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Concentration of Potentially Preventable Spending Among High-Cost Medicare Subpopulations

An Observational Study

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Background: Little is known about whether potentially preventable spending is concentrated among a subset of high-cost Medicare beneficiaries.

Objective: To determine the proportion of total spending that is potentially preventable across distinct subpopulations of high-cost Medicare beneficiaries.

Design: Beneficiaries in the highest 10% of total standardized individual spending were defined as "high-cost" patients, using a 20% sample of Medicare fee-for-service claims from 2012. The following 6 subpopulations were defined using a claims-based algorithm: nonelderly disabled, frail elderly, major complex chronic, minor complex chronic, simple chronic, and relatively healthy. Potentially preventable spending was calculated by summing costs for avoidable emergency department visits using the Billings algorithm plus inpatient and associated 30-day post-acute costs for ambulatory care–sensitive conditions (ACSCs). The amount and proportion of potentially preventable spending were then compared across the high-cost subpopulations and by individual ACSCs.

Setting: Medicare.

Participants: 6 112 450 Medicare beneficiaries.

Measurements: Proportion of spending deemed potentially preventable.

Results: In 2012, 4.8% of Medicare spending was potentially preventable, of which 73.8% was incurred by high-cost patients. Despite making up only 4% of the Medicare population, high-cost frail elderly persons accounted for 43.9% of total potentially preventable spending ($6593 per person). High-cost nonelderly disabled persons accounted for 14.8% of potentially preventable spending ($3421 per person) and the major complex chronic group for 11.2% ($3327 per person). Frail elderly persons accounted for most spending related to admissions for urinary tract infections, dehydration, heart failure, and bacterial pneumonia.

Limitation: Potential misclassification in the identification of preventable spending and lack of detailed clinical data in administrative claims.

Conclusion: Potentially preventable spending varied across Medicare subpopulations, with the majority concentrated among frail elderly persons.

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To increase the efficiency of the U.S. health care system, policymakers from both sides of the political aisle have supported the development and implementation of alternative payment models, such as accountable care organizations and patient-centered medical homes. In addition, under the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA), physicians will have even stronger incentives to join alternative payment models. A key feature of these models is the notion that if health care providers assume greater responsibility for patients' health care costs and clinical outcomes, they will make better clinical decisions that may lead to more efficient and effective care. For clinical leaders, finding areas of care where money can be saved and quality improved is an imperative but has often proved difficult.

One approach that has received substantial attention recently has been focusing on high-need, high-cost patients (1, 2). Although definitions of this population vary, it is commonly considered to be the 10% of beneficiaries who account for the most Medicare spending (3). These patients often have several chronic conditions with physical and cognitive limitations and may struggle to care for themselves independently (2). A key advancement of recent work has been to recognize that these high-need, high-cost patients are not a monolithic population and thus, for more effective targeting, should be characterized into subpopulations (1–5). By definition, this population is very expensive to care for (6); however, we know less about whether their spending is preventable.

Although prior work suggests that the proportion of preventable spending among high-need, high-cost patients may be small (3), it did not account for much of the downstream spending generated by the initial preventable event. Furthermore, given the heterogeneity of the high-need, high-cost population, preventable spending likely varies substantially among subgroups. Better understanding where that spending is concentrated and how clinical leaders might target their efforts would be immensely helpful, yet we lack the empirical data to guide our efforts.

See also:

Editorial comment 1

Table 1. Patient Characteristics in Medicare Subpopulations, by High-Cost Status*

Characteristic	Nonelderly Disabled		Frail Elderly		Major Complex Chronic	
	HC (*n* = 156 434 [2.6%])	Non-HC (*n* = 937 108 [15.3%])	HC (*n* = 241 538 [4.0%])	Non-HC (*n* = 281 422 [4.6%])	HC (*n* = 122 564 [2.0%])	Non-HC (*n* = 979 636 [16.0%])
Median age, *y*	54	53	80	82	75	77
Female, %	51.9	47.0	64.9	68.2	54.3	55.4
Race, %						
White	62.1	68.5	81.3	83.7	77.8	83.8
Black	23.8	19.2	10.1	8.6	10.2	7.5
Hispanic	10.2	8.5	5.9	4.8	8.0	5.4
Other	3.9	3.9	2.8	3.0	4.0	3.4
Dually eligible, %	68.9	51.2	27.8	22.1	29.6	15.7
Mental health diagnosis, %	33.2	21.5	12.0	8.9	11.1	6.8
Alcohol/substance use, %	10.2	5.6	2.8	2.0	2.8	1.9
Median chronic conditions, *n*	9	4	12	9	12	9

HC = high-cost.
* Data are based on Medicare administrative claims from 2012. Values are for each subpopulation by cost status. Percentages may not sum to 100 due to rounding.

Therefore, in this study, we sought to answer 3 questions. We used validated algorithms to identify preventable spending to determine what proportion of total spending may be potentially preventable across clinically distinct subpopulations of high-cost Medicare beneficiaries and how it compares with that of non–high-cost beneficiaries. We sought to define how the amount and type of potentially preventable spending differ by care setting (preventable emergency department [ED] visits, inpatient hospitalizations, and post-acute care use) among these high-cost subpopulations. Finally, because prior work suggests that most preventable spending comprises hospitalizations for ambulatory care–sensitive conditions (ACSCs), we attempted to clarify the specific types of ACSC hospitalizations that drive potentially preventable spending in each Medicare subpopulation.

METHODS

Data

We obtained and merged Medicare claims files from 2011 and 2012, including the Medicare beneficiary denominator file (demographic and enrollment data); 20% of the carrier file (claims submitted by providers for inpatient and outpatient services); the inpatient file (facility claims for inpatient hospitalizations); 20% of the outpatient file (for example, facility claims for outpatient visits, testing, and surgeries); 20% of the skilled-nursing facility, home health agency, hospice, and durable medical equipment files (facility claims for each of these settings); the Part D file (pharmaceutical claims); and the impact file (wage index and other hospital payment information). All Medicare patients in the denominator database were considered for inclusion in the study. We excluded those with Medicare Advantage coverage for any portion of the study period, who were not continuously enrolled in Part A or B for 12 months, and who lacked a valid beneficiary identification number or sex designation. We excluded beneficiaries who died during the study period because they could not contribute 12 months of costs. They were also excluded because assessing preventability of end-of-life costs was beyond the scope of this analysis, so those data might bias us toward overestimating preventable spending. Our final sample consisted of 6 112 450 beneficiaries.

We calculated costs for each patient in 2012 using methods described by the Centers for Medicare & Medicaid Services (7). We focused on standardized costs, in which each type of service is assigned a cost based on national Medicare rates; this allowed us to examine patterns of use across geographies independent of differences in price. We then classified "high-cost" patients as those in the highest 10% of spending in 2012.

Segmenting the Medicare Population

Using a previously described claims-based algorithm based on expert opinion (3) and informed by the "Bridges to Health" taxonomy proposed by Lynn and colleagues (5), we categorized Medicare beneficiaries into the following 6 mutually exclusive subpopulations: nonelderly disabled, frail elderly, major complex chronic illness, minor complex chronic illness, simple chronic illness, and relatively healthy (those with no chronic conditions). This segmentation strategy was developed with input from a multidisciplinary team of clinicians in general medicine, cardiology, surgery, and emergency medicine and from experts at a 3-part workshop series focused on high-need patients convened by the National Academy of Medicine (8–10). The Appendix and Appendix Figure (available at Annals.org) provide further details on this approach.

Identifying Preventable Hospitalizations and ED Visits

We examined potentially preventable hospitalizations, ED visits, and associated costs by subpopulation. To identify potentially preventable hospitalizations, we used the Agency for Healthcare Research and Quality Prevention Quality Indicators software (11). This algorithm defines potentially preventable hospitalizations related to specific conditions, such as heart failure, di-

Table 1–Continued

Minor Complex Chronic		Simple Chronic		Relatively Healthy	
HC (*n* = 62 056 [1.0%])	**Non-HC (*n* = 1 635 728 [26.8%])**	**HC (*n* = 22 232 [0.4%])**	**Non-HC (*n* = 1 079 215 [17.7%])**	**HC (*n* = 6421 [0.1%])**	**Non-HC (*n* = 588 096 [9.6%])**
74	74	73	73	69	69
53.9	56.5	56.6	61.8	44.9	45.4
83.6	83.5	88.4	86.4	82.2	77.2
7.6	7.4	5.2	6.0	8.1	8.8
5.0	5.0	3.2	3.8	6.0	8.6
3.7	4.2	3.1	3.8	3.7	5.6
18.8	11.4	9.5	6.9	15.6	8.5
5.3	3.6	0	0	0	0
0.8	0.5	0.5	0.3	0	0
8	6	6	4	7	2

abetes, hypertension, and asthma, for which good outpatient care can likely prevent the need for hospitalization. The algorithm has been validated and used in prior work on the Medicare population. A full list of the potentially preventable hospitalization diagnoses and their associated International Classification of Diseases, Ninth Revision, codes is in Appendix Table 1 (available at Annals.org).

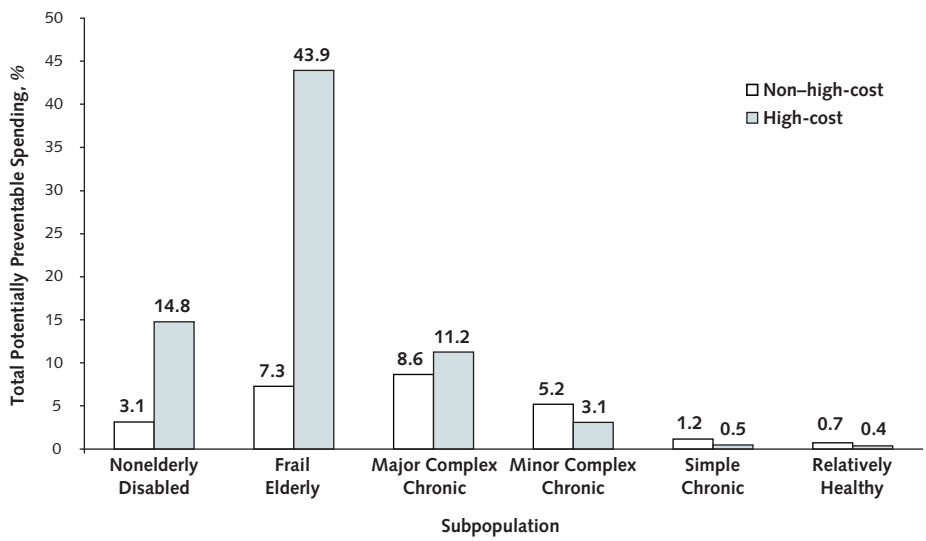
To identify potentially preventable ED visits, we used an algorithm created by Billings and colleagues (12, 13). This algorithm, which has been validated and used in prior published work (6), employs diagnosis codes to separate ED visits into the following 4 categories: nonemergent; emergent but primary care–treatable; emergent, ED care needed, but preventable; and emergent, ED care needed, and not preventable. Similar to prior work, we classified as potentially preventable the nonemergent; emergent but primary care–treatable; and emergent, ED care needed, but preventable ED visits. Because Medicare data combine ED costs with inpatient costs if a patient is hospitalized, we limited our sample of independent ED visits to those not leading to an admission.

Statistical Analysis

We categorized spending for 30 days after an admission or ED visit for ACSCs into the following major categories: inpatient care, ambulatory care, rehabilitative or long-term care, hospice care, skilled-nursing facilities, home health, physician services and tests, and durable medical equipment.

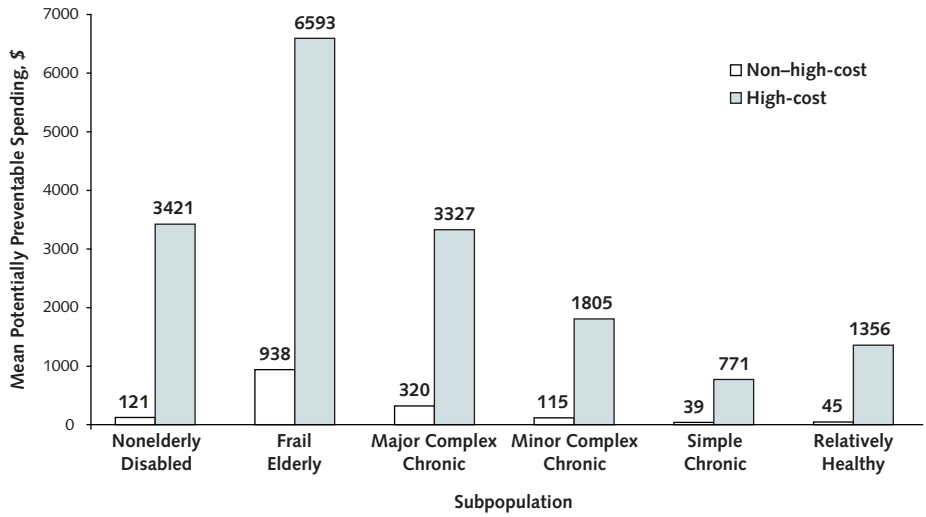
We first compared demographics and comorbid conditions across the 6 subpopulations. We then calculated the amount and proportion of potentially preventable spending incurred overall and for each high-cost

Figure 1. Proportion of total potentially preventable spending, by high-cost subpopulation.



Data were calculated from Medicare administrative claims from 2012.

Figure 2. Mean potentially preventable spending, by high-cost status, in Medicare subpopulations.



Costs were calculated from Medicare administrative claims data from 2012.

and non–high-cost subpopulation. Variations in spending patterns were then examined by setting (for example, inpatient, outpatient, and postacute) across each group. Finally, we examined spending for individual ACSCs across the subpopulations.

All analyses were done using SAS software (SAS Institute). This study was approved by the Harvard School of Public Health Office of Human Research Administration.

Role of the Funding Source

This work was funded and supported by The Commonwealth Fund, which had no role in the study's design, conduct, or reporting.

RESULTS

Patient Characteristics

Our sample included 6 112 450 Medicare beneficiaries, all of whom were assigned to 1 of the 6 subpopulations. Using our claims-based algorithm, we assigned: 1 093 542 patients (17.9%) to the nonelderly disabled group, 522 960 (8.6%) to the frail elderly group, 1 102 200 (18.0%) to the major complex chronic group, 1 697 784 (27.8%) to the minor complex chronic group, 1 101 447 (18.0%) to the simple chronic group, and 594 517 (9.7%) to the relatively healthy group (**Appendix Table 2**, available at Annals.org).

The top 10% of spenders, or 611 240 beneficiaries, were designated as high-cost. The proportion of patients designated as high-cost was high in the frail elderly (46.2%), nonelderly disabled (14.3%), and major complex chronic groups (11.1%). It was low for the minor complex chronic (3.7%) and simple chronic (2.0%) groups, although it was still higher than for the relatively healthy group (1.1%). High-cost patients in each subpopulation were more likely to be dually eligible and have higher rates of chronic medical conditions and mental illness (**Table 1**).

Preventable Spending, by Subpopulation

Of total health care spending in our sample, we identified 4.8% as potentially preventable. High-cost patients accounted for 73.8% of that and non–high-cost patients 26.2%. However, the proportion of spending that was potentially preventable varied across the high-cost subpopulations. Despite making up only 4% of the total population, high-cost frail elderly persons accounted for the highest proportion (43.9%) of potentially preventable spending (**Figure 1**). High-cost nonelderly disabled persons accounted for the second-highest proportion of potentially preventable spending (14.8%), followed by the major complex chronic group (11.2%). Mean potentially preventable spending in the high-cost frail elderly group was $6593 per beneficiary, compared with $3421 in the high-cost nonelderly disabled group, $3327 in the high-cost major complex chronic group, $1805 in the high-cost minor complex chronic group, and $1356 in the high-cost relatively healthy group (**Figure 2**). Non–high-cost patients incurred much lower potentially preventable costs, except non–high-cost frail elderly persons ($938).

Patterns were similar when we examined the full population across the main 6 segments (**Figure 3**). The frail elderly group contributed 51.2% of total potentially preventable spending, despite being only 8.6% of the population. The nonelderly disabled and major complex chronic groups accounted for proportions of potentially preventable spending that were equal to their individual proportions of the population. The minor complex, simple chronic, and relatively healthy groups accounted for only 11% of potentially preventable spending, despite being 55.5% of the Medicare population.

Specific Types of Preventable Spending, by High-Cost Subpopulation

Potentially preventable spending for high-cost frail elderly persons was largely in the inpatient setting ($3164 per person) and skilled-nursing facilities ($1917 per person) (Table 2). The high-cost nonelderly disabled group spent $2128 per person and the major complex chronic group spent $1960 per person in the inpatient setting. Of all high-cost groups, the high-cost nonelderly disabled group spent the most in home health services ($489 per person). Overall preventable type of spending by the 6 main segments is in Appendix Table 3 (available at Annals.org).

Spending, by Individual ACSC, by Subpopulation

On average, frail elderly persons accounted for the most potentially preventable inpatient spending for nearly all individual ACSCs. Much of the preventable inpatient spending in the frail elderly group was related to acute care visits for heart failure ($451 per person), bacterial pneumonia ($355 per person), urinary tract infections ($289 per person), diabetes long-term complications ($152 per person), and dehydration ($121 per person) (Figure 4). The nonelderly disabled group accounted for the most potentially preventable spending for admissions related to diabetes short-term complications. Appendix Table 4 (available at Annals.org) provides a full list of preventable spending by individual ACSCs.

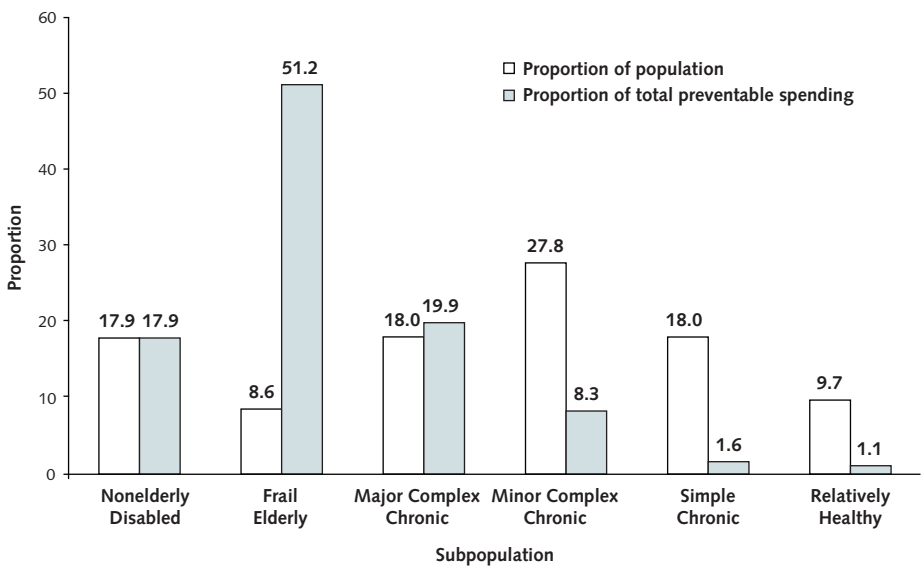
DISCUSSION

About 5% of total health care spending incurred by our sample of Medicare beneficiaries was identified as potentially preventable, and most of this spending was incurred by high-cost patients. However, large variations existed across high-cost subgroups. The high-cost frail elderly group accounted for nearly half of all potentially preventable spending after admissions for ACSCs or potentially avoidable ED visits. This spending was particularly high for heart failure, pneumonia, chronic obstructive pulmonary disease or asthma, and urinary tract infections.

For clinical leaders and policymakers, focusing on frail elderly Medicare beneficiaries may be highly efficacious. High-cost frail elderly persons in particular incurred the most substantial proportion of potentially preventable spending among high-cost subpopulations. Of note, the non–high-cost frail elderly group had more potentially preventable spending than all other non–high-cost groups. Meanwhile, more than half of the population accounted for very little potentially preventable spending related to ACSCs. These findings highlight the need to understand and mitigate the health consequences of frailty, especially as the U.S. population ages and frailty becomes more prevalent. Given the high concentration of potentially modifiable spending among frail elderly persons, interventions that target this population may lead to disproportionate reductions in health care costs.

Our work suggests that simple interventions in the outpatient setting, such as close management of heart failure and prevention of urinary tract infections, may substantially reduce unnecessary spending. Prior work has shown that a range of strategies targeting frail elderly persons can help reduce hospitalizations, improve quality, and control costs for this subpopulation. For example, simple, home-based physical therapy programs that aid in maintaining physical agility have been shown to decrease functional decline over time (14), which in turn could prevent hospitalizations (15)

Figure 3. Proportion of total beneficiaries, by Medicare subpopulation, with associated proportion of potentially preventable spending.



Data were generated from Medicare administrative claims from 2012. The number of beneficiaries in this sample is 6 112 450.

Table 2. Mean Preventable Spending in Medicare Subpopulations, by Category*

Preventable Costs	Nonelderly Disabled		Frail Elderly		Major Complex Chronic		Minor Complex Chronic		Simple Chronic		Relatively Healthy	
	HC	Non-HC	HC	Non-HC	HC	Non-HC	HC	Non-HC	HC	Non-HC	HC	Non-HC
Total preventable spending (per beneficiary)	3421	121	6593	938	3327	320	1805	115	771	39	1356	45
Total cost within population, %	4.8	1.7	9.4	5.9	5.8	3.3	3.3	1.9	1.4	0.9	2.3	1.5
Total inpatient costs (per beneficiary)†	2128	86	3164	460	1960	214	1082	79	446	27	745	31
Acute hospital	1856	85	2708	440	1873	212	1021	78	422	26	628	31
Long-term care hospital	183	0	221	4	50	1	33	0	13	0	52	0
Inpatient rehabilitation facility	67	1	203	13	27	1	22	0	10	0	32	0
Total outpatient costs (per beneficiary)	239	5	194	25	218	12	114	5	51	2	122	2
Physician services and tests‡	583	21	917	135	567	58	305	20	141	7	254	5
Home health	489	4	295	94	160	19	62	5	24	2	64	2
Skilled-nursing facility	279	2	1917	210	336	13	199	5	95	2	176	2
Hospice	8	0	50	6	34	1	22	0	8	0	6	0
Durable medical equipment	72	2	56	7	51	4	21	1	6	0	22	0

HC = high-cost.
* Data are based on Medicare administrative claims from 2012. Values are for each subpopulation and are U.S. dollars unless otherwise indicated.
† Includes emergency department costs.
‡ Includes costs from physician evaluation and management, laboratory studies, and tests.

and reduce spending in the long run. Programs that help increase physical activity and maintain functional status have also been shown to be cost-effective (16). Thus, such programs as the Geriatric Resources for Assessment and Care of Elders model and the Program of All-Inclusive Care for the Elderly may be particularly beneficial for these persons (1, 2). In addition, focusing on shifting them from skilled-nursing facilities and rehabilitation centers to less costly home-based services may lead to further savings.

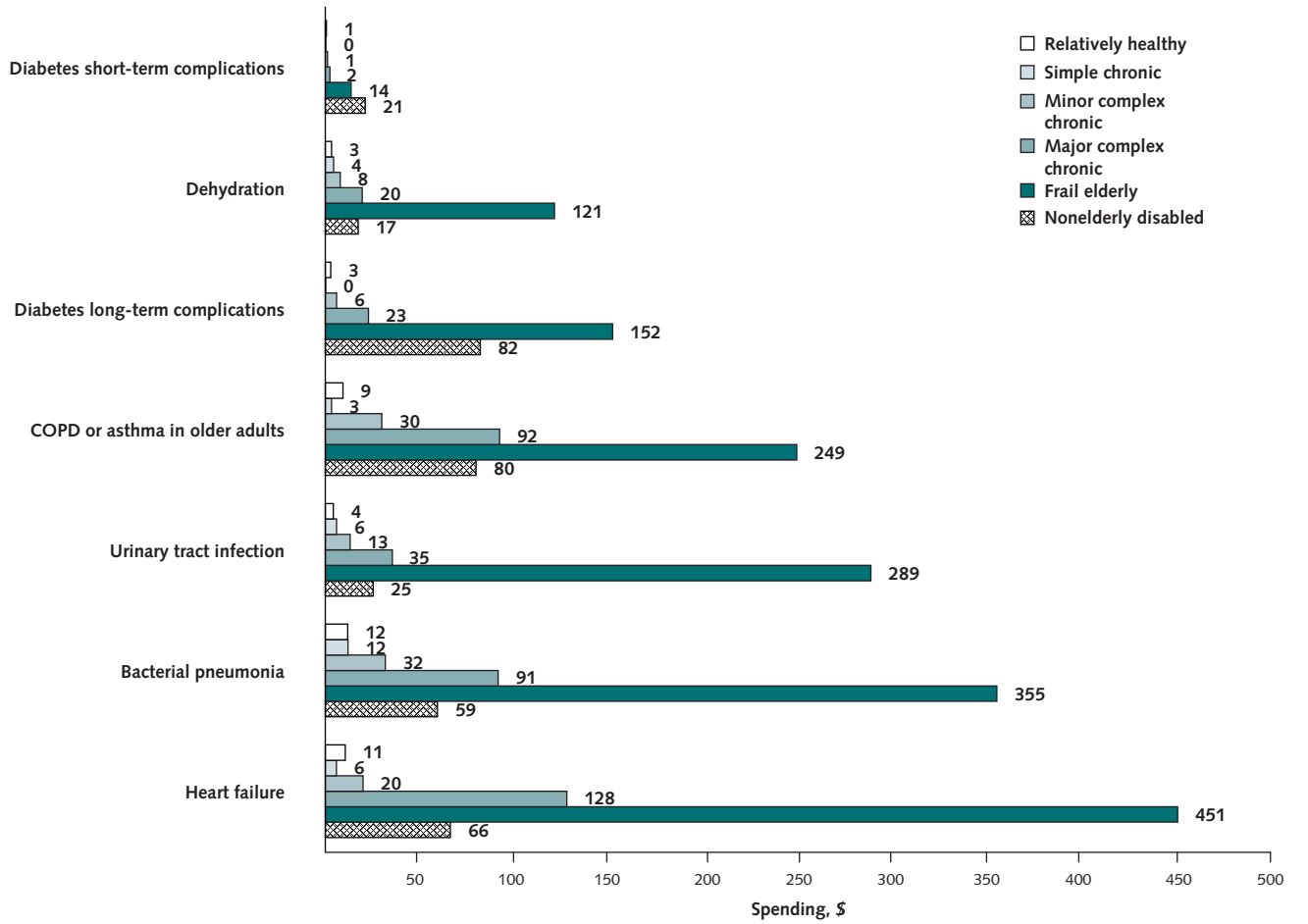
The nonelderly disabled group, who qualified for Medicare on the basis of disability (and a small percentage because of end-stage renal disease), also accounted for a substantial proportion of potentially preventable spending, particularly for conditions related to asthma and diabetes, including short- and long-term complications and admissions for hyperglycemia. Prior work has shown that serious mental illness (including major depression, bipolar disease, and schizophrenia) is highly and disproportionately prevalent in this group (3, 17). Serious mental illness is associated with a higher risk for nonadherence to diabetes self-care—including dietary restrictions, medications, and blood glucose monitoring—resulting in worse overall clinical outcomes (18, 19). Although treating serious mental illness is challenging, our work suggests that new interventions to treat comorbid mental illness in patients with chronic medical conditions may be of value. In addition, alcohol and substance use was common in this population. Given the high prevalence of mental health or substance use issues among disabled persons, our findings indicate that targeting this group may help reduce spending and improve outcomes. This is consistent with prior studies showing that unnecessary health care use and spending can be prevented through social services, such as supported employment (20), and preventive health care services, such as peer educators and behavior modeling (21).

Finally, the minor complex chronic, simple chronic, and relatively healthy groups made up only about 11% of total potentially preventable spending, despite comprising more than 55% of the Medicare population. This finding highlights the utility of segmenting populations, which allows clinical leaders and policymakers to more clearly identify and target groups that may benefit. Such segmentation is especially relevant as we continue to shift accountability for costs and outcomes to health care providers under MACRA and through programs like accountable care organizations, which directly include quality measures of ACSCs.

Our study adds to the literature examining preventable spending in Medicare beneficiaries. Prior work has shown that preventable spending was only a small percentage of cost in the top decile of Medicare spending (6). However, this work did not provide insight into which clinical groups may benefit from specific strategies or interventions to reduce costs. To our knowledge, our study is the first to examine preventability by subpopulation. In doing so, we gained insight into particular targets for avoidable admissions by patient population. Furthermore, by including costs incurred in the post–acute care setting, our estimates may better reflect true long-term preventable spending than those of prior studies. Other work also found that congestive heart failure and bacterial pneumonia were the 2 most common reasons for potentially preventable hospitalizations (22). Our work shows that nearly 80% of spending for heart failure admissions and 70% of spending for bacterial pneumonia are attributable to only 2 populations, frail elderly persons and persons with major complex chronic illness. Finally, our work contributes to a growing body of literature showing that frailty is a powerful predictor of both clinical outcomes (23–26) and cost (27).

This study has limitations. First, although we used well-established algorithms to define potentially preventable acute care episodes, these probably represent a spectrum of preventability, with some individual admissions not preventable through better outpatient care. For example, admission for some of the ACSCs

Figure 4. Mean potentially preventable inpatient spending, by subpopulation, for individual ambulatory care–sensitive conditions.



COPD = chronic obstructive pulmonary disease.

may be driven by socioeconomic status or other factors not under direct control of the health care system, such as poor air quality driving asthma admissions. Second, preventable spending can persist past the 30-day time frame we used, and we may have missed some preventable spending within the 30-day time frame. Third, we determined the presence of chronic disease through claims data, which may underestimate its true incidence. Preventable visits, as defined by Agency for Healthcare Research and Quality methodology, do not always incorporate disease stage, other measures of health status, or precise indications for admission. Fourth, our data are limited to Medicare patients. Whether our findings would apply to patients insured through Medicare Advantage, commercial plans, or Medicaid is unclear. We also could not determine spending from supplemental plans or Medicaid for persons enrolled in both Medicare and Medicaid; we therefore could have underestimated spending in these groups.

In summary, we found large variations in potentially preventable spending across Medicare subpopulations. Frail elderly persons were at particularly high risk for incurring potentially modifiable costs. Therefore, as we continue to move toward value-based frameworks, interventions that focus on frail elderly patients may be particularly valuable.

From Harvard T.H. Chan School of Public Health, Brigham and Women's Hospital, and Harvard Medical School, Boston, Massachusetts, and Washington University School of Medicine, St. Louis, Missouri.

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Reproducible Research Statement: *Study protocol:* Available in the Appendix. *Statistical code:* Portions available on request. Please contact jzheng@hsph.harvard.edu with specific queries. *Data set:* Not available. Research-identifiable Medicare claims data are obtained and analyzed under a data-use agreement with the Centers for Medicare & Medicaid Services and can be shared only with its prior authorization.

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Appendix: Segmenting Medicare Patients into Subpopulations

We divided beneficiaries into distinct subpopulations. We based our initial approach to creating these cohorts on the taxonomy proposed by Lynn and colleagues (5), supplementing this starting point with input from clinicians in general medicine, cardiology, general surgery, and emergency medicine, and then obtaining additional expert input as part of a 3-part series of workshops focused on high-need patients convened by the National Academy of Medicine. On the basis of beneficiaries' claims in 2011, we first divided beneficiaries into the following 4 mutually exclusive groups in a waterfall fashion (such that the groups were assigned in hierarchical order and are mutually exclusive): 1) the under-65 Medicare population, which consists of those qualifying for Medicare on the basis of the presence of end-stage renal disease or disability as determined by the Social Security Administration; 2) frail, defined as aged 65 years or older and having at least 2 conditions on a modified list of 12 specific claims-based diagnoses potentially indicative of frailty as proposed by Kim and Schneeweiss (28) (gait abnormality, malnutrition, failure to thrive, cachexia, debility, difficulty walking, history of fall, muscle wasting, muscle weakness, decubitus ulcer, senility, or durable medical equipment use); 3) beneficiaries aged 65 years or older with chronic illness, defined as those with 1 or more chronic conditions as defined by a set of clusters of 29 disease categories we created by harmonizing the Centers for Medicare & Medicaid Services Hierarchical Conditions Categories with the Medicare Chronic Conditions Data Warehouse; and 4) relatively healthy beneficiaries, defined as all others (Joynt and colleagues [3]).

Given that the chronic conditions group included 63.1% of the Medicare population, we further subdivided this group into 3 distinct segments based on the specific type and number of chronic conditions. Starting with the list of key chronic disease groups outlined by the Centers for Medicare & Medicaid Services in its measure for unplanned admissions for patients with several chronic conditions, we defined the following 9 conditions as "complex": acute myocardial infarction/ischemic heart disease, chronic kidney disease, congestive heart failure, dementia, chronic lung disease, psychiatric disease, specified heart arrhythmias, stroke, and diabetes. We defined the remaining 20 conditions as "other noncomplex conditions." The 3 segments were described as major complex chronic illness (2 or more complex conditions or at least 6 noncomplex conditions), minor complex chronic illness (only 1 complex condition and fewer than 6 noncomplex conditions), and simple chronic illness (1 to 5 noncomplex chronic conditions).

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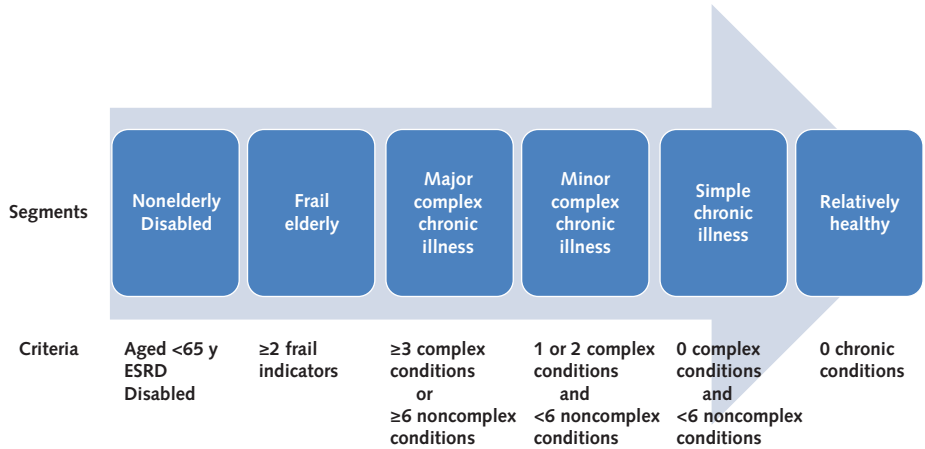
Appendix Figure. Population segments.



Segments were assigned in a waterfall fashion in the order shown, such that the groups are mutually exclusive. First, beneficiaries aged <65 y were assigned to a group (nonelderly disabled). Then, of remaining beneficiaries, those with >2 frailty indicators were assigned to a group (frail elderly). Then, on the basis of the number of chronic conditions present, the remaining beneficiaries were divided into the 4 remaining groups shown. ESRD = end-stage renal disease.

Appendix Table 1. Agency for Healthcare Research and Quality PQIs

PQI	ICD-9 Codes Used to Indicate Diagnosis
PQI 01 Diabetes Short-term Complications	25010, 25011, 25012, 25013, 25020, 25021, 25022, 25023, 25030, 25031, 25032, 25033
PQI 02 Perforated Appendix	5400, 5401
PQI 03 Diabetes Long-term Complications	25040, 25041, 25042, 25043, 25050, 25051, 25052, 25053, 25060, 25061, 25062, 25063, 25070, 25071, 25072, 25073, 25080, 25081, 25082, 25083, 25090, 25091, 25092, 25093
PQI 05 Chronic Obstructive Pulmonary Disease or Asthma in Older Adults	4910, 4911, 49120, 49121, 4918, 4919, 4920, 4928, 494, 4940, 4941, 496, 4660, 490
PQI 07 Hypertension	4010, 4019, 40200, 40290, 40300, 40310, 40390, 40400, 40410, 40490
PQI 08 Congestive Heart Failure	39891, 40201, 40291, 40401, 40403, 40111, 40413, 40491, 40493, 4280, 4281, 42820, 42821, 42822, 42823, 42830, 42831, 42832, 42833, 42840, 42841, 42842, 42843, 4289, 39891
PQI 09 Low Birth Weight (excluded for Medicare)	NA
PQI 10 Dehydration	2765, 27650, 27651, 27652
PQI 11 Bacterial Pneumonia	481, 4822, 48230, 48231, 48232, 48239, 48241, 48242, 4829, 4830, 48314838, 485, 486
PQI 12 Urinary Tract Infection	59010, 59011, 5902, 5903, 59080, 59081, 5909, 5950, 5959, 5990
PQI 13 Angina Without Procedure	4111, 41181, 41189, 4130, 4139
PQI 14 Uncontrolled Diabetes	25002, 25003
PQI 15 Asthma in Younger Adults	49300, 49301, 49302, 49310, 49311, 49312, 49320, 49321, 49322, 49381, 49382, 49390, 49391, 49392
PQI 16 Lower-Extremity Amputation Among Patients With Diabetes (procedure codes)	8410, 8411, 8412, 8413, 8414, 8415, 8416, 8417, 8418, 8419

ICD-9 = International Classification of Diseases, Ninth Revision; NA = not available; PQI = prevention quality indicator.

Appendix Table 2. Patient Characteristics of the 6 Medicare Subpopulations

Characteristic	Nonelderly Disabled (*n* = 1 093 542 [17.9%])	Frail Elderly (*n* = 522 960 [8.6%])	Major Complex Chronic (*n* = 1 102 200 [18.0%])	Minor Complex Chronic (*n* = 1 697 784 [27.8%])	Simple Chronic (*n* = 1 101 447 [18.0%])	Relatively Healthy (*n* = 594 517 [9.7%])
Designated as high-cost, %	14.3	46.2	11.1	3.7	2.0	1.1
Median age, *y*	53	81	77	74	73	69
Female, %	47.7	66.6	55.3	56.4	61.7	45.4
Race, %						
White	67.6	82.5	83.1	83.6	86.4	77.2
Black	19.8	9.3	7.8	7.4	6.0	8.8
Hispanic	8.7	5.3	5.7	5.0	3.8	8.5
Other	3.9	3.0	3.4	7.1	3.8	5.6
Dually eligible, %	53.7	24.7	17.2	11.6	7.0	8.6
Mental health diagnosis, %	23.2	10.3	7.3	3.6	0.0	0.0
Alcohol/substance use, %	6.3	2.4	2.0	0.5	0.3	0.0
Median chronic conditions, *n*	4	7	8	5	3	0

Appendix Table 3. Mean Overall Potentially Preventable Spending, by Category, in 6 Medicare Subpopulations*

Preventable Costs	Nonelderly Disabled	Frail Elderly	Major Complex Chronic	Minor Complex Chronic	Simple Chronic	Relatively Healthy
Mean preventable spending	839	3836	808	265	105	100
Total cost within population, %	5.1	9.3	5.5	3.4	2.0	2.3
Total inpatient costs (per beneficiary)†	378	1708	408	116	35	46
Acute hospital	339	1487	397	113	34	44
Long-term care hospital	26	104	6	2	0	1
Inpatient rehabilitation facility	10	101	4	1	0	1
Preventable ED visits‡	245	287	165	87	51	33
Total outpatient costs (per beneficiary)	39	103	35	9	3	3
Physician services and tests§	102	496	114	30	10	11
Home health	19	187	35	7	2	2
Skilled-nursing facility	42	998	49	12	4	4
Hospice	1	26	5	1	0	0
Durable medical equipment	18	30	9	2	1	1

ED = emergency department.
* Data are based on Medicare administrative claims data from 2012. Values are U.S. dollars unless otherwise indicated.
† Includes ED costs.
‡ Costs as defined by the Billings algorithm.
§ Includes costs from physician evaluation and management, laboratory studies, and tests.

Appendix Table 4. Mean Inpatient Spending for Each ACSC, by Medicare Subpopulation*

ACSC	Inpatient Spending for Each ACSC Driven by Subpopulation					
	Nonelderly Disabled	Frail Elderly	Major Complex Chronic	Minor Complex Chronic	Simple Chronic	Relatively Healthy
Heart failure						
Mean, $	66	451	128	20	6	11
Percentage of total	14.1	43.5	31.9	7.8	1.5	1.3
Bacterial pneumonia						
Mean, $	59	355	91	32	12	12
Percentage of total	14.6	39.5	26.3	14.3	3.5	1.8
COPD or asthma in older adults						
Mean, $	80	249	92	30	3	9
Percentage of total	21.8	31.0	29.6	15.0	1.1	1.5
Urinary tract infection						
Mean, $	25	289	35	13	6	4
Percentage of total	11.0	56.5	18.0	10.4	3.1	1.1
Diabetes long-term complications						
Mean, $	82	152	23	6	0	3
Percentage of total	42.9	36.2	14.1	5.8	0.1	0.9
Dehydration						
Mean, $	17	121	20	8	4	3
Percentage of total	14.8	47.0	19.6	12.3	4.5	1.7
Amputation in diabetics						
Mean, $	20	60	2	1	0	1
Percentage of total	38.8	52.6	5.7	2.0	0.1	0.8
Hypertension						
Mean, $	8	31	10	4	2	2
Percentage of total	16.9	30.9	26.6	16.6	6.1	2.9
Perforated appendix						
Mean, $	5	15	3	3	4	2
Percentage of total	18.0	25.5	14.1	22.7	14.9	4.9
Diabetes short-term complications						
Mean, $	21	14	2	1	0	1
Percentage of total	63.7	19.1	9.0	6.3	0.7	1.1
Uncontrolled diabetes						
Mean, $	5	9	2	1	0	0
Percentage of total	35.9	30.7	19.0	11.3	0.8	2.2
Angina without procedure						
Mean, $	2	3	3	1	1	0
Percentage of total	20.2	19.5	32.9	19.1	6.6	1.8
Asthma in younger adults						
Mean, $	3	0	0	0	0	0
Percentage of total	100.0	0.0	0.0	0.0	0.0	0.0

ACSC = ambulatory care–sensitive condition; COPD = chronic obstructive pulmonary disease.
* Data are based on Medicare administrative claims data from 2012. The dollar amounts represent mean spending per beneficiary in each subpopulation. The percentages are the proportion of spending by subpopulation across each ACSC (row percentages).