ONLINE FIRST

Contribution of Preventable Acute Care Spending to Total Spending for High-Cost Medicare Patients

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Importance A small proportion of patients account for the majority of US health care spending, and understanding patterns of spending among this cohort is critical to reducing health care costs. The degree to which preventable acute care services account for spending among these patients is largely unknown.

Objective To quantify preventable acute care services among high-cost Medicare patients.

Design, Setting, and Participants We summed standardized costs for each inpatient and outpatient service contained in standard 5% Medicare files from 2009 and 2010 across the year for each patient in our sample, and defined those in the top decile of spending in 2010 as high-cost patients and those in the top decile in both 2009 and 2010 as persistently high-cost patients. We used standard algorithms to identify potentially preventable emergency department (ED) visits and acute care inpatient hospitalizations. A total of 1 114 469 Medicare fee-for-service beneficiaries aged 65 years or older were included.

Main Outcomes and Measures Proportion of acute care hospital and ED costs deemed preventable among high-cost patients.

Results The 10% of Medicare patients in the high-cost group were older, more often male, more often black, and had more comorbid illnesses than non–high-cost patients. In 2010, 32.9% (95% CI, 32.9%-32.9%) of total ED costs were incurred by high-cost patients. Based on validated algorithms, 41.0% (95% CI, 40.9%-41.0%) of these costs among high-cost patients were potentially preventable compared with 42.6% (95% CI, 42.6%-42.6%) among non–high-cost patients. High-cost patients accounted for 79.0% (95% CI, 79.0%-79.0%) of inpatient costs, 9.6% (95% CI, 9.6%-9.6%) of which were due to preventable hospitalizations; 16.8% (95% CI, 16.8%-16.8%) of costs within the non–high-cost group were due to preventable hospitalizations. Comparable proportions of ED spending (43.3%; 95% CI, 43.3%-43.3%) and inpatient spending (13.5%; 95% CI, 13.5%-13.5%) were preventable among persistently high-cost patients. Regions with high primary care physician supply had higher preventable spending for high-cost patients.

Conclusions and Relevance Among a sample of patients in the top decile of Medicare spending in 2010, only a small percentage of costs appeared to be related to preventable ED visits and hospitalizations. The ability to lower costs for these patients through better outpatient care may be limited.

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HIGH AND INCREASING HEALTH care costs are arguably the single biggest threat to the long-term fiscal solvency of federal and state governments in the United States. One compelling strategy for cost containment is focusing on the small proportion of patients in the Medicare programs who account for the vast majority of health care spending. We know from prior work that Medicare spending is highly concentrated: 10% of the Medicare population accounts for more than half of the costs to the program.[1]

By far the biggest sources of spending among high-cost beneficiaries are those related to acute care: emergency department (ED) visits and inpatient hospitalizations, which make up more than 55% of costs for this population.[2] As a result, many interventions targeting high-cost patients have focused on case management and care coordination, aiming to prevent ED visits and hospitalizations for conditions thought amenable to improvement through high-quality outpatient management programs. The premise behind these and related interventions is that high-quality outpatient care should reduce

For editorial comment see p 2600

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unnecessary hospitalizations for high-cost patients.

However, there are few data on the proportion of inpatient hospitalizations among high-cost patients that are potentially preventable. Prior studies have shown that among patients with select chronic diseases, a substantial proportion of ED visits[3,4] and hospitalizations may be preventable.[1,5-7] However, the degree to which these findings apply to high-cost patients more generally is unknown. Furthermore, little is known about the supply-side factors (such as the number of primary care physicians in a community) that affect spending on preventable hospitalizations within this population. A recent Congressional Budget Office report suggested that the various Medicare Coordinated Care Demonstration programs focused on high-cost patients have generally failed to save money, at least in part because little is known about the drivers of costs for this group.[8]

Therefore, in this study, we sought to quantify the preventability of high-cost patients' acute care spending, which is critical to both designing appropriate interventions and predicting their potential clinical and economic benefits. Specifically, the 3 goals of this study were to: (1) determine the proportion of acute care episodes and spending that are attributable to the high-cost patients in the Medicare population; (2) determine the proportion and amount of this spending that is likely preventable using standard criteria; and (3) determine whether specific supply-side variables, including the number of primary care physicians and specialists, are associated with preventable acute care spending.

METHODS

Patients

We used MedPAR as well as standard 5% Medicare outpatient and carrier files from 2009 and 2010. Patients younger than 65 years, those not continuously enrolled during the study period, and those with any Medicare Advantage enrollment were excluded. We excluded patients who died during 2009 or 2010 because assessing preventability of end-of-life costs was beyond the scope of this analysis and might bias us toward overestimating preventable spending. Patient race was categorized in the Medicare data according to self-report. We used the Centers for Medicare & Medicaid Services Hierarchical Condition Categories coding to assign comorbidities to each patient in our database based on their inpatient and outpatient diagnoses. *International Classification of Diseases, Ninth Revision* (*ICD-9*) codes that were used to identify each major comorbidity are provided in eTable 1 (available at http://www.jama.com).

To assess the effect of supply-side variables on our outcome of interest, we used data from the *Dartmouth Atlas of Health Care*[9] at the level of the hospital referral region (HRR) to obtain the supply of primary care physicians, specialist physicians, and ED physicians per 100 000 residents and the supply of hospital beds per 1000 residents.

This study was approved by the Harvard School of Public Health Office of Human Research Administration; the requirement of informed consent was waived because of the deidentified nature of the data.

Identifying High-Cost Patients

We created standardized costs for inpatient care using the MedPAR files. We began with the amount paid by Medicare for each hospitalization, subtracted out duplicate costs from the carrier file, and adjusted for Medicare Wage Index, graduate medical education, and disproportionate-share payments. We used published Medicare fee schedules to assign standardized Medicare costs to each outpatient and carrier file service, regardless of the actual amount Medicare paid for each service (see eAppendix for detailed methods on standardized costs). The use of standardized costs allows us to identify patients who use a comparable amount of medical care across areas of the country in which the actual spending may vary significantly. Costs were summed across the year and across settings for each patient in our sample. We defined patients in the top decile of total cost in 2010 as high-cost patients and those in the top decile in both 2009 and 2010 as persistently high-cost patients based on prior work showing only modest persistence of high expenditures in the Medicare population.[10,11]

Identifying Preventable Emergency Department Visits

To identify preventable ED visits, we used an algorithm created by Billings et al.[12] This algorithm, which has been validated[4] and used in prior published work,[3,13] uses diagnosis codes to separate ED visits into 4 categories: nonemergent; emergent but primary care treatable; emergent, ED care needed, but preventable; and emergent, ED care needed, and not preventable. We defined nonemergent, emergent/primary care treatable, and emergent/ED care needed/preventable or avoidable visits as preventable ED visits. Because Medicare data combine ED costs with inpatient costs if a patient is admitted to the hospital, we limited our sample of independent ED visits to visits not leading to an admission.

Identifying Preventable Hospitalizations

We used the Agency for Healthcare Research and Quality Prevention Quality Indicators software to identify potentially preventable hospitalizations.[14] This algorithm defines potentially preventable hospitalizations as those related to conditions, such as heart failure, diabetes, hypertension, and asthma, for which good outpatient care can likely prevent the need for hospitalization, and it has been validated and used in prior work on the Medicare population.[15-17] The software was altered to include patients admitted from nursing homes, who were excluded from the Prevention Quality Indicators algorithm in the 2009 version. eTable 2 provides a list of the preventable hospitalization diagnoses and their associated *ICD-9* codes. For purposes of comparison, we then grouped nonpreventable diagnoses into

Table 1. Patient Characteristics[a]

Characteristics	High-Cost Patients (n = 113 341)	Non–High-Cost Patients (n = 1 001 128)
Demographics		
Age, median (IQR), y	78 (72-84)	77 (71-83)
Female	55.5	58.3
Race/ethnicity		
Black	8.5	7.1
White	86.7	87.6
Hispanic	1.9	1.6
Other/unknown	3.0	3.7
Medicaid eligible	18.6	12.0
Clinical characteristics		
Congestive heart failure	44.4	11.2
Diabetes	44.1	26.9
Lung disease	38.0	12.6
Kidney disease	35.6	8.7
Cancer	31.4	12.5
Ischemic heart disease	27.5	5.9
Stroke	16.6	3.9
Mental illness	9.9	3.2
Substance abuse	3.0	0.5
Liver disease	2.4	0.6

Abbreviation: IQR, interquartile range.
[a]Data are expressed as percentage of patients unless otherwise indicated.

clinically similar groups (eg, anterior myocardial infarction, subendocardial infarction, and coronary atherosclerosis were all grouped into ischemic heart disease).

Statistical Analysis

We first compared patient characteristics between high-cost and non–high-cost patients. We then compared characteristics for the hospitalizations within each group. We calculated the proportion of total 2010 ED visits and inpatient hospitalizations that were for high-cost patients vs non–high-cost patients, as well as the associated costs. Next, we calculated the proportion of ED visit costs and the proportion of short-stay acute care hospital costs that were potentially preventable within each group, using the algorithms described above. For the high-cost cohort, we created a histogram at the patient level of the proportion of acute care costs that were potentially preventable. We repeated these analyses for the persistently high-cost cohort.

We also classified each high-cost individual in our database into 1 of the 306 HRRs in the country and calculated the average per capita preventable acute care costs for high-cost patients for each HRR. We calculated summary statistics for these costs at the HRR level. We then created HRR-level linear regression models in which the average per capita preventable costs, calculated at the HRR level, were our outcome of interest, and supply-side variables, including primary care physician, specialist physician, and emergency department physician supply and hospital bed supply, were our primary predictors. We included HRR-level age, sex, race, and comorbidity burden as covariates. A 2-tailed $P<.05$ was considered statistically significant.

All analyses were performed using SAS software, version 9.3 (SAS Institute Inc).

RESULTS

Patient Characteristics

There were 1 114 469 patients in our 5% Medicare sample, of which 113 341 constituted the high-cost cohort. High-cost patients were older (median age, 78 vs 77 years), more often male (44.5% vs 41.7%), and more often black (8.5% vs 7.1%) than non–high-cost patients, and were more often Medicaid eligible. High-cost patients had a higher burden of comorbid illnesses, including heart failure, diabetes, and cancer, as well as higher rates of mental illness and substance abuse (TABLE 1). Hospitalizations for high-cost and non–high-cost patients were distributed similarly across hospital types, though a higher proportion of hospitalizations for high-cost patients were in hospitals in the South (38% vs 45%), hospitals located in urban areas (85% vs 78%), and major teaching hospitals (21% vs 13%) and safety-net hospitals (23% vs 17%). Twenty-six percent of hospitalizations for high-cost patients and 30% for non–high-cost patients originated in the ED.

Proportion of Acute Care Services and Costs From the High-Cost Group

The high-cost patient cohort, which included 10% of the patients in our sample, was responsible for 30.8% (95% CI, 30.7%-31.0%) of ED visits not resulting in an admission and 32.9% (95% CI, 32.9%-32.9%) of ED costs. High-cost patients accounted for 56.7% (95% CI, 56.5%-57.0%) of admissions and 79.0% (95% CI, 79.0%-79.0%) of inpatient costs. In total, 73.0% (95% CI, 73.0%-73.0%) of acute care spending in 2010 was attributable to the 10% of patients in our high-cost group.

Preventable Emergency Department Visits

Within the high-cost cohort, 42.6% of ED visits were deemed to be preventable (95% CI, 42.4%-42.9%) according to our algorithm. These visits were associated with 41.0% of the ED costs within this group (95% CI, 40.9%-41.0%, TABLE 2). Patterns were similar for the non–high-cost cohort, with 44.2% of visits (95% CI, 44.0%-44.4%) and 42.6% of costs (95% CI, 42.6%-42.6%) deemed preventable.

Preventable Hospitalizations

The most common reasons for preventable hospitalization in high-cost patients were congestive heart failure, bacterial pneumonia, and chronic

obstructive pulmonary disease (TABLE 3), and the most common reasons for nonpreventable hospitalization were orthopedic conditions, ischemic heart disease, and cancer and chemotherapy (eTable 4); many of the diagnoses that were associated with the highest overall costs in this cohort were considered nonpreventable (FIGURE).

Within the high-cost group, 15.8% (95% CI, 15.8%-15.8%) of the admissions were attributable to preventable causes; 9.6% (95% CI, 9.6%-9.6%) of hospital costs were attributable to preventable hospitalization, while the remaining 90.4% (95% CI, 90.4%-90.4%) were attributable to other causes of hospitalization (Table 3). Within the non–high-cost group, though overall spending was significantly lower, a higher proportion of inpatient costs were potentially preventable (16.8%; 95% CI, 16.8%-16.8%).

Combining the ED and inpatient settings, 10.0% (95% CI, 10.0%-10.0%) of high-cost patients' costs were considered potentially preventable and 19.1% (95% CI, 19.1%-19.1%) of non–high-cost patients' costs were considered potentially preventable. Only 10% of the high-cost cohort had acute care costs that were considered preventable (eFigure 1).

Persistently High-Cost Cohort

The 31 263 patients in the persistently high-cost cohort were older, more often black, and more often Medicaid eligible and had a higher burden of medical comorbidities than patients who were not persistently high-cost (eTable 5). In this group, 44.7% (95% CI, 44.2%-45.1%) of ED visits were deemed preventable according to our algorithm. These visits were associated with 43.3% (95% CI, 43.3%-43.3%) of the ED costs within this group (eTable 6). Within the persistently high-cost group, 20.3% (95% CI, 20.1%-20.5%) of the admissions and 13.5% (95% CI, 13.5%-13.5%) of the costs were attributable to preventable hospitalization, while the remaining 86.5% (95% CI, 86.5%-86.5%) of the costs were attributable to other causes of hospitalization (TABLE 4).

Regional Variability in Per Capita Preventable Costs

We found significant variability in preventable acute care costs for high-cost patients across HRRs in 2010, ranging from $681 to $5217 per capita across the total population of each HRR (eFigure 2). After adjusting for age, sex, race, and comorbidities of the patient population in each HRR, our supply-side variables were positively associated with these costs: HRRs with the lowest primary care physician supply had $1954 (95% CI, $1837-$2071) in preventable costs per capita vs $2186 (95% CI, $2065-$2307; $P = .009$) for HRRs with the highest primary care physician supply (TABLE 5). Higher specialist physician supply was also associated with higher per capita preventable costs, as was hospital bed supply.

Table 2. Preventable and Nonpreventable Emergency Department Costs, Medicare, 2010

	High-Cost Patients[a]		Non–High-Cost Patients[a]	
Category of Visit	Spending, $	% (95% CI)	Spending, $	% (95% CI)
Not emergent	5 651 399	13.8 (13.8-13.9)	13 538 894	16.3 (16.2-16.3)
Emergent, primary care treatable	8 077 282	19.8 (19.8-19.8)	17 229 592	20.7 (20.7-20.7)
ED care needed, preventable	2 985 055	7.3 (7.3-7.3)	4 729 596	5.7 (5.7-5.7)
ED care needed, not preventable	7 803 385	19.1 (19.1-19.1)	15 194 402	18.2 (18.2-18.3)
Alcohol related	90 063	0.2 (0.2-0.2)	163 108	0.2 (0.2-0.2)
Drug related	35 640	0.1 (0.1-0.1)	45 350	0.1 (0.1-0.1)
Injury	7 714 596	18.9 (18.9-18.9)	19 707 343	23.7 (23.7-23.7)
Mental health related	823 294	2.0 (2.0-2.0)	1 183 228	1.4 (1.4-1.4)
Other/unclassified	7 632 007	18.7 (18.7-18.7)	11 481 232	13.8 (13.8-13.8)
Total preventable	16 713 735	41.0 (40.9-41.0)	35 498 082	42.6 (42.6-42.6)
Total nonpreventable	24 098 985	59.0 (59.0-59.1)	47 774 663	57.4 (57.4-57.4)
Total	40 812 721	100	83 272 745	100

Abbreviation: ED, emergency department.
[a] High-cost patients are those in the top 10% of total Medicare spending annually. Non–high-cost patients are the remaining 90% of Medicare patients.

Table 3. Preventable and Nonpreventable Inpatient Costs, Medicare, 2010

	High-Cost Patients[a]		Non–High-Cost Patients[a]	
Category of Visit	Spending, $	% (95% CI)	Spending, $	% (95% CI)
Congestive heart failure	70 118 556	3.0 (3.0-3.0)	21 745 131	3.5 (3.5-3.5)
Bacterial pneumonia	43 785 718	1.9 (1.9-1.9)	26 445 037	4.3 (4.3-4.3)
Chronic obstructive pulmonary disease	39 436 681	1.7 (1.7-1.7)	20 407 240	3.3 (3.3-3.3)
Urinary tract infection	25 544 251	1.1 (1.1-1.1)	16 528 596	2.7 (2.7-2.7)
Long-term diabetes complication	19 086 485	0.8 (0.8-0.8)	3 640 633	0.6 (0.6-0.6)
Dehydration	13 436 586	0.6 (0.6-0.6)	8 759 133	1.4 (1.4-1.4)
Lower extremity amputation	6 487 601	0.3 (0.3-0.3)	109 556	0.0 (0.0-0.0)
Hypertension	4 097 676	0.2 (0.2-0.2)	3 305 646	0.5 (0.5-0.5)
Perforated appendix	3 576 209	0.2 (0.2-0.2)	1 236 578	0.2 (0.2-0.2)
Short-term diabetes complication	1 453 529	0.1 (0.1-0.1)	709 719	0.1 (0.1-0.1)
Uncontrolled diabetes	1 276 064	0.1 (0.1-0.1)	775 378	0.1 (0.1-0.1)
Angina	871 808	0.0 (0.0-0.0)	728 887	0.1 (0.1-0.1)
Total preventable	225 714 461	9.6 (9.6-9.6)	104 352 566	16.8 (16.8-16.8)
Total nonpreventable[b]	2 114 710 763	90.4 (90.4-90.4)	516 610 792	83.2 (83.2-83.2)
Total	2 340 425 224	100	620 963 357	100

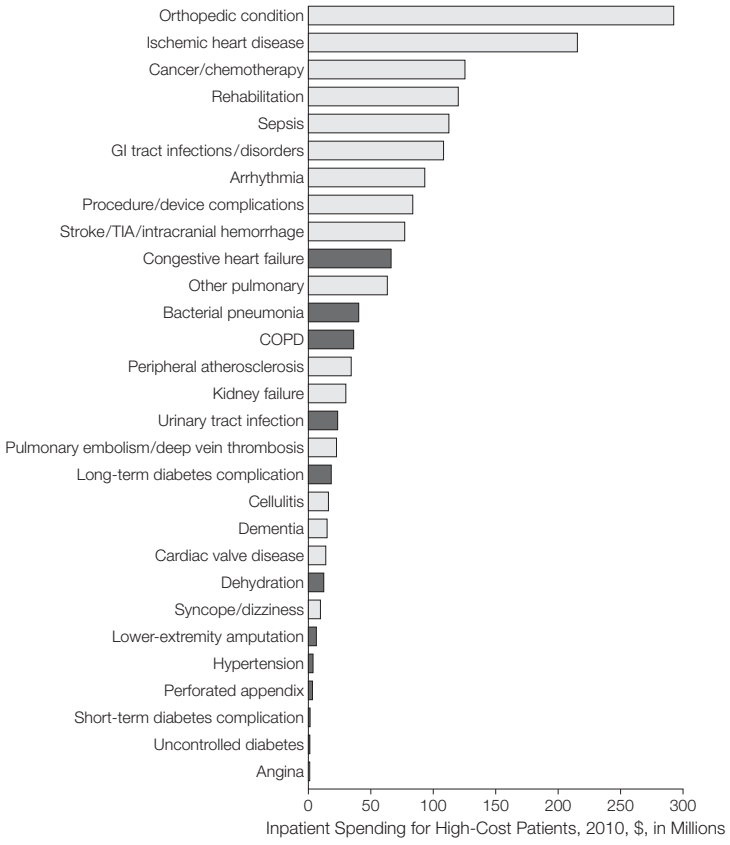
[a] High-cost patients are those in the top 10% of total Medicare spending annually. Non–high-cost patients are the remaining 90% of Medicare patients.
[b] eTable 3 provides details on the primary diagnosis codes associated with nonpreventable admissions.

DISCUSSION

We found that more than 70% of the roughly $91.7 billion in acute care costs in the Medicare population in 2010 were for the 10% of patients that comprise the high-cost cohort. Approximately 10% of these costs were for what were deemed potentially preventable causes as calculated using standard algorithms; the percentage was slightly higher for the persistently high-cost cohort. Hospital referral regions with a higher primary care or specialist physician supply had higher annual preventable costs per capita.

The biggest drivers of inpatient spending for high-cost patients were catastrophic events such as sepsis, stroke, and myocardial infarction, as well as cancer and expensive orthopedic procedures such as spine surgery and hip replacement. These findings suggest that strategies focused on enhanced outpatient management of chronic disease, while critically important, may not be focused on the biggest and most expensive problems plaguing Medicare's high-cost patients. Indeed, while a proportion of these very expensive inpatient episodes may be potentially preventable (such as acute myocardial infarction or degenerative joint disease leading to orthopedic procedures), their prevention would likely require a long time horizon and substantial investments in population wellness. Such investments are critically important for ensuring the health of the population, but the time frame needed to see cost savings is likely years, not weeks or months.

Figure. Preventable and Nonpreventable Inpatient Costs Among High-Cost Patients, Medicare 2010



Dark gray bars indicate conditions that are considered preventable; light gray bars indicate those that are considered nonpreventable. GI indicates gastrointestinal; TIA, transient ischemic attack; COPD, chronic obstructive pulmonary disease.

These findings may shed light on why many recent efforts to control costs for these very medically complex, high-utilizing patients, including the Medicare Coordinated Care Demonstration programs, have failed to do so,[8] even in cases in which there was a small decrease in hospital admissions.[18] The majority of these programs have focused on providing enhanced outpatient services, such as frequent telephone and in-person contact, patient education, enhanced medication management services, and assistance with transitional care following a hospitalization.[8,18,19] These types of services are targeted toward reducing ambulatory care–sensitive hospitalizations, and investing further in disease management programs may lead to reductions in avoidable ED visits and hospitalizations. Although these visits are still very expensive in aggregate, our findings suggest that they make up a small proportion of the total acute care spending among the costliest of patients. As a result, while disease management may yield cost savings, even a substantial reduction in these preventable hospitalizations is unlikely to have a large effect on overall spending levels within this cohort.

Our findings suggest that a complementary approach to saving money on acute care services for high-cost patients may be to additionally focus on reducing per-episode costs for high-cost disease entities through clinical innovation and care delivery redesign. It is feasible that current policy interventions, such as bundled payments,[20] might spur such innovation in inpatient cost control. Furthermore, as shared-savings programs such as accountable care organizations become more common, clinical leaders may need to prioritize both reducing preventable admissions and reducing the cost of hospitalizations for catastrophic or acute disease to reap meaningful savings.

We found that HRRs with high primary care physician supply or high specialist physician supply had higher preventable spending for their high-cost

patients; it is unclear whether this is due to supply-induced demand for ED visits and hospitalizations or simply reflective of a more complex underlying patient population. However, it suggests that simply increasing access to primary care services may not in itself lead to lower health care spending for high-cost patients.

Our study adds to prior literature examining acute care spending for high-cost patients. For example, the Congressional Budget Office examined Medicare data from 2001 and showed that high-cost patients were more likely than non–high-cost patients to use short-term hospital care as well as ED care and that per-episode costs in these categories were higher in the high-cost group as well.[21] Riley[2] studied spending trends over time on high-cost Medicare patients and found an increasing proportion of their costs coming from services such as skilled nursing and home health care between 1975 and 2004, though inpatient spending remained the dominant source of costs throughout. However, to our knowledge, this is the first study to examine preventability, especially of acute care services, within this cohort. Our findings regarding the effect of primary care and specialty care on per-capita preventable costs are somewhat in contrast to prior work by Baicker and Chandra[22] demonstrating that states with high primary care supply had lower costs and higher quality for their Medicare beneficiaries, although these authors did not focus on high-cost patients, and the relationship in this group, who may have a higher need for services, may be different.

There are limitations to this study. Although we used well-established algorithms to define preventable acute care episodes, it is likely that these represent a spectrum of preventability and that admissions for perforated appendicitis or lower extremity amputation, for example, may actually have not been preventable through better outpatient care. However, this would have biased us toward finding a greater proportion of spending due to preventable causes, and thus our data are likely conservative. Our findings that regions with more primary care and specialist physicians have higher per-capita preventable acute care spending may be due to factors such as a generally sicker or more complex patient population that uses more health care services and, thus, may be demand driven rather than supply driven.

Table 4. Inpatient Hospitalizations Among Persistently High-Cost Patients

	Persistently High-Cost Patients[a]		Other Patients[a]	
Category of Visit	Spending, $	% (95% CI)	Spending, $	% (95% CI)
Congestive heart failure	30 775 934	4.5 (4.5-4.5)	61 087 753	2.7 (2.7-2.7)
Bacterial pneumonia	17 070 678	2.5 (2.5-2.5)	42 773 243	1.9 (1.9-1.9)
Chronic obstructive pulmonary disease	16 135 117	2.4 (2.3-2.4)	54 095 638	2.4 (2.4-2.4)
Urinary tract infection	9 624 771	1.4 (1.4-1.4)	13 102 347	0.6 (0.6-0.6)
Long-term diabetes complication	9 614 090	1.4 (1.4-1.4)	32 458 758	1.4 (1.4-1.4)
Dehydration	4 328 767	0.6 (0.6-0.6)	17 866 952	0.8 (0.8-0.8)
Lower extremity amputation	3 908 470	0.6 (0.6-0.6)	2 688 688	0.1 (0.1-0.1)
Hypertension	1 299 715	0.2 (0.2-0.2)	6 103 607	0.3 (0.3-0.3)
Perforated appendix	614 080	0.1 (0.1-0.1)	4 198 707	0.2 (0.2-0.2)
Short-term diabetes complication	528 967	0.1 (0.1-0.1)	1 522 475	0.1 (0.1-0.1)
Uncontrolled diabetes	506 594	0.1 (0.1-0.1)	1 656 654	0.1 (0.1-0.1)
Angina	301 841	0.0 (0.0-0.0)	1 298 854	0.1 (0.1-0.1)
Total preventable	92 709 560	13.5 (13.5-13.5)	237 357 466	10.4 (10.4-10.4)
Total nonpreventable	593 768 539	86.5 (86.5-86.5)	2 037 553 017	89.6 (89.6-89.6)
Total	686 478 099	100	2 274 910 483	100

[a] Persistently high-cost patients are those in the top 10% of total Medicare spending in both 2009 and 2010. Other patients are the remaining Medicare patients.

Table 5. Regional Variation in Preventable Spending Per Capita for High-Cost Patients[a]

	Preventable Spending, Mean $ (95% CI)[b]			
Supply-Side Variables[c]	Low-Supply Tertile	Medium-Supply Tertile	High-Supply Tertile	*P* Value[d]
Primary care physician supply	1954 (1837-2071)	1936 (1836-2036)	2186 (2065-2307)	.009
Specialist physician supply	1981 (1861-2102)	1946 (1847-2045)	2149 (2023-2275)	.06
Emergency department physician supply	2100 (1986-2213)	1963 (1863-2062)	2014 (1903-2126)	.21
Hospital bed supply	2064 (1960-2168)	1920 (1820-2020)	2093 (1986-2200)	.04

[a] Model is adjusted for hospital referral region–level age, sex, race, and comorbidity burden.
[b] Preventable spending is defined as preventable spending on high-cost patients in a hospital referral region divided by the total number of Medicare beneficiaries in that hospital referral region.
[c] Supply-side variables are obtained from the *Dartmouth Atlas of Health Care*.[9]
[d] *P* values presented are those for the model treating each supply-side variable as a continuous variable; means are presented in tertiles for ease of interpretation.

CONCLUSION

Among a sample of patients in the top decile of Medicare spending in 2009, only a small percentage of costs appeared to be related to preventable ED visits and hospitalizations. The ability to lower costs for these patients through better outpatient care may be limited. Also needed may be strategies, perhaps focused on high-cost disease entities, that make hospital care more efficient so that each episode of inpatient care is less expensive regardless of its cause.

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Critical revision of the manuscript for important intellectual content: All authors.
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