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Research Paper

Trends in medicare spending across strata of resource utilization among older individuals in the United States

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A R T I C L E   I N F O

A B S T R A C T

Background: Health care spending is an increasing proportion of government expenditures in most Western countries. How this growth is distributed between individuals with minimal compared to high health care utilization is unknown.

Methods: We examined total and per-capita government expenditure in an observational cohort of fee-for-service U.S. Medicare enrollees aged ≥65 years from 2007 to 2018. We categorized patients into annual resource utilization strata. We examined annualized changes in adjusted spending across resource utilization strata and the distribution of spending within and across strata for a variety of health care settings.

Findings: Examining 314,593,489 beneficiary-years of coverage, the top 1% of beneficiaries accounted for 14.9% of all expenditures, the top 5% for 41.5%, the top 10% for 60.0%, the top 20% for 79.1%, and the top 50% for 95.7%. Annual expenditures remained relatively stable from 2007 to 2018, with annual mean change of 0.7% (standard deviation 1.1%; median 1.1%) and mean per capita change of 0.4% (standard deviation 1·6%; median 0·3%). Changes were similar across strata with mean increases <1% in all, save for the <50th percentile strata (mean annual growth=1·9%), a significant difference (*p* = 0.0002). The overall distribution of expenditures across health care settings remained consistent over time, with different distributions between expenditure strata.

Interpretation: In the U.S. from 2007 to 2018, Medicare spending has a Pareto distribution in which 80% of the costs are attributable to 20% of beneficiaries. Despite low overall Medicare spending growth from 2007 to 2018, growth has been greatest among those in the lowest spending group.

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1. Introduction

Over the past three decades, technological and demographic changes in organisation for Economic Co-operation and Development (OECD) countries have resulted in increasing health care expenditures, raising concerns about unsustainable future increases and the potential need to re-shape health care delivery [1]. Given that growth in health care spending has outpaced economic growth, spending increases will test the viability of many government financed health care systems. The United States (U.S.) is an outlier in terms of high per capita spending; however, spending growth has slowed in the U.S. over the past decade. [14] We explore the sources of this slowdown in health care spending growth, which occurred without direct government action to limit health budgets.

Specifically, we explore how spending growth varied with level of spending at the individual level. It is well known that a significant proportion of health care expenditures are attributable to a small number of high cost individuals [2]. These individuals are disproportionately older and with multiple co-morbidities [3,4]. In the American medical system, many have held that the Pareto Principle (also known as the "80/20 rule") characterizes health care spending such that 80 percent of health care dollars are spent on 20% of the population [5]. As a result, policy experts have argued that it makes sense to design and implement health care interventions focused on the most expensive 20% of individuals [6]. We sought to test the hypothesis that the growth in Medicare spending for high cost individuals would differ from the remainder of the population. If true, it could mean that efforts to constrain spending growth for these individuals would

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Research in context

Evidence before this study

Growth in health care expenditures worldwide has subsumed a large portion of national governmental budgets in much of the Western world and such growth is expected to continue over the coming years. In the United States, rates of growth have diminished in the past ten to fifteen years, in part due to legislative efforts. Previous work from many jurisdictions has demonstrated that health care expenditures are asymmetrically distributed throughout the population with a relatively small proportion of individuals with high health care utilization accounting for a large proportion of overall spending.

Added value of this study

In this analysis of all fee-for-service Medicare beneficiaries in the United States between 2007 and 2018 with Part A and B coverage, we demonstrated relatively low rates of growth in health care expenditure, after adjusting for changes in regulated prices. Notably, when stratified by strata of health care utilization (99th, 95−98th, 90−94th, 80−89th, 50−79th, and <50th percentiles according to previously published cut-offs), rates of change were similar among strata, apart from those in the <50th percentile strata who had significantly greater per capita (mean 1·6%) and overall (mean 1·9%) cumulative increases in Medicare expenditure.

Implications of all the available evidence

Ongoing growth in health care expenditures will test the viability of government funded health care in many jurisdictions. Available data in the United States suggest that a "rising tide" of spending has affected nearly all beneficiaries with similar annual relative increases across strata. This observation suggests at least three potential approaches moving forward which may be explored either preferentially or concurrently: a focus on underlying trends in health care policy or delivery which are independent of individual patient utilization, a focus on the highest-cost individuals as they represent the largest target both on a per capita and aggregate basis, or a focus on low-cost individuals, for which spending appears to be rising fastest.

have effects on both the level of spending overall and on spending growth over time [7,13].

2. Methods

2.1. Data source and population

We utilized the 2007 to 2018 Master Beneficiary Summary File (MBSF) to identify U.S. Medicare enrollees aged 65 and older receiving fee-for-service care. We excluded beneficiaries who were enrolled in Medicare Advantage plans as of July of a given year.

2.2. Primary outcome

The primary outcome of interest was per capita total Medicare spending, adjusted to 2015 levels [8]. Total Medicare spending was defined as aggregate Part A and B spending comprising payments for hospital inpatient care, hospital outpatient care, home health, skilled nursing facilities, hospice, physicians and suppliers, Part B drugs, and other Part B services. We excluded cost sharing amounts and Part D (prescription drug) premiums. We looked at trends in aggregate Medicare payments and trends by setting.

Our adjustment of spending to 2015 service price levels allows us to examine changes in the types of care accessed and the utilization of health care services, rather than changes in the price of a given service or product, though there are interactions between prices and service use. In addition to considering spending changes on a per capita basis, we considered aggregate changes in the population as a whole.

2.3. Primary exposure

In accordance with previous literature [2,3,5], we categorized individuals on the basis of their Medicare resource utilization into the following groups: <50th percentile, 50−79th percentile, 80−89th percentile, 90−94th percentile, 95−98th percentile, and 99th percentile. As health care resource utilization may change from year to year, we assessed this on an annual basis.

2.4. Covariates

To understand the included beneficiaries, we captured a number of demographic and insurance related factors. Relevant demographic factors included age (continuous and categorical), sex, race/ethnicity, location of residence (categorized into nine regions), and rurality (categorized into four groups). We grouped the 26 indicators of chronic disease in the MBSF into eight disease categories (cancer, cardiac, cognitive, endocrine, ophthalmic, pulmonary, skeletal, and other) [9]. We further considered whether patients were dually eligible for the Medicaid program for low-income persons, and categorized this as not at all, partially, or fully Medicaid insured.

2.5. Analysis

We first assessed whether there were changes in the characteristics of individuals with high resource utilization over time by comparing across the study period (2007 to 2018). To allow for comparison over the whole study cohort while accounting for movement of individuals between strata across years, we examined baseline characteristics based on beneficiaries' year of coverage.

Then, we assessed both per capita and overall annual Medicare expenditures by spending strata. To measure trends in spending over time, we calculated the annualized change from the previous year within each spending strata, on both a per capita and overall basis. As year-to-year rates of change may be unstable, we also assessed cumulative change from 2007 to 2018. To examine expenditures over times, we conducted both the unit-root test on stationarity and cointegration test on the time trending relationship among spending groups. We use the algorithms of Im-Pesaran-Shin unit-root test for the overall annual expenditures of all spending groups. We use the algorithms of both Kao's and Westerlund's test of cointegration. To examine expenditure growth variations over times among spending cohorts, we conducted a generalized linear model GLM process. GLM could be used for means comparisons and contrasts among groups with balanced data. The Type I and Type III SS are the same and are equal to the traditional ANOVA SS. There are 11 expenditure year-to-year growth rates from year 2008 to year 2018 for each spending cohort. We performed custom hypothesis testing via CONTRAST statements, for example, testing if the expenditure growth trend of the <50th percentile cohort is higher than all the other groups, or if it is higher than the 50−79th percentile cohort, etc. The CONTRAST statements are preferable to general means comparison methods to distinguish whether a particular spending cohort had significant different growth rate trend than the other(s). We performed Waller-Duncan's multiple range test on all main-effect means to further discriminate spending groups from each other. To better understand

Table 1
Characteristics of the study population stratified by individual resource utilization, 2007 − 2018.

Characteristic	Overall	<50th percentile	50−79 percentile	80−89 percentile	90−94 percentile	95−98 percentile	99th percentile
Sample size, person years*	314,593,489	157,296,743	94,378,051	31,459,351	15,729,674	12,583,739	3145,931
Median age, years (IQR)	76.2 (69.9, 81.4)	74.8 (68.8, 79.6)	76.7 (70.3, 81.8)	78.6 (71.5, 84.8)	79.1 (72.4, 85.9)	79.1 (72.4, 85.7)	76.7 (70.4, 82.3)
Female,%	57.1%	55.4%	59.5%	58.4%	58.3%	56.8%	50.8%
Ethnicity/race,%							
Non-Hispanic White	84.1%	83.2%	85.8%	85.1%	84.4%	81.7%	74.0%
Black	7.5%	7.5%	6.6%	7.5%	8.3%	9.9%	14.7%
Hispanic	4.9%	5.2%	4.3%	4.8%	4.7%	5.4%	7.5%
Other	3.5%	4.1%	3.2%	2.6%	2.6%	2.9%	3.8%
Rurality,%							
Urban	77.5%	76.4%	78.6%	77.6%	78.4%	80.5%	84.1%
Rural (Metro Adjacent)	14.3%	14.9%	13.6%	14.3%	13.9%	12.6%	10.4%
Rural (Not Metro Adjacent)	8.0%	8.5%	7.6%	8.0%	7.5%	6.7%	5.5%
Chronic Conditions,%							
Cancer	16.1%	10.7%	18.5%	24.1%	26.3%	28.3%	29.2%
Cardiac	56.1%	39.2%	66.4%	79.0%	84.2%	89.3%	93.0%
Cognitive	34.0%	21.7%	39.1%	51.9%	58.8%	65.5%	69.2%
Endocrine	56.4%	43.4%	64.1%	72.9%	78.2%	83.9%	90.9%
Ophthalmic	70.4%	61.4%	79.6%	78.9%	79.4%	79.2%	75.6%
Other	89.9%	82.3%	96.5%	98.3%	99.0%	99.4%	99.7%
Pulmonary	29.6%	18.0%	35.0%	46.2%	50.7%	56.7%	64.3%
Skeletal	59.5%	45.2%	70.8%	77.9%	79.1%	79.1%	77.0%
Dual eligibility,%							
Partial	3.1%	3.0%	3.0%	3.6%	3.5%	3.4%	3.3%
Full	11.2%	7.7%	11.4%	16.5%	19.5%	24.3%	29.6%

* Note: sample size = # of beneficiaries * number of years of eligible coverage.

resource use within groups, we examined components of Medicare spending. We categorized these as follows, using standard Centers for Medicare & Medicaid Services (CMS) Research Data Assistance Center (ResDAC) definitions: Hospital − Inpatient, Hospital − Outpatient, Physicians and Suppliers, Hospice and Post-Acute Care Services (Home Health, Skilled Nursing Facilities, and Hospice), Part B Drugs, and other Part B costs (inclusive of ambulatory surgical center, anesthesia, and dialysis services, tests, and durable medical equipment) [10].

In all analyses we utilized adjusted spending measures to 2015 service price levels which allows us to examine changes in the types of care accessed and the utilization of health care services, rather than changes in the price of a given service or product, though there are interactions between prices and service use.

Statistical analysis was performed using both STATA 16 (Stata-Corp, College Station, TX, USA) and SAS Enterprise Guide Version 7.15 (SAS Institute Inc., Cary, NC, USA) with statistical significance defined using a two-sided α of 0.05. This study was reported according to the RECORD statement [11]. The study protocol was approved by the Vanderbilt University Medical Center Institutional Review Board (protocol number 150,704).

2.6. Role of the funding source

The funding source had no role in the study design; collection, analysis and interpretation of data; writing of the report; or decision to submit the paper for publication. The corresponding author has
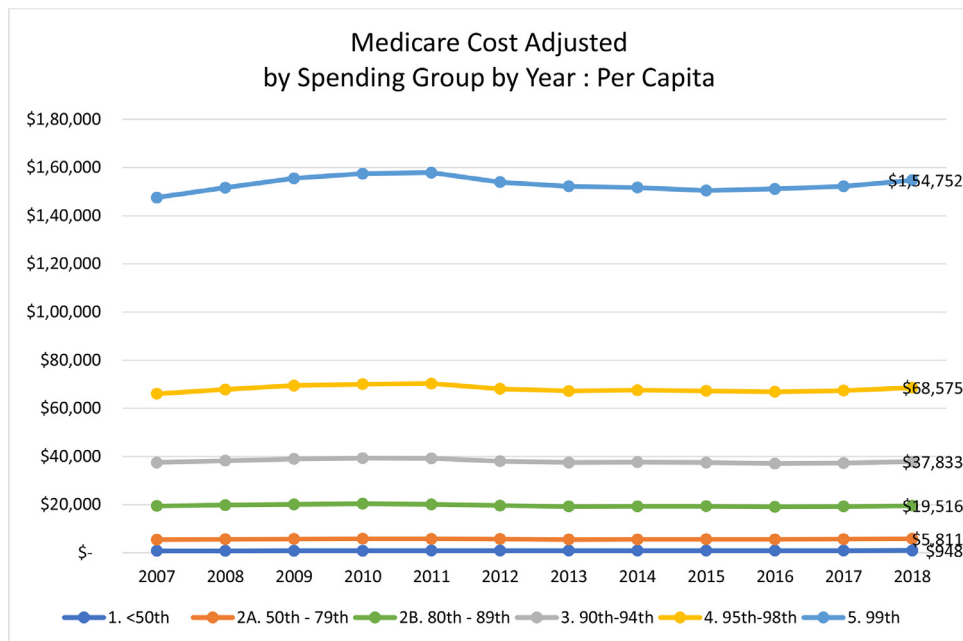

Fig. 1. Annual Adjusted per capita Medicare expenditures, according to strata of individual resource utilization•.

full access to all the data in the study and had final responsibility for the decision to submit for publication.

3. Results

We utilized data on a total of 314,593,489 beneficiary-years of coverage for individuals who received both Part A and B Medicare coverage between 2007 and 2018. In keeping with the expected demographics of the Medicare population over age 65, median age was 76.2 years (interquartile range 69.9 to 81.4 years), 57% were female, and 84% were non-Hispanic white. Patients were predominantly residing in urban locations (77.5%). Chronic conditions were prevalent including cardiac disease in 56%, cancer in 16%, endocrine disorders including diabetes in 56%, and pulmonary disease in 30%. The vast majority received only Medicare coverage (85.7%) while 11.2% had full dual eligibility and 3.1% had partial dual eligibility for Medicaid.

When then stratified all beneficiary-year observations, according to their annual health care utilization, into six mutually exclusive groups: <50th percentile, 50−79th percentile, 80−89th percentile, 90−94th percentile, 95−98th percentile, and 99th percentile. While there was a general trend of increasing age from the <50th percentile (median 74.8 years, IQR 68.8 to 79.6) to the 95−98th percentile (median 79.1, IQR 72.4 to 85.7 years), this did not hold true among patients in the 99th percentile (median 76.7 years, IQR 70.4 to 82.3 years). As would be expected, the prevalence of chronic conditions was higher among individuals who utilized more health care resources (e.g. cardiac disease: 39.2% among individuals in <50th percentile vs 93.0% among individuals in the 99th percentile) (Table 1).

Individual beneficiaries moved from one utilization category to another over time. However, in aggregate, changes over time were small. Between 2007 and 2018, there was, proportionally, an increase in younger individuals (aged 65−69 and 70−74) in the highest bracket of Medicare spending, with corresponding decreases in individuals aged 75−79, 80−84, and 85−89. Similarly, the proportion of

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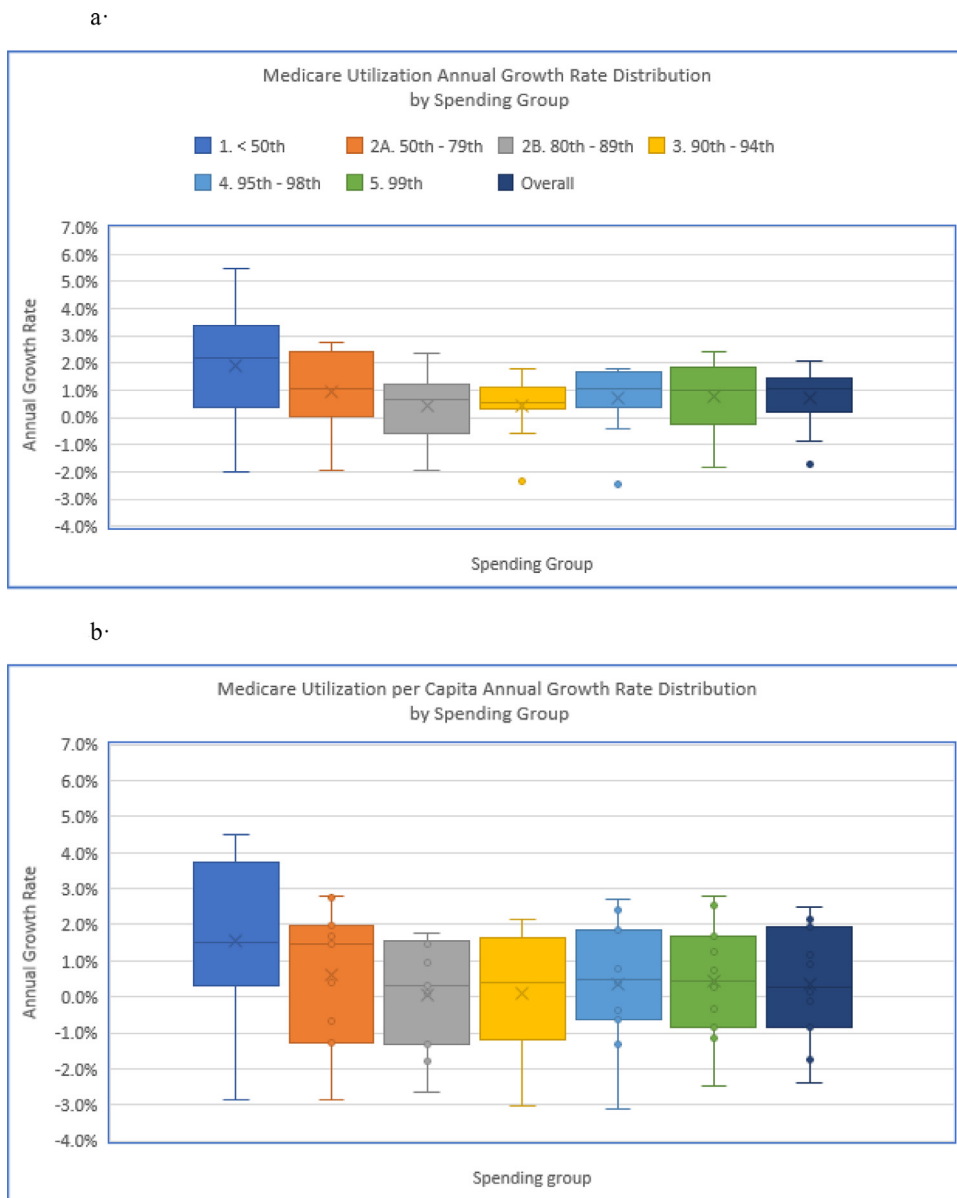
Fig. 2. Distribution of annual Medicare growth rate, according to strata of individual resource utilization: Fig. 2a − annual change in per capita spending; Fig. 2b − annual change in overall spending●.

men in the highest spending category increased over time. While cognitive conditions increased in relative prevalence in all spending categories, this was more prominent among high expenditure individuals.

We assessed both overall and per capita annual expenditures. In overall terms, between 2007 and 2018, the 99th percentile cohort (representing 1% of all Medicare beneficiaries) accounted for 14.9% of overall annual expenditures while the 95−98th percentile cohort accounted for 26.6%, the 90−94th percentile cohort accounted for 18·5%, the 80−89th percentile cohort accounted for 19·1%, the 50−79th percentile accounted for 16.5%, and the <50th percentile cohort accounted for 4.3% of all Medicare expenditures. Thus, in aggregate, the top 1% of beneficiaries accounted for 14·9% of all expenditures, the top 5% for 41.5% of all expenditures, the top 10% for 60.0% of all expenditures, the top 20% for 79.1% of all expenditures, and the top 50% for 95.7% of all expenditures. On an annualized basis, these proportions remained essentially unchanged throughout the study period.

As expected by the group definitions, per capita spending differed substantially between the strata: annual Medicare expenditures averaged $153,044 per beneficiary among those in the 99th percentile cohort, $68,031 per beneficiary among those in the 94−98th percentile cohort, $37,986 per beneficiary among those in the 90−94th percentile cohort, $19,568 per beneficiary among those in the 80−89th percentile cohort, $5645 per beneficiary among those in the 50−79th percentile cohort, and $891 per beneficiary among those in the <50th percentile cohort (Supplementary Table).

Overall, annual Medicare expenditures remained relatively stable during the study period, with annual changes ranging from −1.74% in 2012 to 2·08% in 2010. In addition to stability in overall expenditures, we further found relative stability across all strata of individual resource utilization (Fig. 1 and Fig. 3). To provide a more granular assessment, we assessed relative rates of change by examining annualized rates of change (relative to the year prior). In analyses adjusting prices to 2015 levels, annualized rates of change in Medicare spending were similar across strata of individual resource utilization
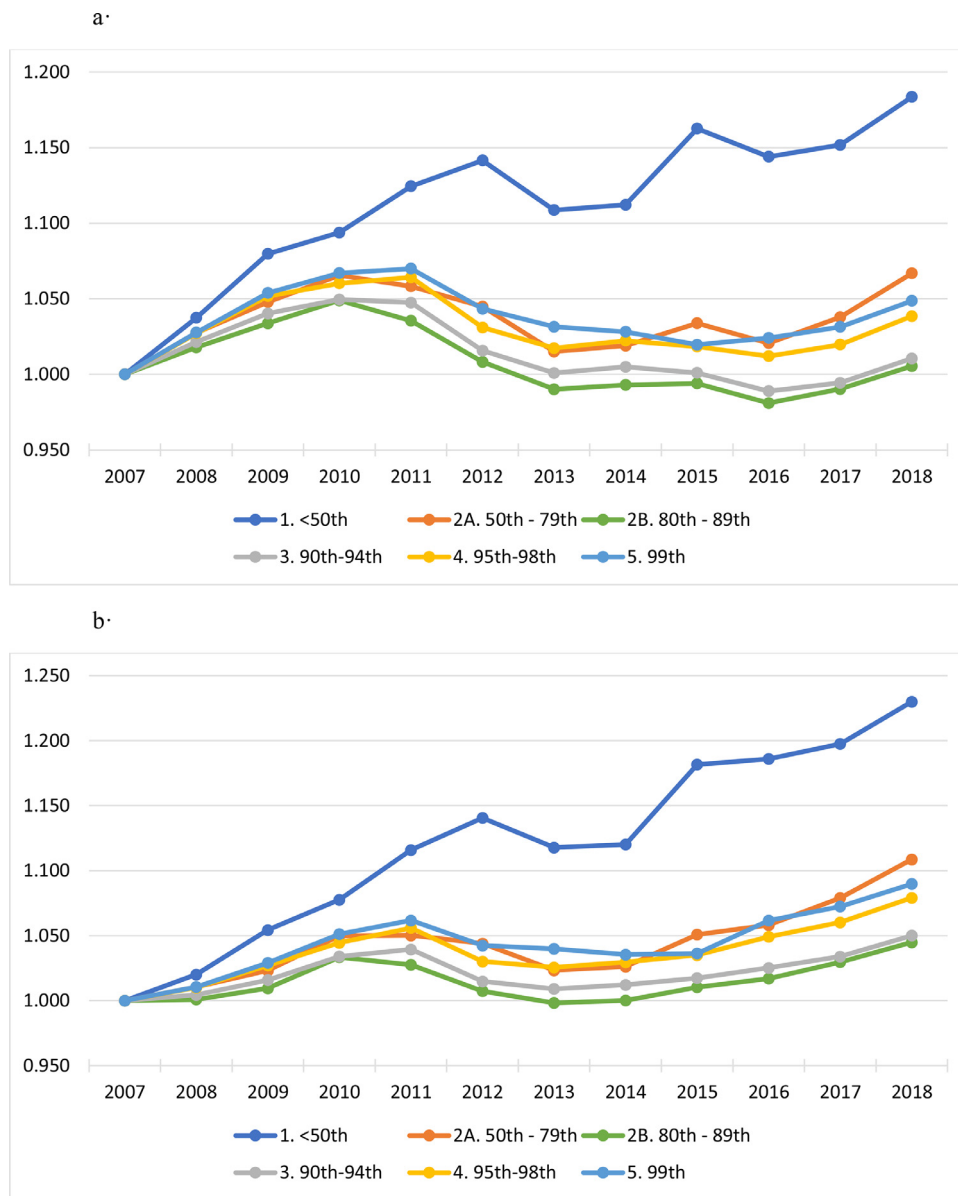
Fig. 3. Cumulative change in adjusted Medicare spending from 2007 onwards according to strata of individual resource utilization: Fig. 3a − per capita cumulative change in spending and Fig. 3b − overall cumulative change in spending•.
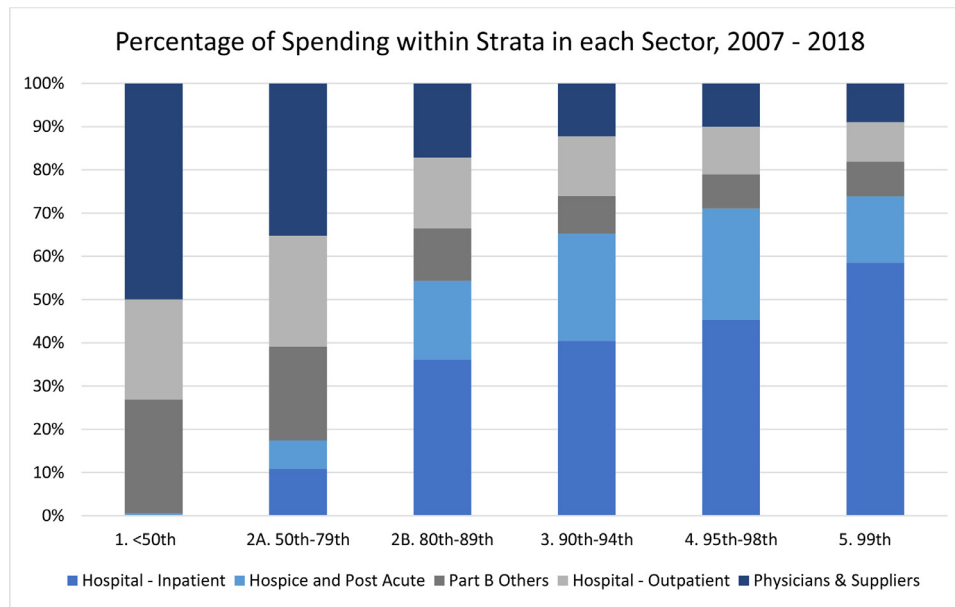
Fig. 4. Proportional allocation of adjusted Medicare spending according to strata of individual resource utilization, 2007 to 2018 inclusive•.

when considering both per capita expenditures and overall expenditures (Supplementary Figures 1a and 1b). We first assessed whether trends in spending were generally in the same direction, using tests for co-integration. We found evidence for co-integration supporting that the expenditure per capita time series move together across all spending groups on the basis of Dickey-Fuller ADF test (Kao test for cointegration $p = 0.0088$) and the Westerlund test for cointegration ($p = 0.0242$). We then subsequently used the GLM procedure on the analysis of variance by year and by spending cohorts, which demonstrated that the expenditure growth both year-to-year ($p<0.0001$) and cumulatively (Type I $p<0.0001$ and Type III $p = 0.0059$) is significantly different between strata of spending groups. Further pairwise comparisons demonstrated that the <50th percentile stratum significantly differed from the remainder of the groups ($p = 0.0002$) while the remaining pairwise comparisons were non-significant, a finding further supported by Waller-Duncan's multiple-comparison test.

As would be expected due to the relatively low absolute expenditures, relative rates of change were greatest amongst individuals with the lowest level of expenditure (<50th percentile) though the expenditures associated with such changes were small. Results were comparable in an unadjusted analysis.

We also assessed the cumulative percentage change (from 2007) over time, stratified according to resource utilization. As can be seen in Fig. 3, cumulative growth in adjusted Medicare spending has been low in the period between 2007 and 2018. Notably, growth both in per capita and total terms has been proportionally greater among individuals in the lowest spending category (<50th percentile), though it bears noting that the absolute per capita change in the group was $147 between 2007 and 2018.

We then utilized our strata definitions to assess differences in the utilization of services including inpatient hospital services, outpatient hospital services, hospice and post-acute care, physicians and other suppliers, and other Part B services (including drugs and others). While physician and supplier services comprised the bulk of expenditures for individuals with the lowest health care expenditures [<50th percentile; mean 49.9%, of all expenditures in this stratum], this is a diminishingly important contributor to expenditures in higher utilization strata [e.g. mean 8·9% of all expenditures in the 99th percentile stratum]. In contrast, hospital inpatient care is the predominant source of expenditures among individuals in the highest (99th percentile) stratum [mean 58.5% of all expenditures in this stratum],

compared to a mean of 0.06% among those in the <50th percentile stratum (Fig. 4). As expected, there is a transition between predominantly inpatient and predominantly outpatient care for individuals in the 80−89th, 90−94th, and 95−98th percentile strata (Fig. 4).

Across the study period, there was an increase in both the absolute and relative expenditures on hospital outpatient care (Fig. 5). Notably, hospital inpatient spending did not decrease in conjunction with increases in outpatient care use. Most other spending categories had relatively stable expenditures over the study period. When we assessed time-trends in resource allocation within each stratum of resource expenditure, we again observed stability between 2007 and 2018 (data not shown).

4. Discussion

In this analysis of U.S. Medicare spending over a twelve-year period, we found notable stability in overall Medicare Part A and B expenditures from 2007 to 2018. More specifically, annualized rates of change varied from −1·74% in 2012 to 2·08% in 2010 and a cumulative increase of only 8%, after direct effects of policy changes on prices are accounted for. We hypothesized that trends in Medicare spending would differ according to beneficiary-level expenditures, with proportionally greater increases among the "high-cost" individuals owing to increased utilization of expensive medical services, as well as the introduction of new medical technologies, which are predominately targeted at costly medical conditions (cancer, organ failure, and others). However, our analysis did not confirm this hypothesis. Instead, the available data suggest that a "rising tide" of spending has affected nearly all beneficiaries with similar annual relative increases across strata, save for patients in the lowest expenditure category who had significantly higher annualized rates of spending increase. Indeed, the "80/20″ rule held to a remarkable extent over our study period, with the lowest spending 80% of the population consuming 20.8% of total resources on average.

When examining the distribution of spending, these changed little over the study period. However, utilization of different types of care differed substantially according to strata of patient resource utilization. Among patients with the lowest health care expenditures (<50th percentile), spending was predominately related to physician and supplier and, to a lesser extent, hospital outpatient and other Part B services. In contrast, hospital

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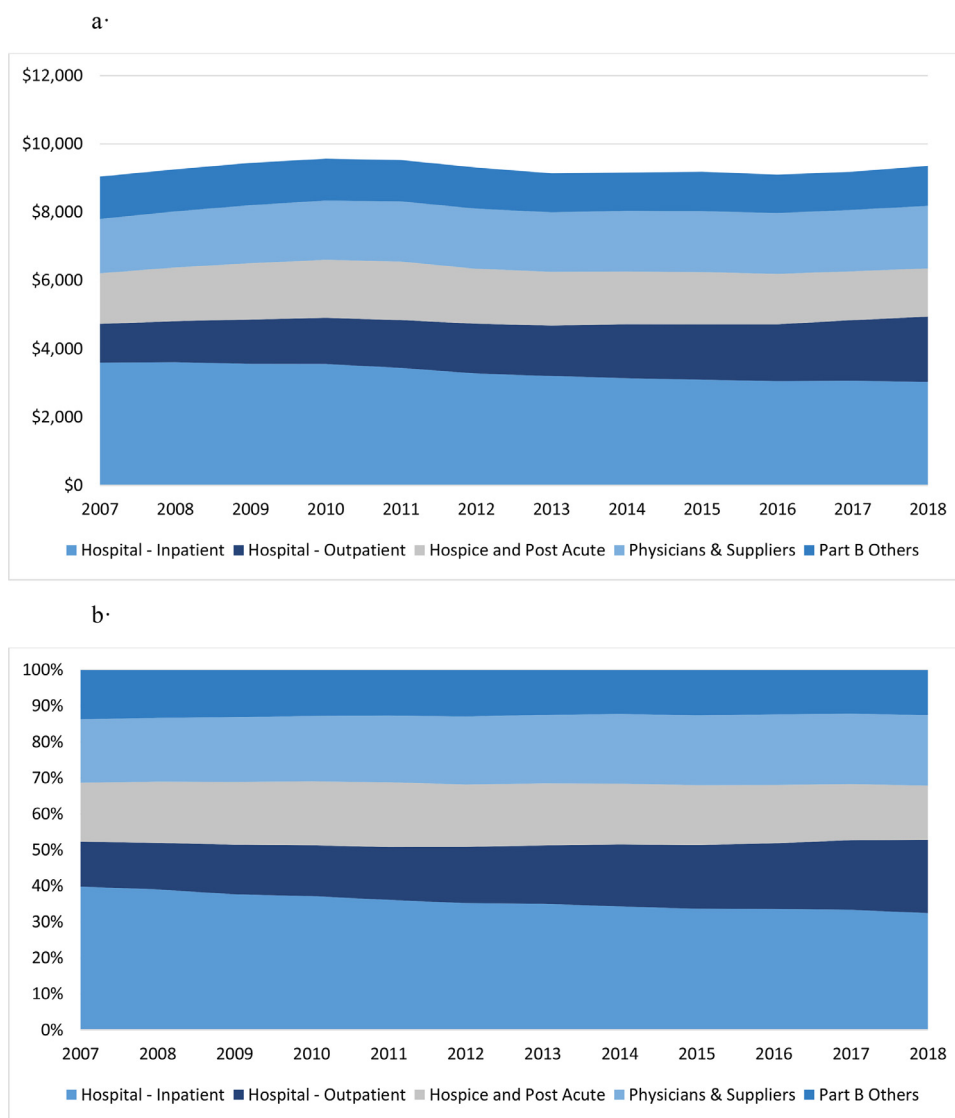
Fig. 5. Per capita absolute and relative costs across six settings of Medicare expenditure, stratified by individual resource utilization strata, 2007 to 2018, operationalized as absolute per capita average annual expenditures (a) and relative proportion of annual expenditures•.

inpatient services, skilled nursing facilities, and Part B drugs were increasingly important contributors to expenditures among individuals in higher strata of Medicare expenditure, with hospital inpatient services accounting for more than half of all expenditures among individuals in the 99th percentile. Similar trends have been observed in other populations; in Ontario, Canada, an increasing proportion of costs were also attributable to acute hospitalization, continuing (post-discharge) care, and drugs among patients in higher strata of spending [2].

This analysis relied on a cohort of patients with Medicare Part A and B coverage, and did not include Part D prescription drug costs for the portion of the population with coverage through Part D. As a result, captured medication costs reflect those reimbursed through Part B coverage. Thus, pharmaceutical costs are not fully captured in this analysis as these are reimbursed through a variety of mechanisms.

In this analysis, we have focused on the role of prior resource utilization as it pertains to growth in health care expenditures. There are many other important patient-level and system-level factors that may influence spending growth including gender, ethnicity, age, comorbidity, and geographic region. This forms the basis of ongoing work.

In contrast to our hypothesis that individuals with high health care utilization would experience the greatest increases in expenditure, the available data suggest that a "rising tide" of care utilization, albeit a slowing rising one, has affected nearly all beneficiaries with similar annual relative increases across strata. In fact, the greatest relative cumulative increase in spending occurred among individuals in the lowest 50th percentile of utilization with 23% and 19% cumulative increases in total and per capita spending, respectively. While these relatively large changes are small in absolute terms on a per capita basis ($147 dollars per person over the 12-year study period), the cumulative effect is a $2.398 billion-dollar increase. Taking these observations (general similarity in annualized and cumulative growth across strata, and the relatively larger growth among the lowest expenditure individuals) into account suggests at least three potential approaches moving forward that could be explored concurrently: a focus on health care policy or delivery trends which are independent of individual patient utilization, a focus on the highest-cost individuals as they represent the largest target both on a per capita and aggregate basis, or a focus on low-cost individuals in which expenditures appear to be rising fastest despite a lower burden of disease.

Consideration of which of these approaches to employ will likely fall to policymakers, rather than clinicians, given both the patterns and the implications for the viability of government funded health care. Prior estimates have suggested anticipated per capita growth of 1·8% annually (95% confidence interval 1.4 to 2.2%) in the United States between 2015 and 204,0[12], rates that are similar to the effects expected among high-income countries (2.1%, 95% confidence interval 1.8 to 2.4%) but smaller than those in upper-middle-income (5.3% annually, 95% confidence interval 4.1 to 6.8%) and lower-middle-income (4.2% annually, 95% confidence interval 3.8 to 4.9%) countries [12]. Legislative intervention has demonstrated an ability to downwardly inflect health care spending growth, in the United States through the Affordable Care Act [8] and in European countries through global budgets. In contrast to these generalized legislative approaches, many jurisdictions have limited access to novel – and expensive – approaches, targeting spending growth among high resource utilizers. In contrast, focused approaches among the lowest strata of health care utilizers have not be widely undertaken.

Beyond the observed trends over time, a number of interesting observations may be made regarding the distribution of Medicare spending. The Pareto Principle (also known as the "80/20 rule) has long been held to characterize spending in the American medical system such that 80 percent of health care dollars are spent on 20% of the population [5]. Our analysis is consistent with this principle (with 79·1% of overall Medicare Part A and B expenditures allocated to the top 20% of beneficiaries) and demonstrates that, despite significant changes in funding models over the past decade, resource allocation remains very asymmetrically distributed.

In this analysis, we undertook a more granular approach to distinguish strata of resource utilization. On the basis of previous work from Ontario, Canada [2], we stratified patients into the 99th percentile, 95−98th percentile, 90−94th percentile, 50−89th percentile, and <50th percentile. In this Medicare population, the 99th percentile cohort (representing 1% of all Medicare beneficiaries) accounted for 15% of overall annual expenditures while the 95−98th percentile cohort accounted for 27%, the 90−94th percentile accounted for 19%, the 50−89th percentile cohort accounted for 37%, and the <50th percentile accounted for 4% of all Medicare expenditures. In contrast, in the Ontario, Canada cohort, the 99th percentile comprised 34% of all spending, the 95−98th percentiles accounted for 32% of spending, the 90−94th percentile accounted for 13%, the 50−89th percentile accounted for 20%, and the bottom 50th percentile accounted for only 1% of spending [2]. These data suggest that health care spending is less concentrated among Medicare beneficiaries than is observed in single payer health system in another jurisdiction. While the expense thresholds were lower for all strata in the Ontario analysis, it is particularly notable that the threshold for the lowest 50th percentile was $181 Canadian dollars (2007; $263·48 inflation adjusted and converted to 2015 USD). This is well below the average per capita Medicare spending in this cohort of $801 in 2007 and $948 in 2018.

In conclusion, this analysis of U.S. Medicare spending between 2007 and 2018 demonstrates notable stability over this period. In contrast to our initial hypothesis, rates of spending growth were highest among individuals with the lowest annual health care resource utilization. These data suggest a number of strategies for continued cost containment.

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Contributor

Conception – CJDW, SJP, MBB
Methodology – CJDW, PL
Software – PL, LP
Validation – PL
Formal analysis – PL
Investigation – CJDW, PL
Resources – MBB
Data curation – PL, LP
Writing (original draft) – CJDW
Writing (review and editing) – SJP, PL, LP, MBB
Visualization – PL, LP
Supervision – MBB
Project Administration – LP, MBB
Funding acquisition – MBB

Data sharing statement

Due to licensing agreements with the data sources/repositories, we are unable to share data. Interested parties are encouraged to contact Centers for Medicare & Medicaid Services (CMS) Research Data Assistance Center (ResDAC) for data access.

Declaration of Competing Interest

CJDW reports personal fees from Janssen Canada, unrelated to the current work. SJP, YL, LP, and MBB declare no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found in the online versionat doi:10.1016/j.eclinm.2021.100873.

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