

BRIEF REPORT

Understanding Predictors of Prolonged Hospitalizations Among General Medicine Patients: A Guide and Preliminary Analysis

Mary E. Anderson, MD^{1*}, Jeffrey J. Glasheen, MD¹, Debra Anoff, MD¹, Read Pierce, MD¹, Roberta Capp, MD, MSPH²,
Christine D. Jones, MD, MS¹

¹Hospital Medicine Section, Division of General Internal Medicine, Department of Medicine, University of Colorado School of Medicine, Aurora, Colorado; ²Department of Emergency Medicine, University of Colorado School of Medicine, Aurora, Colorado.

Targeting patients with prolonged hospitalizations may represent an effective strategy for reducing average hospital length of stay (LOS). We sought to characterize predictors of prolonged hospitalizations among general medicine patients to guide future improvement efforts. We conducted a retrospective cohort study using administrative data of general medicine patients discharged from inpatient status from our academic medical center between 2012 and 2014. Multivariable logistic regression was performed to assess the association between sociodemographic and clinical variables with prolonged LOS, defined as >21 days. Of 18,363 discharges, 416 (2.3%) demonstrated prolonged LOS. Prolonged hospitalizations accounted for 18.6% of total inpatient days and contributed 0.8 days to an average LOS of 4.8 days during the study period. Prolonged hospitalizations were associated with younger age (odds ratio [OR]: 0.80 per 10-year increase in age, 95% confidence interval [CI]: 0.73–

0.87) and Medicaid insurance (OR: 1.99, 95% CI: 1.29–3.05, REF = Medicare). Compared to patients without prolonged LOS, prolonged LOS patients were more likely to have methicillin-resistant *Staphylococcus aureus* septicemia (OR: 8.83, 95% CI: 1.72–45.36); require a palliative care consult (OR: 4.63, 95% CI: 2.86–7.49), ICU stay (OR: 6.66, 95% CI: 5.22–8.50), or surgery (OR: 5.04, 95% CI: 3.90–6.52); and be discharged to a post-acute-care facility (OR: 10.37, 95% CI: 6.92–15.56). Prolonged hospitalizations in a small proportion of patients were an important contributor to overall LOS and particularly affected Medicaid enrollees with complex hospital stays who were not discharged home. Further studies are needed to determine the reasons for discharge delays in this population. *Journal of Hospital Medicine* 2015;10:623–626. © 2015 Society of Hospital Medicine

Hospitalizations frequently last longer than warranted by medical necessity alone, due to inefficiencies within the US healthcare system.^{1,2} Discharge delays place patients at risk for hospital-acquired complications and increase costs. With the growing emphasis on high-value care, hospital length of stay (LOS) has emerged as a key metric for inpatient care and will remain a central focus of hospital-based improvement initiatives for the foreseeable future.

Hospitals may find it difficult to identify the primary drivers of inpatient LOS in a dynamic and increasingly complex healthcare system. Multiple recent policy changes have affected inpatient care. The Health Information Technology for Economic and Clinical Health Act of 2009 has led to widespread adoption of electronic health records (EHRs) that have markedly impacted provider workflows.³ In October 2013, the Centers for Medicare & Medicaid

Services implemented the 2-midnight rule, which reclassified lower acuity inpatients with an expected stay <48 hours to observation status.⁴ In January 2014, expansion of insurance coverage under the Affordable Care Act (ACA) altered payer mix for hospitals nationwide.⁵ At a local level, hospitals that are rapidly adjusting resource allocation, capital investments, and marketing efforts and making complex operational decisions (eg, to open new units or change admission or referral algorithms) may simultaneously experience shifts in patient volumes, case-mix index, and staffing ratios with downstream effects on LOS.

Given the myriad factors influencing inpatient LOS, hospital leaders may encounter real challenges in designing effective LOS reduction strategies. For example, they may expend significant resources on real-time demand-capacity management systems to improve hospital-wide patient flow, but the resultant emphasis on bed placement and early discharges may shave only hours off average LOS.^{6,7} An alternative approach may be to target the small percentage of patients with prolonged hospitalizations who contribute disproportionately to the average LOS, as other initiatives focused on high utilizers have done.^{8–10}

Our institution noted an increase in the average inpatient LOS for general medicine patients from 2012 to 2014, prompting a call to action by hospital leaders. We sought to characterize the predictors of prolonged hospitalizations among medicine patients to

*Address for correspondence and reprint requests: Mary E. Anderson, MD, Assistant Professor, Hospital Medicine Section, Division of General Internal Medicine, Department of Medicine, University of Colorado School of Medicine, Leprino Building, 4th floor, Mailstop F-782, 12401 E. 17th Ave., Aurora, CO 80045; Telephone: 720-848-4289; Fax: 720-848-4293; E-mail: mary.anderson@ucdenver.edu

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guide future efforts aimed at mitigating the contribution of prolonged LOS to overall LOS.

METHODS

Study Design

We performed a retrospective analysis of medicine patients discharged between January 1, 2012 and December 31, 2014, from the University of Colorado Hospital, a 551-bed urban, quaternary-care academic medical center in Aurora, Colorado. Patients were included if they were admitted under inpatient status, ≥ 18 years of age, and discharged from 1 of our 10 medicine services: 7 services with residents, staffed by hospitalists, general internists, or subspecialists; and 3 services with advanced practice providers, staffed by hospitalists.

Data Collection

We obtained LOS, calendar year of discharge, demographic data, insurance type, discharge disposition, number of medications, consults, intensive care unit (ICU) stays, surgeries (ie, procedures requiring anesthesia), and primary diagnosis by International Classification of Diseases, Ninth Revision codes from an administrative database that had been developed, validated, and maintained by our hospital medicine group. This database was populated with variables from our EHR, which was implemented in September 2011; to minimize variability in data input during the EHR roll-out, we excluded data from September 2011 through December 2011. The Colorado Multiple Institutional Review Board reviewed and exempted this database (protocol 13-2953) as a program evaluation.

Outcomes

We defined a *prolonged* hospitalization or LOS as >21 days in duration. This represented approximately 2 standard deviations above the mean LOS in our cohort. This cutoff also helped to remove provider-level variability, as each medicine service was staffed by 2 attendings per month, each working approximately 7 days on and 7 days off. We examined LOS >14 and >30 days in sensitivity analyses to ensure that the selection of >21 days did not impose an arbitrary and invalid limitation on our statistical analysis.

Statistical Analysis

Demographic and clinical data were compared in the group with LOS ≤ 21 days versus the group with LOS >21 days with a χ^2 test for dichotomous variables and Student *t* test for continuous variables. We then built a multivariable logistic regression model to predict LOS >21 days using the variables that were significantly different between groups in bivariate analyses. A two-sided *P* value of <0.05 was considered statistically significant. All data analyses were performed using Stata 12.0 (StataCorp, College Station, TX).

RESULTS

We identified 18,363 inpatient discharges among 12,511 medicine patients between January 1, 2012 and December 31, 2014. Of these discharges, 416 (2.3%) demonstrated prolonged LOS. Prolonged hospitalizations accounted for 18.6% of total inpatient days. The average LOS during the study period was 4.8 days including patients with prolonged LOS and 4.0 days excluding patients with prolonged LOS, a contribution of 0.8 days.

Table 1 compares the characteristics of patients with and without prolonged LOS. Age, insurance, discharge disposition, palliative care consults, ICU stays, and surgeries were among the variables that differed significantly between the 2 groups. Among patients undergoing surgery, those with prolonged LOS were more likely to have surgery >24 hours after admission than those without prolonged LOS (85.7% vs 51.4%, $P < 0.001$).

Unspecified sepsis was the most frequent primary diagnosis, regardless of LOS category (Table 2). However, the second through fifth most frequent diagnoses differed for patients with and without prolonged LOS.

In an adjusted logistic regression model (Table 3), we found lower odds of prolonged LOS for each 10-year increase in age and higher odds of prolonged LOS for Medicaid insurance, discharge to home with home health, discharge to a post-acute-care or long-term acute-care facility, and in-hospital death. Methicillin-resistant *Staphylococcus aureus* (MRSA) septicemia, palliative care consults, ICU stays, and surgeries were all also associated with increased odds of prolonged LOS. We identified a statistically significant interaction between ICU stay and surgical procedure (odds ratio: 2.53, 95% confidence interval: 1.51-4.26, $P < 0.001$).

Sensitivity analyses using LOS >14 and >30 days yielded similar results to LOS >21 days (see Supporting Appendix Table 1 in the online version of this article).

DISCUSSION

We found that a small proportion of medicine patients with prolonged hospitalizations contributed substantially to both total inpatient days and average inpatient LOS. Such disproportionate healthcare utilization is concerning in light of the Institute of Medicine's charge for health systems to deliver "timely, efficient, and equitable" care.¹¹

Few studies in the United States have analyzed patient characteristics that predict prolonged LOS, and to our knowledge, none have evaluated prolonged LOS specifically in general medicine patients.¹²⁻¹⁴ Among selected surgical populations, prolonged hospitalizations are most often related to placement difficulties, operational delays, and payer-related issues, rather than severity of illness, baseline comorbidities, or in-hospital complications.^{12,13} In our study, we found that patients with prolonged LOS were more likely to require a palliative care consult, ICU stay, or surgery, all proxies for disease severity. Patients with

TABLE 1. Baseline Characteristics for Patients With and Without Prolonged Hospitalizations

Variable	LOS ≤21 Days, N = 17,947	LOS >21 Days, N = 416	P Value
Age, y, mean (SD)	56.4 (18.7)	54.4 (17.1)	0.030
Female	9,256 (52%)	199 (48%)	0.132
Year of discharge			<0.001
2012	5,486 (31%)	69 (17%)	
2013	6,193 (35%)	162 (39%)	
2014	6,268 (35%)	185 (44%)	
Race/ethnicity			0.003
White non-Hispanic	9,702 (54%)	242 (58%)	
Black non-Hispanic	4,000 (22%)	68 (16%)	
Hispanic	2,872 (16%)	67 (16%)	
Asian	578 (3%)	9 (2%)	
Other or unknown	795 (4%)	30 (7%)	
Language preference			0.795
English	16,049 (89%)	376 (90%)	
Spanish	1,052 (6%)	23 (6%)	
Other	846 (5%)	17 (4%)	
Insurance			<0.001
Medicare	5,462 (30%)	109 (26%)	
Medicaid	3,406 (19%)	126 (30%)	
Dual	2,815 (16%)	64 (15%)	
Private	2,714 (15%)	60 (14%)	
Indigent/self-pay	2,829 (16%)	42 (10%)	
Other	721 (4%)	15 (4%)	
Length of stay, d (SD)	4.0 (3.5)	39.5 (37.3)	<0.001
Discharge disposition			<0.001
Home with self-care	13,276 (74%)	115 (28%)	
Home with home health	1,584 (9%)	79 (19%)	
Hospice—home or inpatient	369 (2%)	19 (5%)	
Post-acute-care facility or LTAC	1,761 (10%)	141 (34%)	
Expired	113 (1%)	18 (4%)	
Other	844 (5%)	44 (11%)	
No. of admission medications (SD)	9.7 (7.4)	10.9 (7.8)	0.002
Primary diagnosis by ICD-9 code*			
Sepsis, unspecified	1,548 (9%)	55 (13%)	0.001
Acute respiratory failure	293 (2%)	9 (2%)	0.400
MSSA septicemia	36 (0.2%)	8 (2%)	<0.001
MRSA septicemia	13 (0.1%)	7 (2%)	<0.001
Alcoholic cirrhosis of the liver	111 (1%)	7 (2%)	0.007
Palliative care consult	398 (2%)	64 (15%)	<0.001
ICU stay	2,030 (11%)	246 (59%)	<0.001
Surgical procedure	1,800 (10%)	182 (44%)	<0.001

NOTE: Abbreviations: ICD-9, International Classification of Diseases, Ninth Revision; ICU, intensive care unit; LOS, length of stay; LTAC, long-term acute care; MSSA, methicillin-sensitive *Staphylococcus aureus*; MRSA, methicillin-resistant *Staphylococcus aureus*; SD, standard deviation. *Top 5 diagnoses for patients with LOS >21 days.

prolonged LOS were also more likely to undergo surgery >24 hours after admission than those without prolonged LOS, suggesting that the former were either too unstable to proceed directly to surgery or developed complications later during their hospitalization. Even after controlling for palliative care consults, ICU stays, and surgeries, placement at a post-acute-care facility was strongly associated with prolonged LOS. Patients with prolonged LOS were also more likely to have Medicaid compared to other insurance types.

Our findings have several potential implications for efforts aimed at decreasing the number of and length of prolonged hospitalizations. Although demographic and

TABLE 2. Top Five Primary Diagnoses for Patients With and Without Prolonged Hospitalizations

	N	%
LOS ≤21 days		
1. Sepsis, unspecified	1,548	8.6%
2. Acute pancreatitis	435	2.4%
3. Pneumonia	431	2.4%
4. Acute kidney failure	363	2.0%
5. COPD exacerbation	320	1.8%
LOS >21 days		
1. Sepsis, unspecified	55	13.0%
2. Acute respiratory failure	9	2.2%
3. Methicillin-sensitive <i>Staphylococcus aureus</i> septicemia	8	1.9%
4. Methicillin-resistant <i>Staphylococcus aureus</i> septicemia	7	1.7%
5. Alcoholic cirrhosis of the liver	7	1.7%

NOTE: Abbreviations: COPD, chronic obstructive pulmonary disease; LOS, length of stay.

TABLE 3. Predictors of Prolonged Hospitalizations (LOS >21 Days)*

Outcome: LOS >21 Days	Odds Ratio	95% CI	P Value
Age, per 10 years increase in age	0.80	0.73-0.87	<0.001
Year of discharge			
2012	0.47	0.34-0.67	<0.001
2013	1.10	0.84-1.43	0.493
2014	Ref		
Race/ethnicity			
White non-Hispanic	Ref		
Black non-Hispanic	0.89	0.64-1.22	0.454
Hispanic	1.01	0.70-1.46	0.952
Asian	0.85	0.40-1.83	0.679
Other or unknown	1.29	0.73-2.26	0.378
Insurance			
Medicare	Ref		
Medicaid	1.99	1.29-3.05	0.002
Dual	1.06	0.72-1.57	0.765
Private	1.13	0.70-1.82	0.620
Indigent/self-pay	1.66	0.95-2.88	0.073
Other	0.96	0.47-1.96	0.908
Discharge disposition			
Home with self-care	Ref		
Home with home health	4.48	3.10-6.48	<0.001
Hospice—home or inpatient	2.11	0.98-4.55	0.057
Post-acute-care facility or LTAC	10.37	6.92-15.56	<0.001
Expired	5.38	2.27-12.75	<0.001
Other	4.04	2.64-6.18	<0.001
No. of admission medications	1.00	0.99-1.02	0.775
Primary diagnosis by ICD-9 code			
Sepsis, unspecified	1.11	0.78-1.58	0.575
MSSA septicemia	2.44	0.68-8.67	0.074
MRSA septicemia	8.83	1.72-45.36	0.009
Alcoholic cirrhosis of the liver	1.25	0.43-3.65	0.687
Palliative care consult	4.63	2.86-7.49	<0.001
ICU stay	6.66	5.22-8.50	<0.001
Surgical procedure	5.04	3.90-6.52	<0.001

NOTE: Abbreviations: CI, confidence interval; ICD-9, International Classification of Diseases, Ninth Revision; ICU, intensive care unit; LOS, length of stay; LTAC, long-term acute care; MSSA, methicillin-sensitive *Staphylococcus aureus*; MRSA, methicillin-resistant *Staphylococcus aureus*. *Clustered by patient.

clinical factors such as Medicaid insurance, ICU stays, and surgeries are generally not modifiable, they could, particularly in combination, be used to trigger earlier

and more intensive case management involvement. A streamlined insurance approval process for “Medicaid pending” inpatients could be beneficial, given the recent expansion of Medicaid eligibility under the ACA. Hospital partnerships with post-acute-care facilities could also relieve bottlenecks in placement.⁸ Chart review of the patients with MRSA septicemia and prolonged LOS indicated that development of an intensive outpatient parenteral antimicrobial therapy pathway with substance abuse counseling could provide an alternative to extended inpatient treatment for intravenous drug users with complicated infections.¹⁵

This study has several limitations. First, given the lack of consensus in the literature regarding the definition of a “prolonged” hospitalization, it is difficult to directly compare our results with existing studies.^{8,12–14} However, we believe LOS >21 days to be a meaningful cutoff for our cohort. Most demographic and clinical variables that were predictive at >21 days were also predictive at >14 and >30 days, which reassured us that the relationship between variables and prolonged LOS was stable at different thresholds. Second, our database did not allow us to fully adjust for baseline comorbidities or categorize the reasons for discharge delays. Finally, this was a single-center program evaluation. Although this limits generalization to other institutions, we believe our approach may serve as a guide for others interested in reducing prolonged hospitalizations.

In summary, prolonged hospitalizations represent a potentially high-yield target for LOS reduction efforts. Prolonged hospitalizations among medicine patients at our institution particularly affected Medicaid enrollees with complex hospital stays who were not discharged home. Further studies are needed to determine the specific reasons for unnecessary hospital days in this population.

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