[29-35,38-42,44,45,47] Common sources of bias included inadequate details to confirm adequate randomization and/or concealment (n = 13) and lack of adequate blinding (n = 18). Two studies were stopped early,[37,42] and 3 others were possibly stopped early because it was unclear how the number of participants was determined.[29,33,47] Covariate imbalance (failure of randomization) was present in 2 studies.[37,47] There was no evidence of selective outcome reporting or publication bias based on the funnel plots (supplementary Figure 5).

DISCUSSION

In this study, we performed a systematic review and meta-analysis of RCTs of shorter versus longer antibiotic courses for adults and adolescents hospitalized for infection. The rate of clinical cure was indistinguishable between patients randomized to shorter versus longer durations of antibiotic therapy, and the meta-analysis was well powered to confirm noninferiority. The lower 95% CI indicates that any potential benefit of longer antibiotics is not more than 1%, far below the typical margin of noninferiority. Subgroup analysis of patients hospitalized with CAP also showed noninferiority of a prespecified shorter treatment duration.

The rate of microbiologic cure was likewise indistinguishable, and the meta-analysis was again well powered to confirm noninferiority. Any potential benefit of longer antibiotics for microbial cure is quite small (not more than 4%).

Our study also demonstrates noninferiority of prespecified shorter antibiotic courses for mortality. Shorter- and longer-term mortality were both indistinguishable in patients randomized to shorter antibiotic courses. The meta-analyses

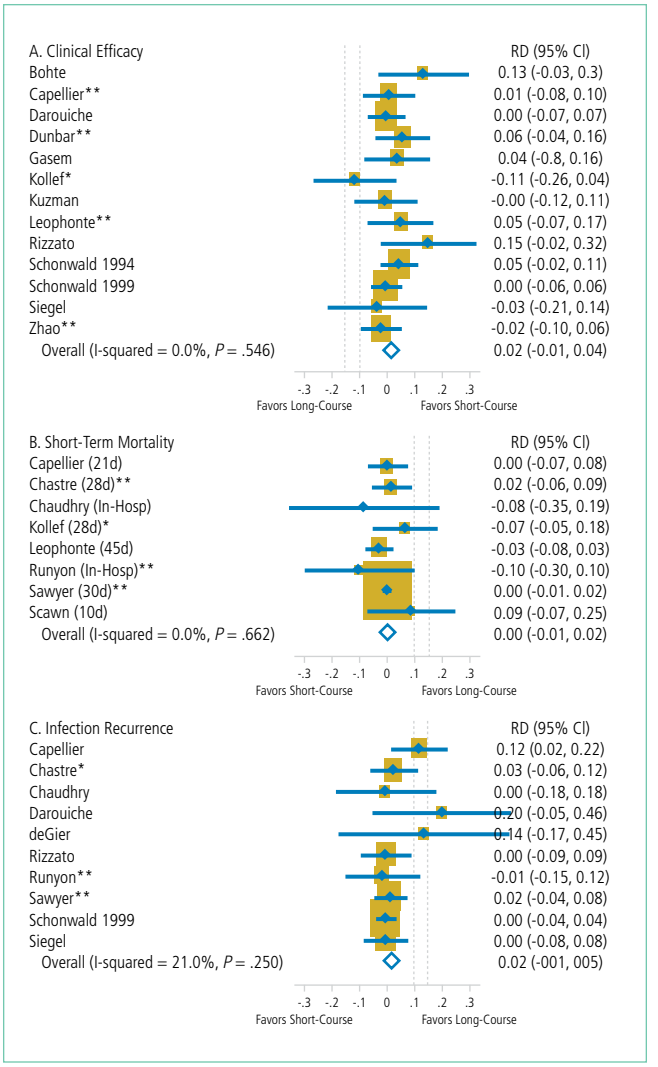

FIG 2. Forest plots (clinical efficacy, short-term mortality, infection recurrence). NOTE: Fifteen percent was used as the limit of equivalence for the difference between short-course and long-course groups in 2 studies (Kollef et al.[37] and Runyon et al[41]). Ten percent was used as the limit of equivalence for the difference between short-course and long-course groups in 7 studies (Capellier et al.,[30] Chastre et al.,[31] Darouiche et al.,[33] Dunbar et al.,[35] Leophonte et al,[39] Sawyer et al,[42] and Zhao et al.[47]). For favorable outcomes (eg, clinical efficacy), positive values favor the short-course arm, and the lower limit of the 95% confidence interval must be >−10% or >−15% to confirm noninferiority. For adverse outcomes (eg, mortality and infection recurrence), negative values favor the short course group, and the upper limit of the 95% confidence interval must be <10% or <15% to confirm noninferiority. **Met prespecified noninferiority margin. *Evaluated noninferiority but did not meet prespecified margin.

for mortality were well powered, with any potential benefit of longer antibiotic durations being less than 2% for short-term and less than 6% for long-term mortality.

We also examined for complications related to antibiotic therapy. Infection recurrence was indistinguishable, with any potential benefit of longer antibiotics being less than 6%. Select infections (eg, VAP due to NF-GNB, catheter-associated UTI) may be more susceptible to relapse after shorter treatment courses, while most patients hospitalized with infection do not have an increased risk for relapse with shorter treatment courses. Consistent with other studies,[8] the emergence of

MDR organisms was 9% less common in patients randomized to shorter antibiotic courses. This difference failed to meet statistical significance, likely due to poor power. The emergence of MDR pathogens was included in just 3 of 19 studies, underscoring the need for additional studies on this outcome.

Although our meta-analyses indicate noninferiority of shorter antibiotic courses in hospitalized patients, the included studies are not without shortcomings. Only 4 of the included studies had low risk of bias, while 15 had at least moderate risk. The nearly universal source of bias was a lack of blinding. Only 1 study[37] was completely blinded, and only 3 others had partial blinding. Adequate randomization and concealment were also lacking in several studies. However, there was no evidence of selective outcome reporting or publication bias.

Our findings are consistent with prior studies indicating noninferiority of shorter antibiotic courses in other settings and patient populations. Pediatric studies have demonstrated the success of shorter antibiotic courses in both outpatient[49] and inpatient populations.[50] Prior meta-analyses have shown noninferiority of shorter antibiotic courses in adults with VAP[15,16]; in neonatal, pediatric, and adult patients with bacteremia[17]; and in pediatric and adult patients with pneumonia and UTI.[3-6,18,19] Our meta-analysis extends the evidence for the safety of shorter treatment courses to adults hospitalized with common infections, including pneumonia, UTI, and intra-abdominal infections. Because neonatal, pediatric, and nonhospitalized adult patients may have a lower risk for treatment failure and lower risk for mortality in the event of treatment failure, we focused exclusively on hospitalized adults and adolescents.

In contrast to prior meta-analyses, we included studies of multiple different sites of infection. This allowed us to assess a large number of hospitalized patients and achieve a narrow margin of noninferiority. It is possible that the benefit of optimal treatment duration varies by type of infection. (And indeed, absolute duration of treatment differed across studies.) We used a random-effects framework, which recognizes that the true benefit of shorter versus longer duration may vary across study populations. The heterogeneity between studies in our meta-analysis was quite low, suggesting that the results are not explained by a single infection type.

There are limited data on late effects of longer antibiotic courses. Antibiotic therapy is associated with an increased risk for CDI for 3 months afterwards.[11] However, the duration of follow-up in the included studies rarely exceeded 1 month, which could underestimate incidence. The effect of antibiotics on gut microbiota may persist for months, predisposing patients to secondary infections. It is plausible that disruption in gut microbiota and risk for CDI may persist longer in patients treated with longer antibiotic courses. However, the existing studies do not include sufficient follow-up to confirm or refute this hypothesis.

Our review has several limitations. First, we included studies that compared an a priori-defined short course of antibiotics to a longer course and excluded studies that defined a short course of antibiotics based on clinical response. Because we did not specify an exact length for short or long courses, we cannot make explicit recommendations about the absolute duration of antibiotic therapy. Second, we included multiple infection types. It is possible that the duration of antibiotics required may differ by infection type. However, there were not sufficient data for subgroup analyses for each infection type. This highlights the need for additional data to guide the treatment of severe infections. Third, not all studies considered antibiotic duration in isolation. One study included a catheter change in the short arm only, which could have favored the short course.[33] Three studies used different doses of antibiotics in addition to different durations.[35,45,47] Fourth, the quality of included studies was variable, with lack of blinding and inadequate randomization present in most studies.

CONCLUSION

Based on the available literature, shorter courses of antibiotics can be safely utilized in hospitalized adults and adolescents to achieve clinical and microbiologic resolution of common infections, including pneumonia, UTI, and intra-abdominal infection, without adverse effect on infection recurrence. Moreover, short- and longer-term mortality are indistinguishable after treatment courses of differing duration. There are limited data on the longer-term risks associated with antibiotic duration, such as secondary infection or the emergence of MDR organisms.

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Things We Do for No Reason – The "48 Hour Rule-out" for Well-Appearing Febrile Infants

Carrie Herzke, MD[1]*, Weijen Chang, MD[2], Rianna Leazer, MD[3]

[1]Department of Pediatrics and Medicine, Johns Hopkins School of Medicine, Baltimore, Maryland; [2]Division of Pediatric Hospital Medicine, Baystate Medical Center/Baystate Children's Hospital, University of Massachusetts Medical School, Springfield, Massachusetts; [3]Department of Pediatrics, Eastern Virginia Medical School, Norfolk, Virginia.

The "Things We Do for No Reason" (TWDFNR) series reviews practices that have become common parts of hospital care but may provide little value to our patients. Practices reviewed in the TWDFNR series do not represent "black and white" conclusions or clinical practice standards but are meant as a starting place for research and active discussions among hospitalists and patients. We invite you to be part of that discussion.

Fever, defined as a rectal temperature of ≥38°C (100.4°F), is a common reason for hospital admission of infants aged ≤ 90 days. Febrile infants are often admitted to the hospital due to risk for serious bacterial infections, such as urinary tract infection, bacteremia, and meningitis. The traditional observation time is 48 hours following the collection of blood, urine, and cerebrospinal fluid cultures. In the majority of these infants, bacterial infection is not the source of fever. When a bacterial source is identified, less than 0.3% of the bacteria will be detected more than 24 hours after the cultures were obtained in low-risk infants.1 Recent studies show that the traditional 48 hour hospital observation period is unnecessary for infants aged ≤ 90 days who are at low risk for serious bacterial infection based on available scoring systems.

CASE PRESENTATION

A 3-week-old, full-term term male febrile infant was evaluated in the emergency department (ED). On the day of admission, he was noted to feel warm to the touch and was found to have a rectal temperature of 101.3°F (38.3°C) at home.

In the ED, the patient was well appearing and had normal physical exam findings. His workup in the ED included a normal chest radiograph, complete blood count (CBC) with differential count, cerebrospinal fluid (CSF) analysis (cell count, protein, and glucose), and urinalysis. Blood, CSF, and catheterized urine cultures were collected, and he was admitted to the hospital on parenteral antibiotics. His provider informed the parents that the infant would be observed in the hospital for 48 hours while monitoring the bacterial cultures. Is it necessary for the hospitalization of this child to last a full 48 hours?

INTRODUCTION

Evaluation and management of fever (T ≥ 38°C) is a common cause of emergency department visits and accounts for up to 20% of pediatric emergency visits.[2]

In infants under 90 days of age, fever frequently leads to hospitalization due to concern for bacterial infection as the cause of fever.[3] Serious bacterial infection has traditionally been defined to include infections such as bacteremia, meningitis, pneumonia, urinary tract infection, skin/soft tissue infections, osteomyelitis, and septic arthritis.[4] (Table 1) The incidence of serious bacterial infection in febrile infants during the first 90 days of life is between 5%-12%.[5-8] To assess the risk of serious bacterial infections, clinicians commonly pursue radiographic and laboratory evaluations, including blood, urine, and cerebrospinal fluid (CSF) cultures.[3] Historically, infants have been observed for at least 48 hours.

Why You Might Think Hospitalization for at Least 48 Hours is Necessary

The evaluation and management of fever in infants aged less than 90 days is challenging due to concern for occult serious bacterial infections. In particular, providers may be concerned that the physical exam lacks sensitivity.[9]

There is also a perceived risk of poor outcomes in young infants if a serious bacterial infection is missed. For these reasons, the evaluation and management of febrile infants has been characterized by practice variability in both outpatient[10] and ED[3] settings.

Commonly used febrile infant management protocols vary in approach and do not provide clear guidelines on the recommended duration of hospitalization and empiric antimicrobial treatment.[11-14] Length of hospitalization was widely studied in infants between 1979 and 1999, and results showed that the majority of clinically important bacterial pathogens can be detected within 48 hours.[15-17] Many textbooks and online references, based on this literature, continue to support 48 to 72 hours of observation and empiric antimicrobial treatment for febrile infants.[18,19] A 2012 AAP Clinical Report advocated for limiting the antimicrobial treatment in low-risk infants suspected of early-onset sepsis to 48 hours.[20]

***Address for correspondence:** Carrie Herzke, MD, Department of Pediatrics and Medicine, Johns Hopkins School of Medicine, 600 N. Wolfe Street, Meyer 8-134, Baltimore, MD 21287; Telephone: 443-287-3631, Fax: 410-502-0923
E-mail: cherzke1@jhmi.edu

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TABLE 1. **Rate of Serious Bacterial Infections by Age**

Age (months)	Blood	CSF	All SBI
0–1	2.1% (1.4, 3.1)	0.9% (0.4, 1.6)	8.8% (7.2, 10.6)
1–2	1.0% (0.6, 1.5)	0.2% (0.1, 0.5)	7.3% (6.2, 8.5)
2–3	0.8% (0.4, 1.5)	0.2% (0.1, 0.7)	7.1% (6.0, 8.4)
Total	1.4% (0.9, 1.6)	0.4% (0.2, 0.7)	7.6% (6.9, 8.3)

All SBI group data were published; however, the specific rates of bacteremia and bacterial meningitis were unpublished but derived from the same data set and calculated as rate of positive cultures per total cultures obtained per group. Numbers in parentheses are the 95% confidence intervals.

Abbreviations: CSF, cerebral spinal fluid; SBI, serious bacterial infections.

Used with permission from Harper, Marvin. Update on the Management of the Febrile Infant; *Clin Ped Emerg Med;* 2005;5(1):5-12.

TABLE 2. **Rates of Blood Culture Positivity**

Observation period (hours)	Percentage of pathogenic blood cultures positive	Number needed to evaluate to capture 1 additional bacteremic infant beyond this period
24	91%	556–1,235
36	96%	1250–2,778
48	99%	5000–11,111

Why Shorten the Period of In-Hospital Observation to a Maximum of 36 Hours of Culture Incubation

Discharge of low-risk infants with negative enhanced urinalysis and negative bacterial cultures at 36 hours or earlier can reduce costs[21] and potentially preventable harm (eg, intravenous catheter complications, nosocomial infections) without negatively impacting patient outcomes.[22] Early discharge is also patient-centered, given the stress and indirect costs associated with hospitalization, including potential separation of a breastfeeding infant and mother, lost wages from time off work, or childcare for well siblings.[23]

Initial studies that evaluated the time-to-positivity (TTP) of bacterial cultures in febrile infants predate the use of continuous monitoring systems for blood cultures. Traditional bacterial culturing techniques require direct observation of broth turbidity and subsequent subculturing onto chocolate and sheep blood agar, typically occurring only once daily.[24] Current commercially available continuous monitoring bacterial culture systems decrease TTP by immediately alerting laboratory technicians to bacterial growth through the detection of $^{14}CO2$ released by organisms utilizing radiolabeled glucose in growth media.[24] In addition, many studies supporting the evaluation of febrile infants in the hospital for a 48-hour period include those in ICU settings,[25] with medically complex histories,[24] and aged < 28 days admitted in the NICU,[15] where pathogens with longer incubation times are frequently seen.

Recent studies of healthy febrile infants subjected to continuous monitoring blood culture systems reported that the TTP for 97% of bacteria treated as true pathogens is ≤36 hours.[26] No significant difference in TTP was found in infants ≤28 days old versus those aged 0–90 days.[26] The largest study conducted at 17 sites for more than 2 years demonstrated that the mean TTP in infants aged 0-90 days was 15.41 hours; only 4% of possible pathogens were identified after 36 hours. (Table 2)

In a recent single-center retrospective study, infant blood cultures with TTP longer than 36 hours are 7.8 times more likely to be identified as contaminant bacteria compared with cultures that tested positive in <36 hours.[26] Even if bacterial cultures were unexpectedly positive after 36 hours, which occurs in less than 1.1% of all infants and 0.3% of low-risk infants,[1] these patients do not have adverse outcomes. Infants who were deemed low risk based on established criteria and who had bacterial cultures positive for pathogenic bacteria were treated at that time and recovered uneventfully.[7, 31]

CSF and urine cultures are often reviewed only once or twice daily in most institutions, and this practice artificially prolongs the TTP for pathogenic bacteria. Small sample-sized studies have demonstrated the low detection rate of pathogens in CSF and urine cultures beyond 36 hours. Evans et al. found that in infants aged 0-28 days, 0.03% of urine cultures and no CSF cultures tested positive after 36 hours.[26] In a retrospective study of infants aged 28-90 days in the ED setting, Kaplan et al. found that 0.9% of urine cultures and no CSF cultures were positive at >24 hours.[1] For well-appearing infants who have reassuring initial CSF studies, the risk of meningitis is extremely low.[7] Management criteria for febrile infants provide guidance for determining those infants with abnormal CSF results who may benefit from longer periods of observation.

Urinary tract infections are common serious bacterial infections in this age group. Enhanced urinalysis, in which cell count and Gram stain analysis are performed on uncentrifuged urine, shows 96% sensitivity of predicting urinary tract infection and

TABLE 3. **Commonly Used Criteria for Management of Febrile Infants**

Children with the following criteria are defined as low risk			
Criteria	**Rochester[36]**	**Boston[15]**	**Philadelphia[13]**
Age (days)	0–60	28–89	29–56
Clinical Appearance	Well	Well	Well by infant observation score
Peripheral WBC/mm3	5,000–15,000	5,000–20,000	<15,000
Bands	<1500 cells per mm3	NA	<0.2 ratio bands: pmn
UA	<10wbc/hpf	<10wbc/hpf	<10wbc/hpf; negative gram stain
CSF	N/A	<10wbc/mm3	<8wbc/mm3; nonbloody
Stool if diarrhea present	<10wbc/hpf	<5wbc/hpf	<5wbc/hpf; no hematochezia
CXR		Not required	Required for all

NOTE: Abbreviations: CSF, cerebral spinal fluid; CXR, chest x-ray; pmn (polymorphonuclear cell); UA, urinalysis); WBC, white blood cell; wbc/hpf (white blood cells per high-powered field.

can provide additional reassurance for well-appearing infants who are discharged prior to 48 hours.[27]

When a Longer Observation Period May Be Warranted

An observation time of >36 hours for febrile infants can be considered if the patient does not meet the generally accepted low-risk clinical and/or laboratory criteria (Table 2) or if the patient clinically deteriorates during hospitalization. Management of CSF pleocytosis both on its own[28] and in the setting of febrile urinary tract infection in infants remains controversial[29] and may be an indication for prolonged hospitalization. Incomplete laboratory evaluation (eg, lack of CSF due to unsuccessful lumbar puncture,[30] lack of CBC due to clotted samples) and pretreatment with antibiotics[31] can also affect clinical decision making by introducing uncertainty in the patient's pre-evaluation probability. Other factors that may require a longer period of hospitalization include lack of reliable follow-up, concerns about the ability of parent(s) or guardian(s) to appropriately detect clinical deterioration, lack of access to medical resources or a reliable telephone, an unstable home environment, or homelessness.

What You Should Do Instead: Limit Hospitalization to a Maximum of 36 Hours

For well-appearing febrile infants between 0–90 days of age hospitalized for observation and awaiting bacterial culture results, providers should consider discharge at 36 hours or less, rather than 48 hours, if blood, urine, and CSF cultures do not show bacterial growth. In a large health system, researchers implemented an evidence-based care process model for febrile infants to provide specific guidelines for laboratory testing, criteria for admission, and recommendation for discontinuation of empiric antibiotics and discharge after 36 hours in infants with negative bacterial cultures. These changes led to a 27% reduction in the length of hospital stay and 23% reduction in inpatient costs without any cases of missed bacteremia.[21] The reduction in the in-hospital observation duration to 24 hours of culture incubation for well-appearing febrile infants has been advocated [32] and is a common practice for infants with appropriate follow up and parental assurance. This recommendation is supported by the following:

- Recent data showing the overwhelming majority of pathogens will be identified by blood culture <24 hours in infants aged 0-90 days[32] with blood culture TTP in infants aged 0-30 days being either no different[26] or potentially shorter[32]
- Studies showing that infants meeting low-risk clinical and laboratory profiles further reduce the likelihood of identifying serious bacterial infection after 24 hours to 0.3%.[1]

RECOMMENDATIONS

- Determine if febrile infants aged 0-90 days are at low risk for serious bacterial infection and obtain appropriate bacterial cultures.
- If hospitalized for observation, discharge low-risk febrile infants aged 0–90 days after 36 hours or less if bacterial cultures remain negative.
- If hospitalized for observation, consider reducing the length of inpatient observation for low-risk febrile infants aged 0–90 days with reliable follow-up to 24 hours or less when the culture results are negative.

CONCLUSION

Monitoring patients in the hospital for greater than 36 hours of bacterial culture incubation is unnecessary for patients similar to the 3 week-old full-term infant in the case presentation, who are at low risk for serious bacterial infection based on available scoring systems and have negative cultures. If patients are not deemed low risk, have an incomplete laboratory evaluation, or have had prior antibiotic treatment, longer observation in the hospital may be warranted. Close reassessment of the rare patients whose blood cultures return positive after 36 hours is necessary, but their outcomes are excellent, especially in well-appearing infants.[7,33]

What do you do?

Do you think this is a low-value practice? Is this truly a "Thing We Do for No Reason"? Let us know what you do in your practice and propose ideas for other "Things We Do for No Reason" topics. Please join in the conversation online at Twitter (#TWDFNR)/Facebook and don't forget to "Like It" on Facebook or retweet it on Twitter. We invite you to propose ideas for other "Things We Do for No Reason" topics by emailingTWDFNR@hospitalmedicine.org.

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Scratching Beneath the Surface

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.

Michael A. Santos, MD[1,2*], Andrew A. White, MD[3], Paul S. Pottinger, MD[4]

[1]Department of Medicine, Penn State Hershey Medical Center, Hershey, Pennsylvania; [2]Department of Medicine, WellSpan Good Samaritan Hospital, Lebanon, Pennsylvania; [3]Department of Medicine, University of Washington Medical Center, Seattle, Washington; [4]Division of Allergy and Infectious Diseases, University of Washington Medical Center, Seattle, Washington.

A 62-year-old man with severe chronic obstructive pulmonary disease (COPD; forced expiratory volume during the first second [FEV1] 40% predicted) and type 2 diabetes mellitus presented to a Veterans Affairs emergency department (ED) with a steadily worsening cough of 4-months' duration. He also reported subjective fevers, sputum production, shortness of breath, and unintentional 20-pound weight loss. He denied chills, chest pain, nausea, or vomiting.

Cough is classified as acute, subacute, or chronic based on duration of less than 3 weeks, between 3-8 weeks, and greater than 8 weeks, respectively. Common causes of chronic cough include bronchitis, acid reflux, cough-variant asthma, and a side effect of angiotensin converting enzyme inhibitors. Unintentional weight loss suggests a serious disorder, including indolent infection, end-stage COPD, malignancy, and autoimmune causes. Among patients with chronic bronchitis, the microbiology of sputum is often mixed with commensal respiratory flora, including *Streptococcus pneumoniae* and *Haemophilus* species. When these organisms are not recovered in sputa, or when patients fail to respond to empiric treatment, the differential diagnosis should be broadened to include pulmonary tuberculosis, nontuberculous mycobacterial infection, lung abscess, pulmonary nocardiosis, or pertussis.

An exposure and social history can focus the differential. For example, coccidioidomycosis or histoplasmosis may present indolently, but have distinct geographic distributions. Bird fanciers may acquire hypersensitivity pneumonitis, psittacosis, or cryptococcosis. Risk factors including smoking history, corticosteroid use, uncontrolled diabetes, and ill contacts should be assessed.

***Address for correspondence:** Michael A. Santos, MD, 500 University Drive, Department of Medicine, H034, Hershey, PA 17033; Telephone: 717-450-6166; Fax: 717-270-3875; E-mail: masantospitt@gmail.com

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He was discharged from the ED twice in the last 2 weeks after presenting with similar symptoms. On each occasion, he was treated for presumed COPD exacerbations with nebulized albuterol and ipratropium, methylprednisolone followed by oral prednisone, and azithromycin, which did not lead to improvement. Over the last 3 days, he developed lower extremity edema, orthopnea, and dyspnea at rest. He reported worsening fatigue, night sweats, and anorexia. He denied any sick contacts.

Two diagnostic issues have emerged. His edema, orthopnea, and dyspnea at rest suggest a new cause of hypervolemia, perhaps caused by sodium retention from corticosteroids, pulmonary edema from valvular or myocardial disease, or renal failure. More concerning is that he has been treated with azithromycin twice recently but still has night sweats, fatigue, and anorexia. The presence of weight loss despite extracellular volume accumulation suggests an indolent systemic illness. Infection with macrolide-resistant organisms, such as nocardia, mycobacteria, or endemic mycoses, remains high on the differential diagnosis.

His past medical history included hypertension, untreated chronic hepatitis C, tobacco dependence, alcohol use disorder, and extraction of 8 decayed teeth 2 months earlier. He served in a noncombat role during the Vietnam War. He consumed 12 beers weekly with a remote history of alcoholism which required rehabilitation, reported a 50 pack-year smoking history, and denied intravenous (IV) drug use. He lived with an appropriately vaccinated dog and denied recent insect or animal exposures. He had a cat that passed away from an unknown illness 3 years prior. He was in a monogamous relationship with his girlfriend of 35 years. His father had coronary disease. His medications included glyburide, hydrochlorothiazide, lisinopril, theophylline, and meloxicam.

Chronic cough, weight loss, diabetes, alcoholism, and history of dental disease raise concern for lung abscess. Oral microbiota such as *Streptococcus viridans* and *Actinomycetes* are usu-

ally harmless, but when aspirated repeatedly, such as during alcohol intoxication, may evolve into a lung abscess via bronchogenic spread. The combination of unintentional weight loss and smoking history raises concern for lung malignancy. Small cell lung cancer can present with paraneoplastic Cushing's syndrome and could explain the patient's volume overload. Finally, human immunodeficiency virus (HIV) serostatus should be determined in all adult patients.

His temperature was 37 °C, blood pressure 161/69 mm Hg, pulse 104 beats per minute, respiratory rate 20 breaths per minute, and oxygen saturation was 95% on room air. On examination, he was an unkempt, ill-appearing man. He had poor dentition, but no oral ulcers or petechiae. Pulmonary exam revealed diffuse rhonchi and scattered wheezes. He developed dyspnea after speaking 2 sentences. Cardiovascular exam showed regular tachycardia, normal S1 and S2 heart sounds, and both an S3 and S4 gallop. A grade III/VI holosystolic murmur at the left lower sternal border with apical radiation, and an early, grade III/IV diastolic murmur at the right upper sternal border were present. Neck exam showed jugular venous distention (JVD) 8 cm above the right clavicle. Lower extremities showed symmetric 3+ pitting edema to the knees. His abdomen was soft, nondistended, and without hepatosplenomegaly. There was no lymphadenopathy. Skin exam showed small, healed excoriations on his anterior shins, forearms, and knuckles. There were no petechiae, Janeway lesions, or Osler's nodes.

These exam findings change the differential substantially. New regurgitant murmurs strongly suggest infective endocarditis (IE). A diastolic murmur is never normal and suggests aortic regurgitation. The holosystolic murmur with apical radiation suggests mitral regurgitation. Cutaneous stigmata should always be sought, but are found in fewer than half of cases of subacute IE, and their absence does not rule out this diagnosis. Disheveled hygiene and excoriations suggest a skin source of infection, and poor dentition is concerning for an oral source. For the moment, the source does not matter. His clinical condition is serious: tachycardia, JVD, edema, and two-sentence dyspnea indicate congestive heart failure. Even before labs and imaging return, inpatient admission is warranted.

Serum sodium concentration was 140 mEq/L, potassium 3.7 mEq/L, chloride 103 mEq/L, bicarbonate 30 mEq/L, blood urea nitrogen (BUN) 26 mg/dL, creatinine 0.8 mg/dL, glucose 120 mg/dL, and calcium 9.0 mg/dL. The white blood cell count was 7100/μL, hemoglobin 11.8 g/dL, and platelet count 101 K/μL. Brain natriuretic peptide (BNP) was 785 pg/mL (reference range 0-100 pg/mL), aspartate aminotransferase 77 U/L, alanine aminotransferase 57 U/L, alkaline phosphatase 125 U/L, total bilirubin 0.8 mg/dL, total protein 7.7 g/dL, and albumin 3.7 g/dL. Erythrocyte sedimentation (ESR) rate was 38 mm/hour (reference range 0-25 mm/hour) and C-reactive protein (CRP) 0.62 mg/dL (reference range <1.0 mg/dL). Cardiac troponins were 0.03 ng/mL (reference range <0.04 ng/mL). Screening for HIV was negative. Urinalysis showed trace blood by dipstick, but no glucose, protein, dysmorphic red blood cells, or casts. Two sets of peripheral blood cultures were drawn. Two sets of blood cultures from his previous ED visits were negative (drawn 6 and 14 days prior).

These laboratory values are nonspecific, and the differential remains unchanged, with top concern for IE, then lung abscess. Ideally, 3 sets of cultures drawn greater than 12 hours apart should be obtained because the likelihood of pathogen detection rises with the volume of blood tested. Thrombocytopenia and microscopic hematuria suggest microangiopathic hemolytic anemia, and a peripheral blood smear should be examined for schistocytes. Glomerulonephritis from immune complex deposition can occur in IE, but is unlikely with a normal serum creatinine and lack of proteinuria, dysmorphic red blood cells, or casts. The elevated BNP suggests cardiac strain due to a regurgitant valve. ESR and CRP are rarely helpful in this situation, and perhaps previous treatment with azithromycin and steroids prevented significant elevation.

An electrocardiogram (EKG) showed sinus tachycardia and findings suggestive of left atrial enlargement and left ventricular hypertrophy. Chest x-ray demonstrated diffuse bronchial markings and prominent pulmonary vasculature (Figure 1). He was admitted and treated with IV furosemide for acute congestive heart failure. Oral prednisone and IV azithromycin were continued for COPD exacerbation. He noted an improvement in his orthopnea after 2 liters of urine output.

His chest x-ray is not consistent with acute or chronic pulmonary infection. His symptoms, EKG, edema, and improvement with diuresis support the diagnosis of congestive heart failure. The leading diagnosis is left-sided IE, and antimicrobial therapy should not be delayed for the sake of awaiting positive blood cultures. He should immediately receive empiric antibiotics to cover gram-positive bacteria (*Methicillin-resistant Staphylococ-*

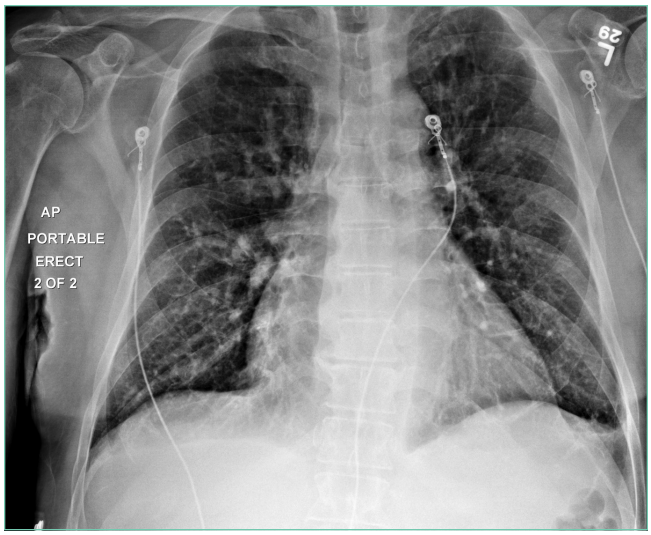

FIG 1. Chest x-ray on admission showing hyperinflation, diffuse bronchial markings, and vascular congestion with prominent pulmonary vasculature.

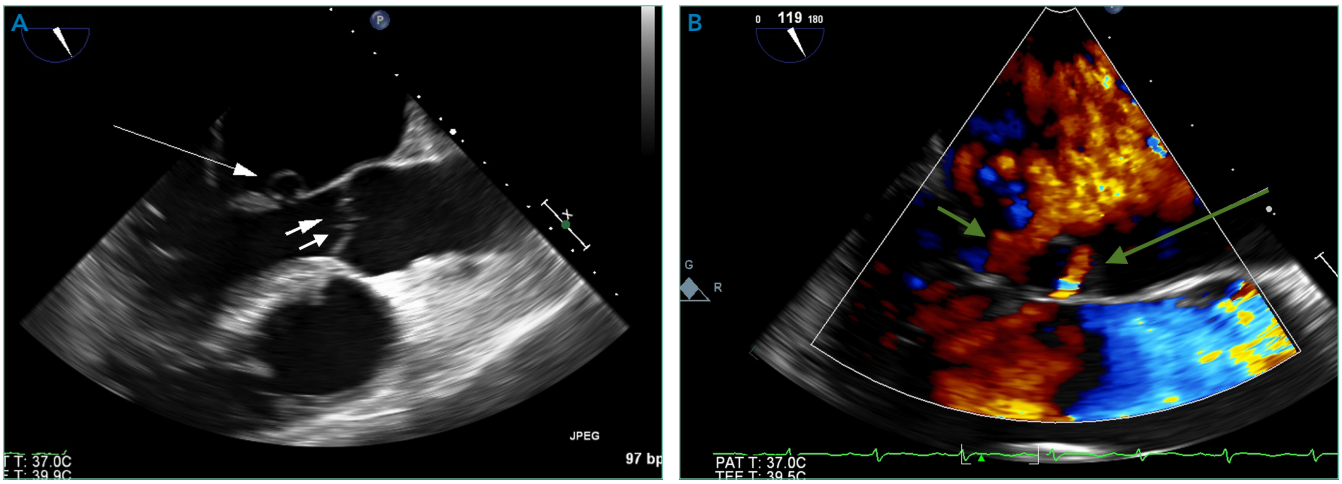

FIG 2. (A) Transesophageal echocardiogram (2-dimensional long axis view) in the end-diastolic phase illustrating small vegetations on the coronary cusps of the aortic valve (short arrows) and a mitral valve aneurysm (long arrow). (B) Color flow Doppler focused on the mitral valve demonstrates moderate mitral regurgitation (short green arrow) and regurgitant flow within the aneurysm from valve perforation (long green arrow). The combination of these findings suggests an infectious process, in which an aortic valve infection with regurgitation seeds an infection on the anterior leaflet of the mitral valve.

cus aureus, *Methicillin-sensitive S. aureus*, coagulase-negative staphylococci, and enterococci) and *Haemophilus* species, *Actinobacillus actinomycetemcomitans*, *Cardiobacterium hominis*, *Eikenella species*, and *Kingella kingae* (the HACEK group). In accordance with Infectious Diseases Society of America (IDSA) practice guidelines, he should empirically receive IV vancomycin plus ceftriaxone and urgently undergo echocardiography.

Transthoracic echocardiogram (TTE) showed severe aortic insufficiency, aortic valve vegetations, and raised suspicion for a moderate-sized vegetation on the anterior leaflet of the mitral valve. There was moderate mitral insufficiency, moderate tricuspid insufficiency, and an elevated right ventricular systolic pressure of 50 mm Hg. The left ventricle showed concentric hypertrophy with an ejection fraction of 55%. A previous echocardiogram 2 years prior showed mild mitral insufficiency, but no aneurysm or aortic insufficiency. Blood cultures from admission yielded no growth.

Due to concern for IE, blood cultures were repeated, and IV vancomycin, IV ceftriaxone, and IV gentamicin were initiated. Azithromycin and prednisone were discontinued. His respiratory status continued to improve with IV furosemide, albuterol, ipratropium, and supportive care.

TTE inadequately visualizes the mitral valve, but is useful for tricuspid valve assessment because the right ventricle is closer to the chest wall. Transesophageal echocardiography (TEE) is indicated for a more detailed assessment of the left heart valves for vegetations and perivalvar abscesses. The new regurgitant murmurs satisfy a major criterion of the modified Duke criteria, and valvar vegetations suggests IE. He does not yet fulfill the other major modified Duke criterion for IE, nor does he satisfy enough minor criteria because there are no diagnostic vascular, microbiologic, or immunologic phenomena. However, no diagnostic rubric is perfect, and these results should not supersede clinical judgment. Despite the absence of positive cultures, the concern for bacterial IE remains high. The absence of embolic phenomena fits best with subacute rather than acute IE. Three negative blood cultures to date suggest a fastidious organism is responsible, although oral flora remain on the differential.

There is rarely a need to "hold" blood cultures for prolonged periods because modern instruments typically yield positive results within 7 days for most bacteria, including the HACEK group. Blood culture-negative endocarditis (BCNE) is considered when 3 sets of cultures are negative for at least 5 days. In this situation, one should consider other microorganisms based on the patient's exposure history. Only certain species with complex growth requirements, such as *Brucella* and *Bartonella*, require prolonged holds. Revisiting his exposure history would be helpful in deciding whether serologic testing warranted. If he recalls exposure to parturient animals, then *Coxiella* is worth pursuing; if he has been bitten by lice, then *B. quintana* rises as a possibility; if the scratches on his limbs are from recent cat scratches, then *B. henselae* becomes more likely. Both *C. burnetti* and *Bartonella* endocarditis might be partially treated by his courses of azithromycin, confounding the picture.

If the infectious work-up is ultimately negative, one could then consider other etiologies of endocarditis, such as nonbacterial thrombotic endocarditis, which is seen in the context of malignancy and systemic lupus erythematosus (Libman-Sacks endocarditis). Other mimickers of IE include myxomatous valve degeneration, ruptured mitral chordae, and eosinophilic heart disease (Löffler's endocarditis).

A transesophageal echocardiogram confirmed the presence of small echodensities on the aortic valve's right and left coronary cusps, consistent with vegetations. The vegetation on the anterior leaflet of the mitral valve from the TTE also showed an aneurysm with a small perforation (Figure 2).

He denied exposure to parturient animals. All blood cultures remained negative at 7 days. He was placed on empiric

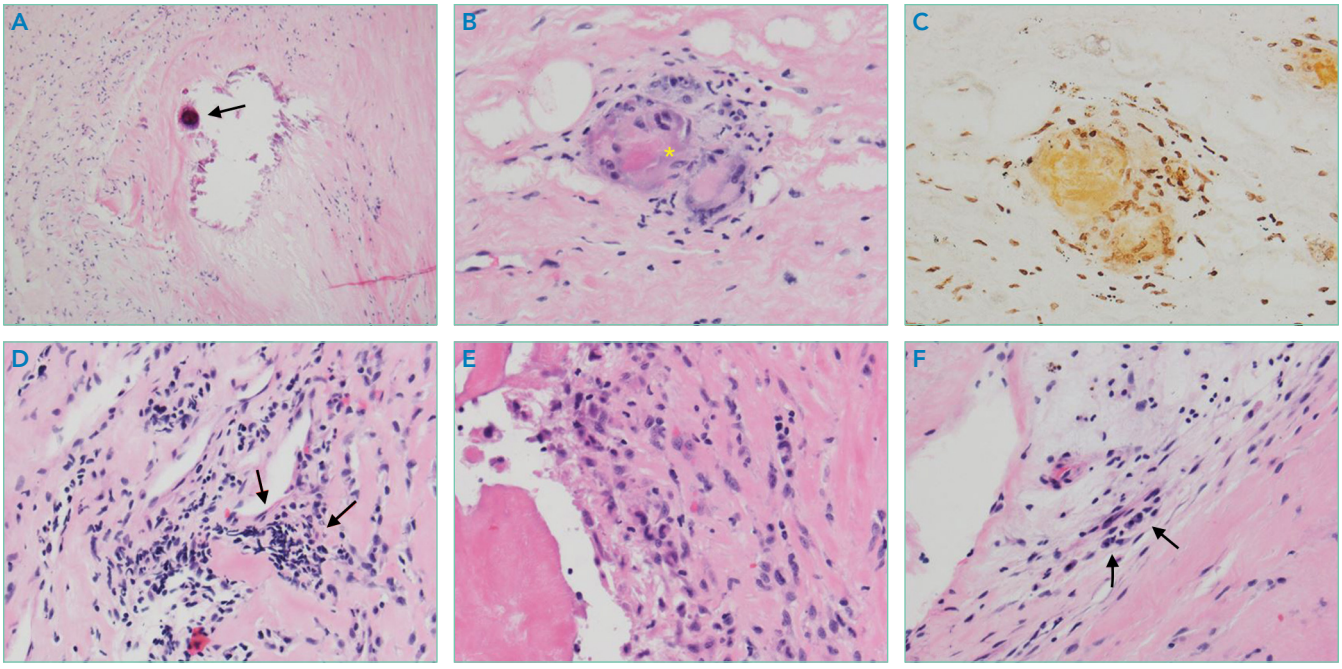

FIG 3. Histopathological changes in the excised aortic and mitral valves. Sections show the following: (A) hematoxylin-eosin stain of the aortic valve with focal calcification (arrow); (B) the mitral valve with a small granuloma (*) and subsequent (C) Steiner stain negative for *Legionella* and spirochetes; (D) patches of acute and chronic inflammation with infiltrates of lymphocytes and neutrophils (arrows); (E) histiocytes; and (F) plasma cells with myxoid degeneration (arrows).

IV vancomycin, IV gentamicin, and IV ampicillin-sulbactam for suspected culture-negative endocarditis. Serology studies for *Bartonella quintana* immunoglobulin G (IgG) and immunoglobulin M (IgM), *Coxiella burnetii* IgG and IgM, *C. burnetti* DNA polymerase chain reaction (PCR), and urine *Legionella* antigen were negative. IgM titers for *Bartonella henselae* were <1:64, but IgG returned markedly elevated at ≥1:1024 (Positive > 1:256). Serum DNA PCR for *B. henselae* was positive.

The combination of aortic regurgitation and the mitral valve aneurysm supports IE, because the aortic regurgitant jet directly strikes the anterior mitral valve leaflet, seeding the valve with infection from the aortic cusps. A positive serum PCR is diagnostic, but if it had been negative or unavailable, the serology would remain very helpful. In this context, the elevated IgG titer implicates *B. henselae*, the agent responsible for cat scratch disease (CSD). Out of context, these titers would not be diagnostic, because anti-*Bartonella* IgG may be increased due to a prior subclinical episode of CSD. Anti-*Bartonella* IgM is an unreliable indicator of recent infection because it may wane within weeks, and this IgG titer is higher than what is observed with most remote infections.

Revisiting previous cat exposure is warranted. He lost his cat to an illness 3 years prior, however it would be appropriate to inquire about other animals, such as a stray kitten with fleas, which his skin scratches suggest. Up to 50% of all cats in flea endemic regions harbor *Bartonella* and are asymptomatic. Rarely, dogs can serve as reservoirs of this organism, with a presumed transmission route via flea, louse, or tick. Regardless of the route of infection, treatment should be focused on *B. henselae* IE.

Azithromycin can treat CSD, and its use for his presumed COPD exacerbation may have temporized his infection. However, azithromycin monotherapy is not recommended for *B. henselae* IE. Treatment is usually with 2 antibiotics, including an aminoglycoside (gentamicin) for the first 2 weeks, combined with either a tetracycline, a macrolide, or a beta-lactam for a minimum of 4-6 weeks. Oral rifampin can be considered if gentamicin is not tolerated. After completing IV treatment, an additional 6 months of oral doxycycline or azithromycin should be considered, especially for those who have not undergone valve surgery.

Significant probing revealed that he was scratched by a neighborhood cat 6 months earlier but had no symptoms. The scratches on his leg were from his dog. He received IV antibiotics for 6 weeks and was transitioned to oral doxycycline. He suffered a seizure from a presumed mycotic middle cerebral artery aneurysm, thus valve replacement was postponed for another 6 weeks. He underwent bioprosthetic aortic and mitral valve replacement. Valve pathology (Figure 3) showed myxoid degeneration, focal calcifications, mixed acute and chronic inflammation of both valves, and a small granuloma on the mitral valve. No organisms were seen on hematoxylin-eosin (H&E) staining, and Steiner stain was negative for *Legionella* and spirochetes. A Warthin-Starry stain was not performed. He felt well at 24 months.

The mitral valve aneurysm, abscesses, and heart failure warranted valve replacement. Surgery should be considered for all patients with *Bartonella* IE, primarily because delayed diagnosis often leads to irreversible valve damage. Ideally, surgically explanted tissue should be divided into 2 portions: half should

be sent to pathology and stained with H&E, Warthin-Starry, and Steiner staining procedures, while the other half should be sent for culture, and then PCR if stains are negative.

His symptoms are compatible with subacute IE, which is typically more difficult to diagnose than acute IE due to its insidious onset. He meets criteria for blood culture negative IE based on 3 sets of negative blood cultures for greater than 5 days and major criteria for IE. The pathologic changes are consistent with *B. henselae* infection.

DISCUSSION

The incidence of IE in the United States is 40,000 cases per year[1] with an in-hospital mortality of 15%-20% and a 1-year mortality of up to 40%.[2,3] Five to 20% of patients with IE never develop positive blood cultures[4] due to receipt of antibiotics prior to culture, inadequate microbiologic testing, or infection caused by noncultivable bacteria (eg, *Tropheryma whipplei*), fastidious extracellular bacteria (eg, HACEK group and nutritionally variant streptococci), or by intracellular pathogens with complex nutrient requirements (eg, *Bartonella*, *Chlamydia*, *Brucella*, or *Coxiella*). Previous administration of antibiotics reduces the likelihood of isolating an organism by 35%-40%.[5] Patients meeting criteria for BCNE should prompt consideration of serologic testing. The most prevalent pathogens vary globally, and incidence data in the US is scarce. Worldwide, the majority of BCNE cases are caused by *Coxiella*, *Bartonella*, and *Brucella* species.[6,7]

When clinical suspicion for IE remains high despite negative cultures, detailed history can uncover clues and guide additional testing. For example, contact with contaminated milk products or farm animals are associated with *Brucella*, *Coxiella*, and *Erysipelothrix* species IE.[7,8] *Bartonella* species are zoonotic gram-negative bacilli with a tropism for endothelial cells and are transmitted by arthropod vectors (ie, fleas, lice, ticks, and sandflies), cat scratches, or cat bites. *Bartonella* may account for 3%-4% of all cases of IE, most of which are due to *B. henselae* and *B. quintana*.[7,9] Underlying heart valve disease, alcoholism, cirrhosis, and homelessness are associated with *B. henselae* endocarditis.[10]

Diagnostic criteria are lacking for *B. henselae* IE, and the modified Duke criteria is of limited utility for diagnosing *Bartonella* IE because blood cultures are often negative and echocardiographic evidence of vegetation is not always apparent. Serology plays a critical role in the diagnosis of *Bartonella* infections. The addition of positive serology, Western blot or PCR for *B. henselae* and *B. quintana* as a major criterion in the modified Duke criteria for IE has been proposed but has not yet been formally accepted.[9] For *B. henselae* IE, an IgG titer of ≥1:800 has been recommended as a cutoff for subacute IE because it combines a high specificity and positive predictive value along with reasonable sensitivity and negative predictive value in this situation.[9] The humoral immune response rises over time, and thus acute IE due to *Bartonella* may not generate a substantial IgG titer. Interestingly, because of the indolent nature of this pathogen, most cases of IE present once IgG titers have begun to rise. Serum PCR testing has shown a sensitivity and specificity of 58% and 100%, respectively.[11] Isolation by blood culture requires specific growth media and prolonged incubation, with a sensitivity as low as 20% and 30% for blood and tissue, respectively.[10] The microbiology laboratory should be notified of suspected *Bartonella* to intensify efforts to cultivate this organism. If infection with *Coxiella* or *Brucella* is suspected, the lab should also be informed, both to increase diagnostic yield and to trigger enhanced biosafety precautions when handling the specimens. Despite attempts to optimize the yield, up to 75% of *Bartonella* IE may remain culture negative,[12,13] making it difficult to meet the current major modified Duke criterion of positive blood cultures. H&E staining of valve tissue infected with *Bartonella* commonly reveals increased inflammation, fibrosis, and calcified granulomas relative to endocarditis from other causes.[14] The Warthin-Starry silver stain can identify small, darkly staining bacteria in more than 75% of *Bartonella* endocarditis; however, this stain is not specific for *Bartonella* species.[9]

This case highlights the challenge of diagnosing subacute IE because this patient received antibiotics and steroids prior to presentation, clouding the clinical picture. Although he did not exhibit textbook signs of endocarditis, his symptoms (new onset heart failure and new regurgitant murmurs) prioritized the diagnosis. The combination of elevated serum titers, positive PCR, valve granulomas and abscesses on TEE, and pathology findings led the discussant to the correct diagnosis. Scratching beneath the surface revealed his penchant for cats, but this was only considered a key epidemiological feature later in his clinical course.

TEACHING POINTS

- Subacute IE typically presents with indolent constitutional symptoms over a course of weeks to months, whereas acute IE causes a rapid onset of fevers, rigors, and is more likely to exhibit embolic phenomena.
- Epidemiologic features specific to *Bartonella* species include alcoholism, cirrhosis, dog or cat exposure, homelessness, and body lice, and should be considered in suspected cases of BCNE.
- If suspicion for endocarditis remains high and animal exposure is elicited, then serologic and PCR testing for fastidious organisms should be strongly considered. The most common causes of BCNE include *Coxiella*, *Bartonella*, and *Brucella* species.
- The modified Duke criteria do not incorporate *Bartonella* within the diagnostic schema. Presentation is usually late and often requires valve replacement.

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The Harm We Do: The Environmental Impact of Medicine

Julia Schoen, MS[1]*, Vineet Chopra, MD, MSc[1,2]

[1]*The University of Michigan School of Medicine, Ann Arbor, Michigan;* [2]*The Division of Hospital Medicine, Michigan Medicine, Ann Arbor, Michigan.*

While often unseen and infrequently discussed, the environmental impact of hospital systems and healthcare providers is substantial. However, some US hospitals and healthcare systems have developed innovative approaches to reduce their environmental impact while reducing costs. In this perspective, we discuss how hospitalists may support ongoing environmental efforts through education and awareness, measurement and amelioration, public reporting, and individual actions. Given the extent of healthcare's impact on the environment, the benefits of interventions, and the link between hospitalists and hospitals, We must minimize the harm we do. *Journal of Hospital Medicine* 2018;13:353-355. Published online first February 27, 2018. © 2018 Society of Hospital Medicine

Healthcare is a "dirty" business with widespread effects on the environment. In the US, healthcare is estimated to generate 9.8% of our greenhouse gases and 9% of our particulate matter emissions.[1] Hazardous wastes must be incinerated, emitting carbon dioxide, nitrogen oxides, and volatile substances into the atmosphere.[2] Similarly, hospitals are responsible for 7% of commercial water use in the US.[3] Conventional water treatment systems are not designed to remove heavy metals, pharmaceuticals, and disinfectants in hospital wastewaters; these compounds have been detected in rivers and streams throughout the US.[4,5] Furthermore, pharmaceutical compounds such as antibiotics, anti-epileptics, and narcotics have even been isolated in our drinking water.[5]

As hospitalists, we are the directors of inpatient care, yet we only witness brief moments in the lives of our patients and the products we use for their care. For example, we are unaware of particulate matter emissions needed to power an extra imaging study or the contribution of unused materials to a growing landfill. However, pollution, including that from our clinical practice, is detrimental to human health in many ways. Exposure to particulate matter and toxic wastes has been linked to increased rates of reproductive and developmental disorders, cancer, and respiratory disease. [6] Particles <2.5 μm in diameter can diffuse through alveoli into the bloodstream, contributing to heart disease, stroke, and lung disease.[7] Climate change has been linked to a wide range of adverse cardiovascular, respiratory, infectious, and mental health outcomes.[8,9] These examples of the health impacts of pollution are illustrative but not exhaustive.

Address for correspondence: Julia Schoen, MS; University of Michigan Medical School, 3852 E Medical Center Drive, Ann Arbor, MI 48109; E-mail: jhschoen@med.umich.edu

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The environmental impact of US healthcare accounts for an estimated 470,000 disability-adjusted life years lost; this figure is on par with the burden of preventable medical errors.[1] Clearly, change is necessary at all levels in the healthcare system to address our impact on human health. Fortunately, healthcare systems and hospital administrators have begun to address this issue. This perspective describes sustainability efforts in hospitals and healthcare systems and seeks to motivate hospitalists to build upon these efforts.

EFFORTS BY HOSPITALS AND HEALTHCARE SYSTEMS

With the ability to affect change from the top down, health systems are playing an important role in healthcare's environmental sustainability. Ambitiously, Kaiser Permanente outlined eight environmental stewardship goals, which include becoming net carbon positive and recycling, reusing, or composting 100% of their non-hazardous waste by 2025.[10] The Cleveland Clinic has pledged to become carbon neutral within the next 10 years.[11] Other healthcare systems may follow suite. Many "green" interventions aimed at reducing waste and pollution also protect population health and reduce hospital operating costs.

From 2011 to 2015, a group of Boston Hospitals decreased energy use by 9.4% compared with a historical growth of 1.5% per year and saved over 15 million dollars.[12] Similarly, Virginia Mason reduced landfill waste by reprocessing single-use medical devices, thereby decreasing purchasing costs by $3 million.[13] As part of a regional campaign to protect the St. Croix River, Hudson Hospital and Clinic in Wisconsin saved over $20,000 with new recycling and waste reduction programs.[13] Notably, these programs not only benefit hospitals but also patients and payers by reducing costs of care.

ROLE OF THE HOSPITALIST

These examples illustrate that a greener healthcare industry is achievable. Despite the potential benefits, sustainability efforts in US hospitals are the exception, not the rule, and the

diffusion of such innovations must be encouraged from within.

In addition to the moral case for environmentally sustainable healthcare,[14,15] such efforts can also improve our quality of care. The conversation around healthcare waste has focused on costs. Yet, examining our waste from a new perspective may reveal new ways to increase the value of patient care while protecting population health. Our communities and families are not immune to the health impacts of pollution, including that generated by our industry. However, predicted effects of climate change including altered patterns of vector-borne disease and frequent hurricanes and forest fires are upon us, affecting our communities, hospitals, and health delivery enterprise today. These challenges represent educational, academic, and economic opportunities that hospitalists should embrace.

RECOMMENDATIONS FOR ACTION

Education and Awareness

The first step to engagement is to promote awareness of the effects of healthcare waste. Physicians remain one of the most trusted sources of information about the health impacts of climate change.[16] By educating ourselves, we can spread accurate knowledge to our patients and communities. Furthermore, we have the ability to advocate for our hospitals to follow institutions such as Kaiser Permanente and the Cleveland Clinic.

Given that hospitalists play a key role in educating students and residents, they are ideal vehicles for such dissemination. Education should begin in medical and nursing schools, where curricula detailing the importance and impact of healthcare pollution may be introduced. As hospitalists, we should champion such efforts.

Measurement and Amelioration

Second, resource use, waste production, and areas for improvement must be systematically quantified. At a national level, the Sustainable Development Unit of the National Health System (NHS) measures and reports water use, waste production, and energy consumption of the UK's healthcare sector. Consequently, the NHS has surpassed their 2015 goal of reducing their carbon footprint by 10%.[17] By establishing a baseline understanding of our carbon emissions, waste production, and water consumption, areas where physicians and hospitals can target improvement can similarly be identified.

Hospitalists appreciate the practical tradeoffs between clinical work and change efforts; thus, they are critical in establishing pragmatic policies. Physicians, often in collaboration with environmental engineers, have used evidence-based methods such as life-cycle analysis (LCA) to evaluate the environmental impacts of the pharmaceuticals and procedures that they use.[18-20] An LCA is a cost-benefit analysis that examines multiple parameters of a product, namely, emissions, water use, costs, and waste production, from production to disposal. For example, an LCA of disposable custom packs for hysterectomies, vaginal deliveries, and laryngeal masks found costs savings and environmental benefits from choosing reusable over single-use items and removing unnecessary materials such as extra towels in this setting. [18-20] By considering the full life cycle of a procedure, LCAs reveal important information about the value and safety of care. LCAs, along with other sustainable design strategies, are tools that can provide hospitalists with new insights for quality improvement.

Public Reporting

Numerous physicians are known for educating their communities about the impacts of pollution on health. Recently, a pediatrician brought the presence of lead in Flint's water supply to the public's attention, instigating government action and policy change.[21] A group called Utah Physicians for a Healthy Environment publishes online summaries of peer-reviewed information on air pollution and health. The Huma Lung Foundation led by a pulmonologist in Chennai, India, is working with a local radio station to report daily air quality measurements along with health advisories for the city.

We must now extend this paradigm to encompass transparency about healthcare's practices and their impact on health. Indeed, the public is comfortable with this idea: a survey of 1011 respondents in the UK found that 92% indicated that the healthcare system should be environmentally sustainable.[22] One idea may be a public-facing scorecard for hospitals, akin to publicly reported quality metrics. We can look to the example of the SDU and corporations such as Apple, which publicly report their carbon emissions, waste production, water use, and other metrics of their environmental impact. By galvanizing efforts to quantify and report our impact, hospitalists have the opportunity to be a role model for the industry and increase trust within their communities.

Individual Actions

What can a hospitalist do today? First, simple measures, like turning off idle electronics, recycling appropriately, or avoiding the use of unnecessary supplies or tests, are behavioral steps in the right direction. Second, just as education, goal setting, and feedback have met success in improving hand hygiene,[23] we must begin the hard work of developing programs to monitor our environmental impact. Individual hospitalist carbon scores may help intensify efforts and spur improvement. Finally, we should learn and celebrate each other's success. Renewed focus on this topic with increased reporting of interventions and outcomes is needed.

CONCLUSIONS

As hospitalists, we must look within ourselves to protect our planet and advocate for solutions that assure a sustainable future. By recognizing that a healthy environment is crucial to human health, we can set an example for other industries and create a safer world for our patients. Eliminating the harm we do is the first step in this process.

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Patient-Centered, Payer-Centered, or Both? The 30-Day Readmission Metric

Craig A. Umscheid, MD, MSCE[1,2,3,4]*, S. Ryan Greysen, MD, MHS, MA[3,4]

[1]*Center for Evidence-based Practice, University of Pennsylvania Health System, Philadelphia, Pennsylvania;* [2]*Department of Biostatistics, Epidemiology and Informatics, University of Pennsylvania Perelman School of Medicine, Philadelphia, Pennsylvania;* [3]*Department of Medicine, University of Pennsylvania Perelman School of Medicine, Philadelphia, Pennsylvania;* [4]*Leonard Davis Institute of Health Economics, University of Pennsylvania, Philadelphia, Pennsylvania.*

There is little doubt that preventing 30-day readmissions to the hospital results in lower costs for payers. However, reducing costs alone does not make this metric a measure of "high value" care.[1] Rather, it is the improvement in the effectiveness of the discharge process that occurs alongside lower costs that makes readmission reduction efforts "high value" – or a "win-win" for patients and payers.

However, the article by Nuckols and colleagues in this month's issue of the *Journal of Hospital Medicine* (JHM) suggests that it might not be that simple and adds nuance to the ongoing discussion about the 30-day readmission metric.[2] The study used data collected by the federal government to examine changes not only in 30-day readmission rates between 2009-2010 and 2013-2014 but also changes in emergency department (ED) and observation unit visits. What they found is important. In general, despite reductions in 30-day readmissions for patients served by Medicare and private insurance, there were increases in observation unit and ED visits across all payer types (including Medicare and private insurance). These increases in observation unit and ED visits resulted in statistically higher overall "revisit" rates for the uninsured and those insured by Medicaid and offset any improvements in the "revisit" rates resulting from reductions in 30-day readmissions for those with private insurance. Those insured by Medicare—representing about 300,000 of the 420,000 visits analyzed—still had a statistically lower "revisit" rate, but it was only marginally lower (25.0% in 2013-2014 versus 25.3% in 2009-2010).[2]

The generalizability of the Nuckols' study was limited in that it examined only index admissions for acute myocardial infarction (AMI), heart failure (HF), and pneumonia and used data from only Georgia, Nebraska, South Carolina, and Tennessee—the four states where observation and ED visit data were available in the federal database.[2] The study also did not examine hospital-level revisit data; hence, it was not able to determine if hospitals with greater reductions in readmission rates had greater increases in observation or ED visits, as one might predict. Despite these limitations, the rigor of the study was noteworthy. The authors used matching techniques to ensure that the populations examined in the two time periods were comparable. Unlike previous research,[3,4] they also used a comprehensive definition of a hospital "revisit" (including both observation and ED visits) and measured "revisit" rates across several payer types, rather than focusing exclusively on those covered by fee for service Medicare, as in past studies.[4,5]

What the study by Nuckols and colleagues suggests is that even though patients may be readmitted less, they may be coming back to the ED or getting admitted to the observation unit more, resulting in overall "revisit" rates that are marginally lower for Medicare patients, but often the same or even higher for other payer groups, particularly disadvantaged payer groups who are uninsured or insured by Medicaid.[2] Although the authors do not assert causality for these trends, it is worth noting that the much-discussed Hospital Readmission Reduction Program (or "readmission penalty") applies only to Medicare patients aged more than 65 years. It is likely that this program influenced the differences identified between payer groups in this article.

Beyond the policy implications of these findings, the experience of patients cared for in these different settings is of paramount importance. Unfortunately, there are limited data comparing patient perceptions, preferences, or outcomes resulting from readmission to an inpatient service versus an observation unit or ED visit within 30 days of discharge. However, there is reason to believe that costs could be higher for some patients treated in the ED or an observation unit as compared to those in the inpatient setting,[6] and that care continuity and quality may be different across these settings. In a recent white paper on observation care published by the Society of Hospital Medicine (SHM) Public Policy Committee,[7] the SHM reported the results of a 2017 survey of its members about observation care. The results were concerning. An overwhelming majority of respondents (87%) believed that the rules for observation are unclear for patients, and 68% of respondents believed that policy changes mandating informing patients of their observation status have created conflict between the provider and the patient.[7] As shared by one respondent, "the observation issue can severely damage the therapeutic bond with patient/family, who may conclude that the hospitalist has more interest in saving someone money at the expense of patient care."[7] Thus, there is significant concern about the nature of observation stays and the experience for patients and providers. We should take care to better understand these experiences given

***Address for correspondence**: Craig A. Umscheid, MD, MSCE, Perelman Center for Advanced Medicine, South Pavilion, 6th Floor, Office 623, 3400 Civic Center Boulevard, Philadelphia, PA 19104; Telephone: (215) 349-8098; Fax: (215) 349-8232; E-mail: craig.umscheid@uphs.upenn.edu

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that readmission reduction efforts may funnel more patients into observation care.

As a next step, we recommend further examination of how "revisit" rates have changed over time for patients with any discharge diagnosis, and not just those with pneumonia, AMI, or HF.[8] Such examinations should be stratified by payer to identify differential impacts on those with lower socioeconomic status. Analyses should also examine changes in "revisit" types at the hospital level to better understand if hospitals with reductions in readmission rates are simply shifting revisits to the observation unit or ED. It is possible that inpatient readmissions for any given hospital are decreasing without concomitant increases in observation visits, as there are forces independent of the readmission penalty, such as the Recovery Audit Contractor program, that are driving hospitals to more frequently code patients as observation visits rather than inpatient admissions.[9] Thus, readmissions could decrease and observation unit visits could increase independent of one another. We also recommend further research to examine differences in care quality, clinical outcomes, and costs for those readmitted to the hospital within 30 days of discharge versus those cared for in observation units or the ED. The challenge of such studies will be to identify and examine comparable populations of patients across these three settings. Examining patient perceptions and preferences across these settings is also critical. Finally, when assessing interventions to reduce inpatient readmissions, we need to consider "revisits" as a whole, not simply readmissions.[10] Otherwise, we may simply be promoting the use of interventions that shift inpatient readmissions to observation unit or ED revisits, and there is little that is patient-centered or high value about that.[9]

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Engaging Families as True Partners During Hospitalization

Alisa Khan, MD, MPH[1], Sharon Cray, BBA[2], Alexandra N. Mercer, BA[1], Matthew W. Ramotar, BA[1], Christopher P. Landrigan, MD, MPH[1,3]

[1]Boston Children's Hospital, Boston, Massachusetts; [2]St. Christopher's Hospital for Children, Philadelphia, Pennsylvania; [3]Department of Medicine, Brigham and Women's Hospital, Boston, Massachusetts.

Communication failures are a leading cause of sentinel events, the most serious adverse events that occur in hospitals.[1] Interventions to improve patient safety have focused on communication between healthcare providers.[2-4] Interventions focusing on communication between providers and families or other patient caregivers are under-studied.[5,6] Given their availability, proximity, historical knowledge, and motivation for a good outcome,[7] families can play a vital role as "vigilant partners"[8] in promoting hospital communication and safety.

In this month's *Journal of Hospital Medicine*, Solan et al. conducted focus groups and interviews of 61 caregivers of hospitalized pediatric patients at 30 days after discharge to assess their perceptions of communication during hospitalization and discharge home.[9] They identified several caregiver themes pertaining to communication between the inpatient medical team and families, communication challenges due to the teaching hospital environment, and communication between providers. Caregiver concerns included feeling out of the loop, excessive provider use of medical jargon, confusing messages on rounds, and inadequate communication between inpatient and outpatient providers.

The manuscript serves both to uncover family concerns that may be underappreciated by clinicians and suggest some potential solutions. For instance, caregivers can be apprehensive about whom to call for postdischarge advice because they are sometimes uncertain whether their outpatient providers have sufficient information about the hospitalization to properly advise them. The authors propose using photo "face sheets" to improve caregiver identification of healthcare provider roles, including families in hospital committees, improving transition communication between inpatient and outpatient healthcare providers through timely faxed discharge summaries and telephone calls, and informing families about such communications with their outpatient providers.

These are important suggestions. However, in order to move from promoting communication alone to promoting true partnership in care, there are additional steps that providers can take to fully engage families in hospital and discharge communications.

Meaningful family engagement in hospital communications—eg, during family-centered rounds (FCRs)—has been associated with improved patient safety and experience.[10-12] To further enhance family partnership in care, we would make the following 3 suggestions for hospitals and healthcare providers: (1) focus on health literacy in all communications with families, (2) work towards shared decision making (SDM), and (3) make discharges family-centered.

HEALTH LITERACY

In order to partner with one another, families and healthcare providers need to speak a common language. A key way to ensure that families and providers speak a common language is for providers to espouse good health literacy principles. Health literacy is the "capacity to obtain, process, and understand basic health information and services to make appropriate health decisions."[13] Health literacy is dynamic, varying based on medical problem, provider, and healthcare system.[14] Overall, only 12% of United States adults possess the health literacy skills required to navigate our complex healthcare system.[15,16] Stress, illness, and other factors can compromise the ability of even these individuals to process and utilize health information. Yet health literacy is routinely overestimated by providers.[17-19]

To optimize communication with families, providers should use "universal health literacy precautions"[16] with all patients, not just those believed to need extra assistance, in both verbal (eg, FCRs) and written communications (eg, discharge instructions).[16] Providers should speak in plain, nonmedical language, be specific and concrete, and have families engage in "teach-back" (ie, state in their own words their understanding of the plan). They should focus on what families "need to know" rather than what is "good to know." They should use simpler sentence structure and "chunk and check"[20] (ie, provide small, "bite-sized" pieces of information and check for understanding by using teach-back).[21] In writing, they should use simpler sentence structure, bullet points, active statements, and be cognizant of reading level, medical jargon, and word choice (eg, "has a fever" instead of "febrile"). It is worth recognizing that even highly educated, highly literate families—not least of all those who are physicians and nurses themselves—can benefit from universal health literacy precautions because the ability to process and grasp information is dynamic and can be markedly lower than usual when faced with the illness of a loved one.

***Address for correspondence:** Alisa Khan, MD, MPH, Boston Children's Hospital, 21 Autumn St., Rm 200.2, Boston, MA 02215;

Telephone: 617-355-2565; Fax: 617-730-0957; E-mail: alisa.khan@childrens.harvard.edu

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At a systematic level, medical schools, nursing schools, residency training programs, and continuing education should include health literacy training in their curricula. While learning to speak the language of medicine is an important part of medical education, the next step is learning to "unspeak" it, a challenging but important charge to promote partnership.

SHARED DECISION MAKING

SDM is the process by which providers and patients make decisions together by balancing clinical evidence with patient preferences and values.[22] However, despite providers believing they are engaging in SDM,[23,24] families report they are often not as involved in SDM as they would like.[24-26] Indeed, most hospital communications with families, including FCRs and discharge instructions, typically emphasize information sharing, not SDM. SDM tends to be more commonly applied in outpatient settings.[27] To encourage SDM in the hospital setting, patients and families should not only understand communication during FCRs and at discharge but should be encouraged to be active participants in developing care plans,[26] no matter how minor the decisions involved.[28] SDM can be applied to a variety of discussions, both during hospitalization (eg, initiation of antibiotics, transition from intravenous to oral medications, pursuing imaging) and at discharge (eg, assessing discharge readiness, deciding duration of therapy, formulating follow-up recommendations). Providers will benefit from incorporating information from personal and medical histories that only families possess, resulting in more informed and potentially safer care plans that may be more likely to fit into the family's life at home. SDM can also ensure patient and family "buy-in" and increase the likelihood of compliance with the shared plan.

FAMILY CENTERED DISCHARGES

Discharge processes often involve multiple redundancies and parallel processes that fail to actively involve families or promote transparency.[29] Discharge summaries are typically written in medical jargon and intended for the outpatient provider (who may not receive them in a timely fashion), not the family.[30-32] Separate discharge instructions are often provided to families without sufficient attention to health literacy, contingency planning, or individualization (eg, a generic asthma fact sheet).[30] Outpatient providers are not always contacted directly about the hospitalization, nor are families always informed when providers are contacted, as Solan et al. describe.

Providers can apply lessons from FCRs to discharge processes, pursuing a similar family-centered, interprofessional approach promoting partnership and transparency. Just as providers engage families during discussions on FCRs, they can engage families in discharge conversations with outpatient providers and nursing colleagues. Indeed, Berry et al. propose a discharge framework that emphasizes involvement of and dialogue between patients, families, and providers as they systematically develop and assess plans for discharge and postdischarge care.[33] To accomplish this, inpatient providers can copy families on discharge summaries and other correspondence with outpatient providers (eg, through secure emails or open-source notes such as OpenNotes[34-36]). Moreover, particularly for complex discharges, inpatient providers can call outpatient providers in the family's presence or invite outpatient providers to join—via telephone or videoconference—day-of-discharge FCRs or discharge huddles. Such efforts require logistical and pragmatic considerations, as well as culture change, but are not insurmountable and may help address many family concerns around peridischarge communication and care. Such efforts may also promote accountability on the part of families and providers alike, thereby ensuring that families are truly engaged as vigilant partners in care.

As one of us (SC) reflected once when considering her experience navigating healthcare as a parent of 2 children with cystic fibrosis, "We have to make it easier for families to be a true part of their children's care. When patients and families are true members of the medical team, care is more informed, more targeted, and more safe for everyone."

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The Maturing Antibiotic Mantra: "Shorter Is Still Better"

Brad Spellberg, MD[1,2]*

[1]Los Angeles County + University of Southern California (LAC+USC) Medical Center, Los Angeles, California; [2]Division of Infectious Diseases, Keck School of Medicine at USC, University of Southern California, Los Angeles, California.

The proper duration of antibiotic therapy for various infections is a matter of long-standing consternation. For decades, the standard antibiotic course for most acute bacterial infections has been 7 to 14 days, based largely on the fact that the week has 7 days in it.[1] The reason the week has 7 days in it dates back to an edict issued by Constantine the Great in 321 AD.[1] To underscore the absurdity of basing 21st century antibiotic course durations on an ancient Roman Emperor's decree, I refer to such durations as "Constantine Units." One Constantine Unit is a 7-day course of antibiotics, and 2 Constantine Units is a 14-day course.

It has been nearly 10 years since Dr. Lou Rice first publicly called out the need to move to shorter courses of antibiotic therapy based on high-quality data.[2] Nearly 5 years ago, colleagues picked up Dr. Rice's mantle and again called for the medical community to move to short-course antibiotic therapies.[3] There have been dozens of antibiotic trials comparing shorter versus longer durations of therapy for a variety of acute bacterial infections (Table).[1] Essentially, all such trials studying acute bacterial infections in adults have found that shorter-course therapy is just as effective as longer therapy.

Based on such a plethora of data, a year ago, I suggested that physicians replace the dogma of Constantine-Unit-based durations of therapy with a new mantra, "shorter is better."[1] A year later, that mantra is no longer new. It is maturing, but it is not yet sufficiently widespread among providers. As a result, providers continue to prescribe unnecessarily long durations of antibiotic therapy, which wastes antibiotics, results in increased selective pressure driving antibiotic resistance, and continues to erode the miraculous efficacy of these drugs.

Royer et al.[4] have now added to the overwhelming evidence in favor of short-course antibiotic therapy with a new meta-analysis comparing shorter courses with longer courses of therapy for acute bacterial infections, specifically for hospitalized patients. They studied clinical trials comparing shorter versus longer courses of therapy for hospital inpatients with pneumonia, complicated urinary tract infections, intraabdominal infections, or nosocomial infections of unknown origin. Across 13 clinical trials that included efficacy data, cumulatively, the investigators found no difference in clinical cure, microbiological cure, mortality, or infection relapses between short courses and longer courses of therapy. As mentioned, this result is concordant with an extensive body of literature on this topic (Table).

The fact that short durations of antibiotics can cure infections has been known for a long time. In the early penicillin era, courses of therapy were typically 1 to 4 days with good success rates.[2] Interestingly, in a recent clinical trial in which daptomycin was found to be ineffective for community-acquired pneumonia (because of inactivation by pulmonary surfactant), a single dose of ceftriaxone markedly improved the cure rate for pneumonia in the daptomycin arm.[5,6] The salutary effect of a single dose of ceftriaxone on the clinical cure for pneumonia reinforces how badly we have been overtreating infections for many years.

Many of the signs and symptoms of bacterial infections result from the inflammatory response to the bacteria rather than the direct presence of viable bacteria. Thus, the persistence of symptoms for a few days does not necessarily mean that viable bacteria are still present (ie, symptoms can persist even when all the bacteria are dead). It is likely that a reasonable proportion of patients with acute bacterial infections are cured with 1 day of therapy, and that additional days are decremental to increasing that cure rate. Even 5 days of antibiotics are likely more than is needed to cure the large majority of patients with acute bacterial infections.

Unfortunately, we do not yet have the technology to truly customize durations of therapy in individual patients, although the resolution of high-procalcitonin levels can assist with this question by enabling earlier termination of therapy.[7] Rather, we tend to select fixed durations of therapy knowing that we are overtreating some (if not most) patients because we cannot distinguish individual treatment needs, and we want to be sure that the duration we select will maximally cure everyone we treat. Our desire to maximize cures across a population has led us to expand durations of therapy over many decades based on increments of Constantine Units. Fortunately, more recent randomized controlled trials now tell us with great confidence that shorter courses of antibiotic therapy are as effective as longer courses, with the added benefit of reducing the exposure of patients to antibiotics. Reduced exposure intrinsically reduces the risk of adverse events and of selective pressure that drives resistance in our microbiomes.

Thus, shorter is indeed better. The thought is no longer new; it is maturing. It is based on real, repeated, high-quality randomized controlled trials across multiple types of infections. Medical staffs of hospitals should pass expected practices

***Address for correspondence:** Brad Spellberg, MD, 2051 Marengo Street, Los Angeles, CA 90033; Telephone: 323-409-6734; E-mail: bspellberg@dhs.lacounty.gov

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TABLE. **Infections for which Short-Course Antibiotic Therapy Is Equivalent in Efficacy to Longer Therapy**[1]

Disease	Short Course Studied (days)	Long Course Studied (days)	Result
Acute bacterial sinusitis	5	10	Equal
Acute exacerbation of chronic bronchitis and obstructive pulmonary disease	≤5	≥7	Equal
Intraabdominal infection	4	10	Equal
Osteomyelitis	42	84	Equal
Pneumonia, community-acquired	3-5	7-10	Equal
Pneumonia, nosocomial (including ventilator-associated)	≤8	10-15	Equal
Pyelonephritis	5-7	10-14	Equal
Skin infections (cellulitis, major abscesses, wound infections)	5-6	10-14	Equal

around short-course antibiotic therapy to encourage their providers to practice modern antiinfective medicine. National guidelines for specific types of infections and regulatory standards for clinical trial conduct should also be updated.[3,8] In short, it is time for the medical community to support changing our old habits and help to transform how we use and protect the rapidly eroding societal trust[8] that is effective antimicrobial therapy.

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