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# Emergency department and inpatient utilization among U.S. older adults with multiple chronic conditions: a post-reform update

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## Abstract

**Background:** The Affordable Care Act (ACA) was enacted to enhance access to care primarily among nonelderly and low-income populations; however, several provisions addressed key determinants of emergency department (ED) and inpatient visits among Medicare beneficiaries over age 65 years. We take stock of the overall changes in these visits among older Medicare beneficiaries, focusing on those with multiple chronic conditions (MCCs), and provide a nationally representative post-reform update.

**Methods:** We analyzed a sample of 32,919 older adults (65+) on Medicare from the 2006–2015 Medical Expenditure Panel Survey (MEPS). Using a survey-weighted two-part model, we examined changes in ED visits, inpatient visits, and length of stay (LOS) by MCC status, before (2006–2010), during (2011–2013), and after the ACA (2014–2015).

**Results:** Prior to the ACA, 18.1% of Medicare older adults had  $\geq 1$  ED visit, whereas 17.1% had  $\geq 1$  inpatient visits, with an average of 5.1 nights/visit. Following ACA reforms, among those with 2+ chronic conditions, the rate of ever having an ED visit *increased* by 4.3 percentage points [95% confidence intervals [CI]: 2.5, 6.1,  $p < 0.01$ ], whereas the rate of inpatient visits decreased by 1.4 percentage points [95%CI:  $-2.9, 0.2$ ,  $p < 0.1$ ], after multivariable adjustment.

**Conclusions:** We found sizable increases in ED visits and nontrivial decreases in inpatient visits among older Medicare beneficiaries with MCCs, underscoring the continuing need for improving access to and quality of care among older adults with MCCs to decrease reliance on the ED and reduce preventable hospitalizations.

**Keywords:** Affordable care act, Multiple chronic conditions, Emergency department (ED) visits, Inpatient visits, Length of stay (LOS), Older adults, Medicare

## Background

Having multiple chronic conditions (MCCs), the coexistence of two or more chronic conditions [1], has emerged as a serious public health concern among older adults in the United States [2]. More than 8 out of 10 older adults suffered from MCCs in 2014 [3], requiring ongoing

disease management over a period of years or decades. MCCs are associated with decreased quality of life and functional decline among older adults [1, 4]. Compared to older adults without a chronic condition, older adults with one, two, and three or more conditions are likely to experience a loss of 4.7, 7.9, and 10.8 quality-adjusted life years (QALY), respectively [5]. The presence of MCCs increases the risk of developing functional limitation [6]; onset of moderate functional limitation is far more likely among 80-year-olds with MCCs than their counterparts without MCCs (50% vs. 22%, respectively) [7].

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Further, MCCs are associated with a significant financial burden due to increasing ambulatory, emergency department, and hospital visits [8]. In the Medicare program, the annual Medicare payments for a beneficiary grew from \$7172, to \$14,931, to \$32,498 when the beneficiary had one, two, and three or more chronic conditions, respectively [9]. As the population ages and Baby Boomers continue to retire on to Medicare, the impacts of MCCs on Medicare spending, especially Medicare Part A whose funds are expected to be depleted by 2026 [10], warrant urgent scrutiny.

The Patient Protection and Affordable Care Act (ACA) of 2010 was enacted to accomplish the Triple Aim: better healthcare, better health outcomes, and better value [11–13]. Although ACA's coverage provisions were primarily focused on the non-elderly population [14], the law had several key provisions that specifically applied to older adults in Medicare. First and foremost, the law took direct aim at reducing Medicare spending growth through the Independent Payment Advisory

Board as well as various provisions related to healthcare quality, utilization, and payment [10, 15]. As of January 2011, the ACA eliminated cost-sharing for preventive services and authorized coverage of personalized prevention plans, including Annual Wellness Visits under Part B [16]. Although fee-for-service payment models still dominate the healthcare system [17], older Medicare beneficiaries may have also benefitted from the growth in innovative payment and delivery models (e.g., accountable care organizations, bundled payment, and patient-centered medical homes) [18–20]. Further, ACA's strict regulations and penalties related to hospital utilization (e.g., emergency department [ED] visits, inpatient visits, and length of stay [LOS]), including the Hospital Readmission Reduction Program (HRRP) [21], may have also affected older Medicare beneficiaries, especially those with MCCs. Table 1 lists these and other key ACA provisions relevant to older adults with MCCs.

Rather than evaluating the specific effects of each individual provision on older adults with MCCs [22–25],

**Table 1** Key Affordable Care Act (ACA) Provisions Relevant to Older Adults with Multiple Chronic Conditions

| Key Provisions  | Effective Implementation Date |
|---|-------------------------------|
| <b>Quality</b>  |                               |
| Improve care coordination for dual eligibles by creating a new office within the CMS services.  | March 2010                    |
| Reduce Medicare payments to certain hospitals for hospital-acquired conditions by 1%.   | October 2015                  |
| Reduce Medicare payments that would otherwise be made to hospitals by specified percentages to account for excess (preventable) hospital readmissions.                                  | October 2012                  |
| Provide incentives to Medicare and Medicaid beneficiaries to complete behavior modification programs.   | January 2011                  |
| <b>Access</b>   |                               |
| Provide payments totaling \$400 million in fiscal years 2011 and 2012 to qualifying hospitals in counties with the lowest quartile Medicare spending.                                   | January 2011                  |
| Provide a 10% bonus payment to primary care physicians in Medicare from 2011 through 2015.  | January 2011                  |
| Reduce Medicare Disproportionate Share Hospital (DSH) payments initially by 75% and increase payments.  | October 2014                  |
| Eliminate cost-sharing for Medicare covered preventive services and waive the Medicare deductible for colorectal cancer screening tests.  | January 2011                  |
| Authorize Medicare coverage of annual personalized prevention plan services.  | January 2011                  |
| <b>Cost</b>   |                               |
| Increase the Medicare Part A (hospital insurance) tax rate on wages by 0.9% (from 1.45 to 2.35%) on earnings over \$200,000 for individual taxpayers and \$250,000 for married couples. | January 2013                  |
| Restructure payments to Medicare Advantage (MA) plans by setting payments to different percentages of Medicare fee-for-service (FFS) rates.   | January 2011                  |
| Establish an Independent Payment Advisory Board to submit legislative proposals containing recommendations to reduce the per capita rate of growth in Medicare spending.                | April 2013                    |
| <b>Cost &amp; Quality (Alternative Payment Models)</b>  |                               |
| Allow providers organized as accountable care organizations (ACOs) that voluntarily meet quality thresholds to share in the cost savings they achieve for the Medicare program.         | January 2012                  |
| Establish a hospital value-based purchasing program in Medicare to pay hospitals based on performance on quality measures.  | October 2012                  |
| Establish a national Medicare pilot program to develop and evaluate paying a bundled payment.   | January 2013                  |
| [Promote] patient-centered medical home models for high-need applicable individuals.  | January 2011                  |

which took effect between 2011 and 2014, the present study aims to examine overall changes in ED visits, inpatient visits, and length of hospital stays among older Medicare beneficiaries with MCCs before (2006–2010), during (2011–2013), and after the ACA (2014–2015). By providing a post-reform update with nationally representative estimates, this analysis can inform continuing efforts to improve care quality and reduce spending among older Medicare beneficiaries with MCCs in this era with a precarious healthcare future.

## Methods

### Sample and data

We analyzed data from the Medical Expenditure Panel Survey (2006–2015), a nationally representative survey of the civilian non-institutionalized population. We had an eligible sample of 34,721 MEPS respondents who received Medicare and were age 65 years or older. The vast majority of our study covariates, including outcomes, main demographics, and chronic conditions, were virtually fully available for the entire sample (0 to <0.5% missing). Data for only 4 key variables (education, self-reported general and mental health status, and having a usual source of care) had missing for <1.5% of the eligible sample (Additional file 1: Table S1). With such low missing data rates, our final analytical sample included all respondents with complete data for all study covariates ( $n = 32,919$ ). Excluded respondents (only 5% of the eligible sample) had greater ED and inpatient utilization, were more likely to have had a myocardial infarction or a stroke (and activity limitations), but had fewer chronic conditions overall. On average, excluded respondents were older, poorer, less likely to be white, and less likely to be married (Additional file 1: Table S2). Given the small size and worse characteristics of excluded participants, we did not expect their exclusion to materially bias our findings; if anything, our estimates might be slightly conservative.

We linked respondents' data in MEPS annual files to their respective records from the Medical Conditions files, and then pooled linked datasets for years 2006–2015. Our data cover three distinct periods with respect to the ACA: pre-ACA (2006–2010), implementation period of ACA provisions relevant to older adults with MCCs (2011–2013), and post-ACA (2014–2015).

### Measures

#### Outcomes

As primary outcomes, we first documented the prevalence of having any (at least one) emergency department (ED) visit, hospital inpatient visit, and overnight inpatient stay. As secondary outcomes, we analyzed counts of ED visits, inpatient visits, and LOS (total and average).

### Chronic conditions

We identified chronic conditions by using the definitions developed by Hwang and colleagues, and adopted by the Agency for Healthcare Research and Quality [26, 27], applied to International Classification of Diseases 9th Revision (ICD-9) 3-digit codes in the MEPS Medical Conditions files. We then calculated the total number of unique chronic conditions for each respondent, and categorized them as having 0, 1, 2, 3, 4, or 5+ chronic conditions. Those with  $\geq 2$  conditions were classified as having MCCs.

### Covariates

Our analysis used data about respondents' characteristics known to be related to ED visits, inpatient services, and having MCCs. Respondent sociodemographic characteristics included age, gender, race/ethnicity, language, marital status, Census region, income relative to the federal poverty line (FPL), and education. To measure respondents' health status, we included self-rated general and mental health, activity limitations (physical and cognitive), and their chronic condition(s) (e.g., high blood pressure, diabetes, heart disease, stroke, and asthma). We also considered respondents' access to care including types of payer (i.e., Medicaid, private insurance), having a usual source of care, receiving needed medical care, and getting needed prescription drugs. These factors are key determinants of ED use and hospitalization. Detailed levels of these covariates are reported in Table 2.

### Statistical analysis

The goal of our analysis was to provide an update of where levels of ED visits and inpatient stays stand among older adults with MCCs following relevant ACA reforms, relative to the pre-ACA period. In our statistical models, this was accomplished by interacting a period indicator (pre-ACA = 0, post-ACA = 1) with chronic condition categories (having 5+, 4, 3, 2, 1, vs. 0), while including the main effects of these variables as well as the aforementioned confounding covariates. Since we are interested in the specific associations of having MCCs with ED/inpatient utilization, we adjusted for potential confounding by the following sets of covariates: 1) sociodemographic factors, which predispose (e.g., age) or enable (e.g., income) utilization; 2) particular conditions respondents had (e.g. stroke, myocardial infarction, asthma), which drive both the burden (count) of chronic conditions and the need for ED/inpatient utilization; and 3) additional insurance (Medicaid or private) and access-related factors (e.g., having a usual source of care), which also enable or create the need for ED/inpatient utilization. Our preferred model specification fully adjusts for these three sets of potential confounders. Additionally, we assessed the changes in model fit as we sequentially adjusted for these covariate sets.

**Table 2** Sample Characteristics Before and After the Affordable Care Act (ACA), MEPS 2006–2015

|   | <i>Pre-ACA (2006–2010)</i> | <i>ACA (2011–2013)</i> | <i>Post-ACA (2014–2015)</i> | <i>Overall</i> |
|---|----------------------------|------------------------|-----------------------------|----------------|
| Sample Size   | 15,548                     | 10,313                 | 7058                        | 32,919         |
| Population Represented                                      | 16,723,986                 | 11,515,758             | 8,256,622                   | 36,496,366     |
| Outcomes  |                            |                        |                             |                |
| Any ED Visits   | 18.1                       | 18.2                   | 21.0                        | 18.8           |
| Number of ED Visits (if 1+), Mean (SD)                      | 1.4 (0.9)                  | 1.4 (0.8)              | 1.6 (1.1)                   | 1.4 (0.9)      |
| Any Inpatient Visits  | 17.1                       | 15.2                   | 15.6                        | 16.2           |
| Number of Inpatient Visits (if 1+), Mean (SD)               | 1.4 (0.8)                  | 1.4 (0.8)              | 1.5 (1.0)                   | 1.4 (0.9)      |
| Total Inpatient Nights (if 1+), Mean (SD)                   | 7.6 (10.9)                 | 7.4 (13.8)             | 7.8 (11.6)                  | 7.6 (12.0)     |
| Average Number of Nights/Inpatient Visit (if 1+), Mean (SD) | 5.1 (6.5)                  | 5.0 (7.5)              | 4.9 (6.2)                   | 5.0 (6.8)      |
| Demographics  |                            |                        |                             |                |
| Age, Mean (SD)  | 74.1 (6.3)                 | 73.7 (6.4)             | 73.5 (6.3)                  | 73.9 (6.3)     |
| Female (%)  | 57.4                       | 55.7                   | 55.9                        | 56.5           |
| Race/Ethnicity (%)  |                            |                        |                             |                |
| White (Non-Hispanic)  | 80.8                       | 79.5                   | 77.4                        | 79.6           |
| Black (Non-Hispanic)  | 7.9                        | 8.3                    | 8.6                         | 8.2            |
| Other (Non-Hispanic)  | 4.5                        | 5.1                    | 6.3                         | 5.1            |
| Hispanic  | 6.8                        | 7                      | 7.7                         | 7.1            |
| Poverty Level (%)   |                            |                        |                             |                |
| Poor/Negative-Income (< 100%FPL)                            | 9.3                        | 9.1                    | 9.2                         | 9.2            |
| Near-Poor (100–125%FPL)                                     | 7.4                        | 6.2                    | 6.1                         | 6.7            |
| Low-Income (125–200%FPL)                                    | 18                         | 18                     | 16.3                        | 17.6           |
| Middle-Income (200–400%FPL)                                 | 29.9                       | 29.3                   | 27.2                        | 29.1           |
| High-Income (≥400%FPL)                                      | 35.4                       | 37.4                   | 41.3                        | 37.4           |
| Education (%)   |                            |                        |                             |                |
| Less than High School                                       | 23.7                       | 18.4                   | 16.6                        | 20.5           |
| High School Diploma   | 35.3                       | 32.4                   | 30.5                        | 33.3           |
| Some College  | 18.6                       | 22.9                   | 24.4                        | 21.3           |
| Bachelor's Degree or Higher                                 | 22.3                       | 26.3                   | 28.6                        | 25.0           |
| Census Region (%)   |                            |                        |                             |                |
| Northeast   | 19.9                       | 18.7                   | 18.7                        | 19.2           |
| Midwest   | 22.1                       | 22.8                   | 22.3                        | 22.4           |
| South   | 37.0                       | 36.8                   | 37.2                        | 37.0           |
| West  | 21.0                       | 21.7                   | 21.8                        | 21.4           |
| Marital Status (%)  |                            |                        |                             |                |
| Single/Never Married  | 3.5                        | 4.2                    | 4.2                         | 3.9            |
| Widowed/Divorced/Separated                                  | 42.3                       | 41.4                   | 40                          | 41.5           |
| Married/Cohabiting  | 54.2                       | 54.5                   | 55.8                        | 54.6           |
| Interview Not In English (%)                                | 3.3                        | 4.2                    | 4.6                         | 3.9            |
| Health Status (%)   |                            |                        |                             |                |
| General Health Status (Self-Rated)                          |                            |                        |                             |                |
| Excellent   | 14.9                       | 17.1                   | 17.6                        | 16.2           |
| Very Good   | 29.9                       | 30.5                   | 31.1                        | 30.4           |
| Good  | 32.8                       | 32.5                   | 31.4                        | 32.4           |
| Fair  | 16.2                       | 15.0                   | 14.6                        | 15.5           |

**Table 2** Sample Characteristics Before and After the Affordable Care Act (ACA), MEPS 2006–2015 (Continued)

|   | Pre-ACA (2006–2010) | ACA (2011–2013) | Post-ACA (2014–2015) | Overall |
|---|---------------------|-----------------|----------------------|---------|
| Poor  | 6.2                 | 4.9             | 5.3                  | 5.6     |
| Mental Health Status (Self-Rated)                     |                     |                 |                      |         |
| Excellent   | 27.8                | 29.5            | 30.2                 | 28.9    |
| Very Good   | 30.9                | 30.4            | 29.1                 | 30.3    |
| Good  | 30.8                | 30.1            | 29.8                 | 30.3    |
| Fair  | 8.2                 | 7.9             | 8.5                  | 8.1     |
| Poor  | 2.4                 | 2.3             | 2.5                  | 2.4     |
| Any Physical or Cognitive Limitations (Self-Reported) | 59.2                | 56.6            | 57.4                 | 58.0    |
| Chronic Conditions (%)                                |                     |                 |                      |         |
| Number of Chronic Conditions                          |                     |                 |                      |         |
| 0   | 7.4                 | 7.2             | 8.2                  | 7.5     |
| 1   | 12.6                | 11.1            | 11.4                 | 11.8    |
| 2   | 16.7                | 16.4            | 16.4                 | 16.5    |
| 3   | 16.5                | 16.9            | 16.7                 | 16.7    |
| 4   | 14.7                | 15.2            | 15.8                 | 15.1    |
| 5+  | 32.2                | 33.2            | 31.6                 | 32.4    |
| High Blood Pressure                                   | 67.8                | 69.5            | 68.2                 | 68.4    |
| Coronary Heart Disease                                | 19.3                | 19.9            | 18.9                 | 19.4    |
| Angina  | 9.0                 | 7.7             | 7.1                  | 8.2     |
| Myocardial Infarction                                 | 12.3                | 11.8            | 12.4                 | 12.2    |
| Other Heart Disease                                   | 25.0                | 27.1            | 29.3                 | 26.6    |
| Stroke  | 12.2                | 12.2            | 11.6                 | 12.0    |
| Diabetes  | 20.6                | 21.4            | 23.2                 | 21.4    |
| Emphysema   | 6.5                 | 6.5             | 6.2                  | 6.4     |
| Asthma  | 8.8                 | 8.7             | 9.0                  | 8.8     |
| Arthritis   | 58.1                | 59.4            | 60.2                 | 59.0    |
| Insurance and Access to Care (%)                      |                     |                 |                      |         |
| Had Any Private Insurance                             | 52.3                | 52.7            | 54.6                 | 53.0    |
| Had Any Public Insurance                              | 47.7                | 47.3            | 45.4                 | 47.0    |
| Had Medicaid (Ever)                                   | 9.7                 | 10.3            | 10.0                 | 10.0    |
| Have a Usual Source of Care                           | 93.9                | 93.9            | 94.0                 | 93.9    |
| Cannot Get Needed Medical Care                        | 0.9                 | 1.1             | 1.6                  | 1.1     |
| Cannot Get Needed Prescription Drugs                  | 1.4                 | 1.7             | 2.2                  | 1.7     |

We analyzed binary outcomes (prevalence of having  $\geq 1$  utilization event [i.e., visit or night]) in logit models. For count outcomes, we used a two-part, logit-negative binomial model. In the two-part model (known as a hurdle model for count data), a logit model is fitted for the probability of having  $\geq 1$  utilization event, and concurrently a negative binomial regression model is fitted for the actual count of events, conditional on a positive utilization event. By doing so, this two-part model handles the severely right-skewed nature of count distributions, with a concentrated mass of zeros on the left-hand side of the distribution and a very long right tail [28].

Two-part models also allow recovering population-average estimates of change in outcome levels from the entire sample, as opposed to conditional estimates obtained from models fit only to the subsample with  $\geq 1$  event [29]. After estimating each of our logit and two-part models, we recovered the adjusted, average marginal probability (of having  $\geq 1$  event) and count of events, by ACA period and MCC category. Finally, we estimated the pre-post-ACA changes in probabilities and counts for each MCC category.

For our logit models of binary outcomes, we assessed the goodness of fit using a modified version of the

Hosmer-Lemeshow test for complex survey data [30]. *P*-values for our preferred fully adjusted models were all between 0.3 and 0.4, indicating adequate fit. For the hurdle models of count data, we used Akaike and Bayesian Information Criteria (AIC & BIC) to compare model specifications. Our fully-adjusted models had the smallest AIC and BIC, indicating best fit among all tested specifications.

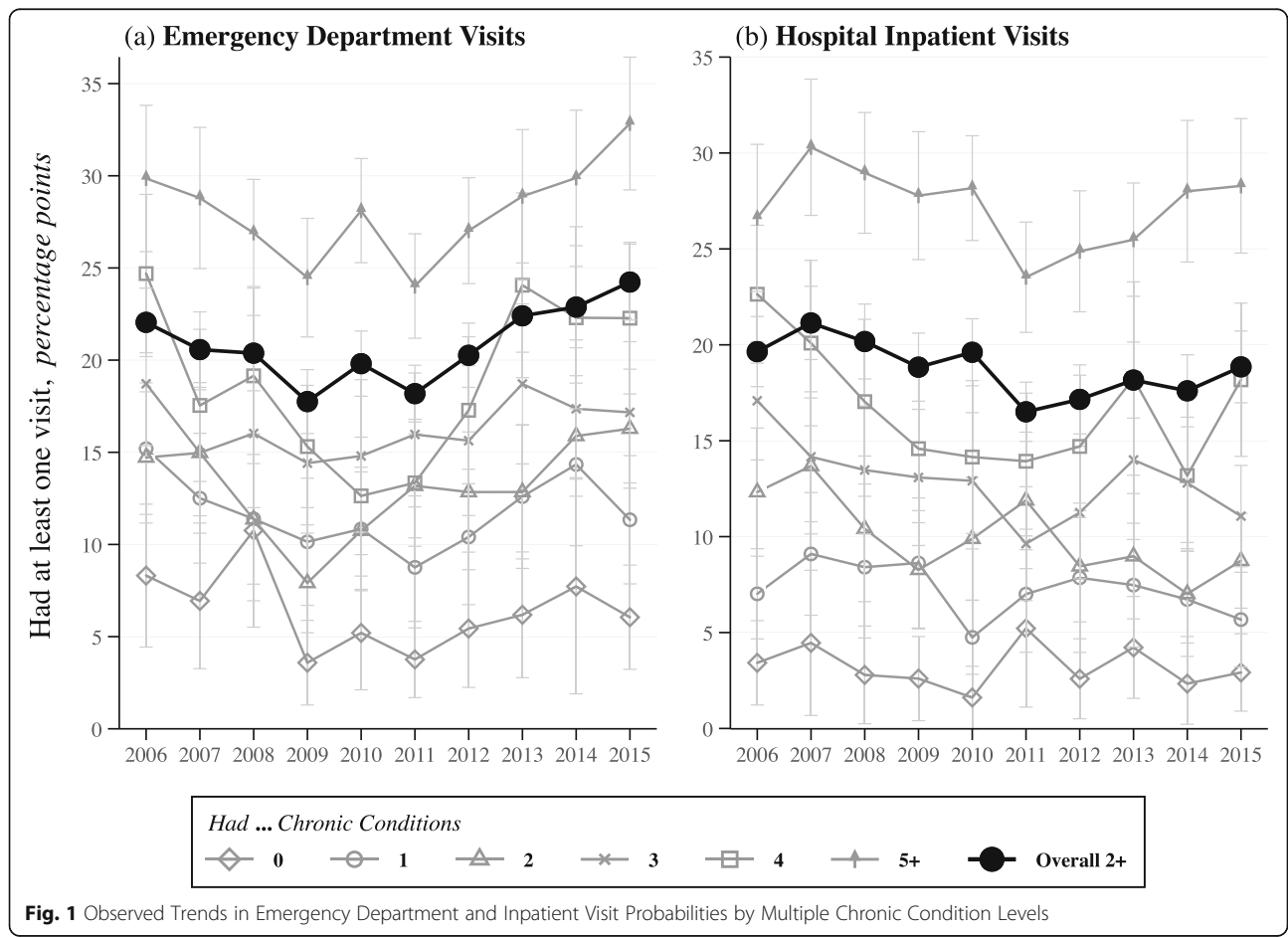
All models were estimated using maximum likelihood estimation. All estimates were also generated using Stata’s “svy” prefix, which uses survey weights to make estimates nationally representative. This prefix also calculates linearized standard errors, which account for MEPS’s complex, multi-stage sampling. All analyses were performed in Stata 14.2 (StataCorp, College Station, TX).

**Results**

As Table 2 shows, respondents were 74 years-old on average (±6.3 years), and 56.5% were female, 79.6% were non-Hispanic White, and 33.5% were poor or low-income (< 200% FPL). Fifty-eight percent had physical or cognitive limitations, while 80.6% had MCCs, including 32.4% with ≥5 chronic conditions. High blood pressure

(68.4%) and arthritis (59.0%) were the most prevalent conditions. Besides Medicare, 53% also had private supplementary insurance and 10% received Medicaid. The vast majority (93.9%) had a usual source of care and reported no problems accessing needed care or prescription drugs (97.2%). Sample characteristics were generally stable over the study period.

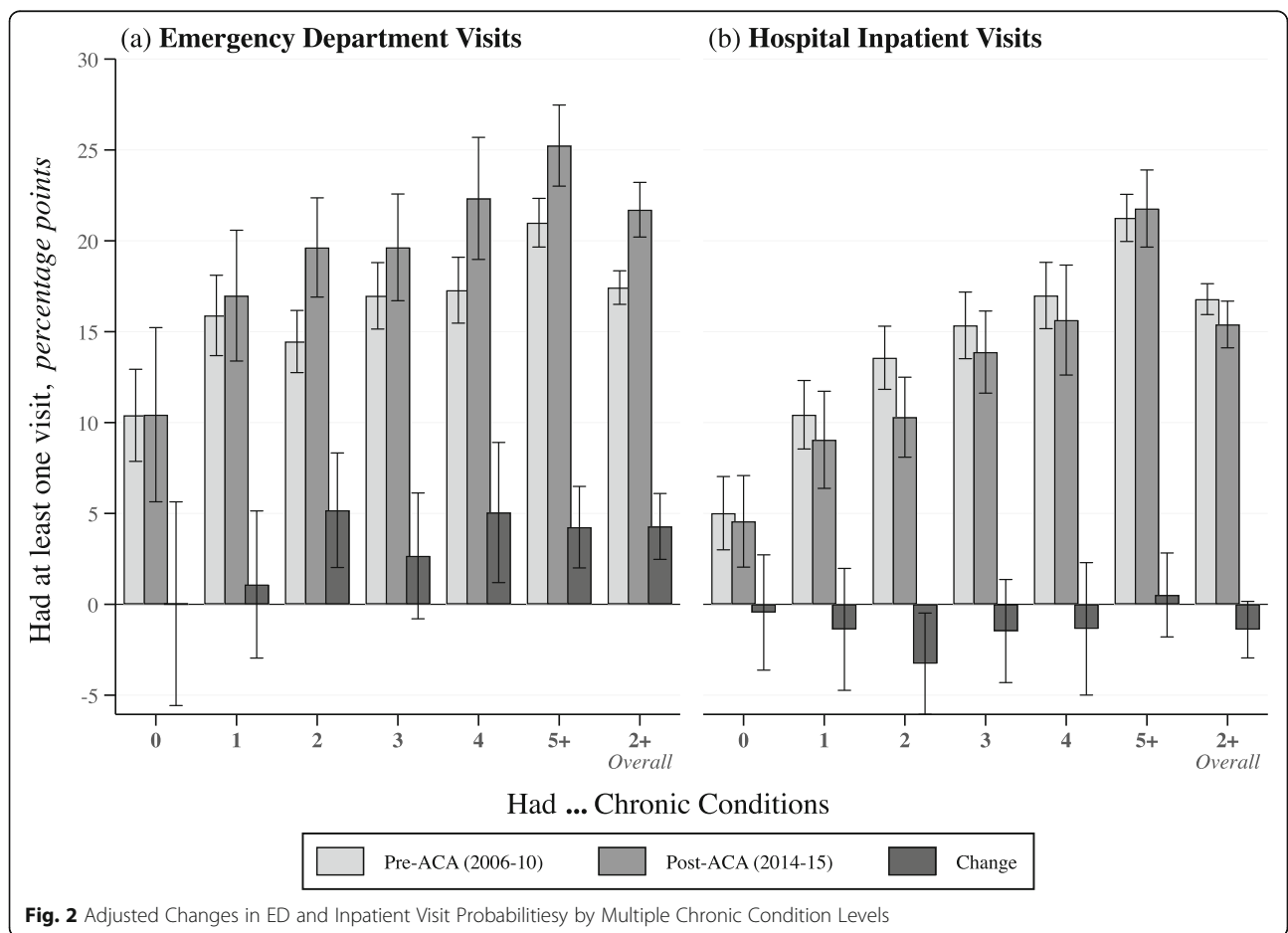
The rates of having any ED visits and inpatient stays in our sample changed from 18.1 and 17.1% pre-ACA (2006–2010) to 21.0 and 15.6% post-ACA (2014–15), respectively. Among those who ever had a visit, there was an average of 1.4 ED visits and 1.4 inpatient visits, with 5.1 nights spent in the hospital on average per visit, prior to the ACA (Table 2). While there was generally a downward trend in ED visits until 2011 (Fig. 1a), rates increased between 2011 and 2013 among all groups (see Additional file 1: Tables S3-S5 for detailed statistics). The data further reveal some tapering off into 2015, except among those with ≥5 conditions who continued to see a potentially steeper increase. Inpatient visit rates (Fig. 1b) also trended down from 2006 to 2015 for groups with < 4 conditions. However, among those with ≥4 conditions, inpatient visit rates increased after 2011 into 2015.

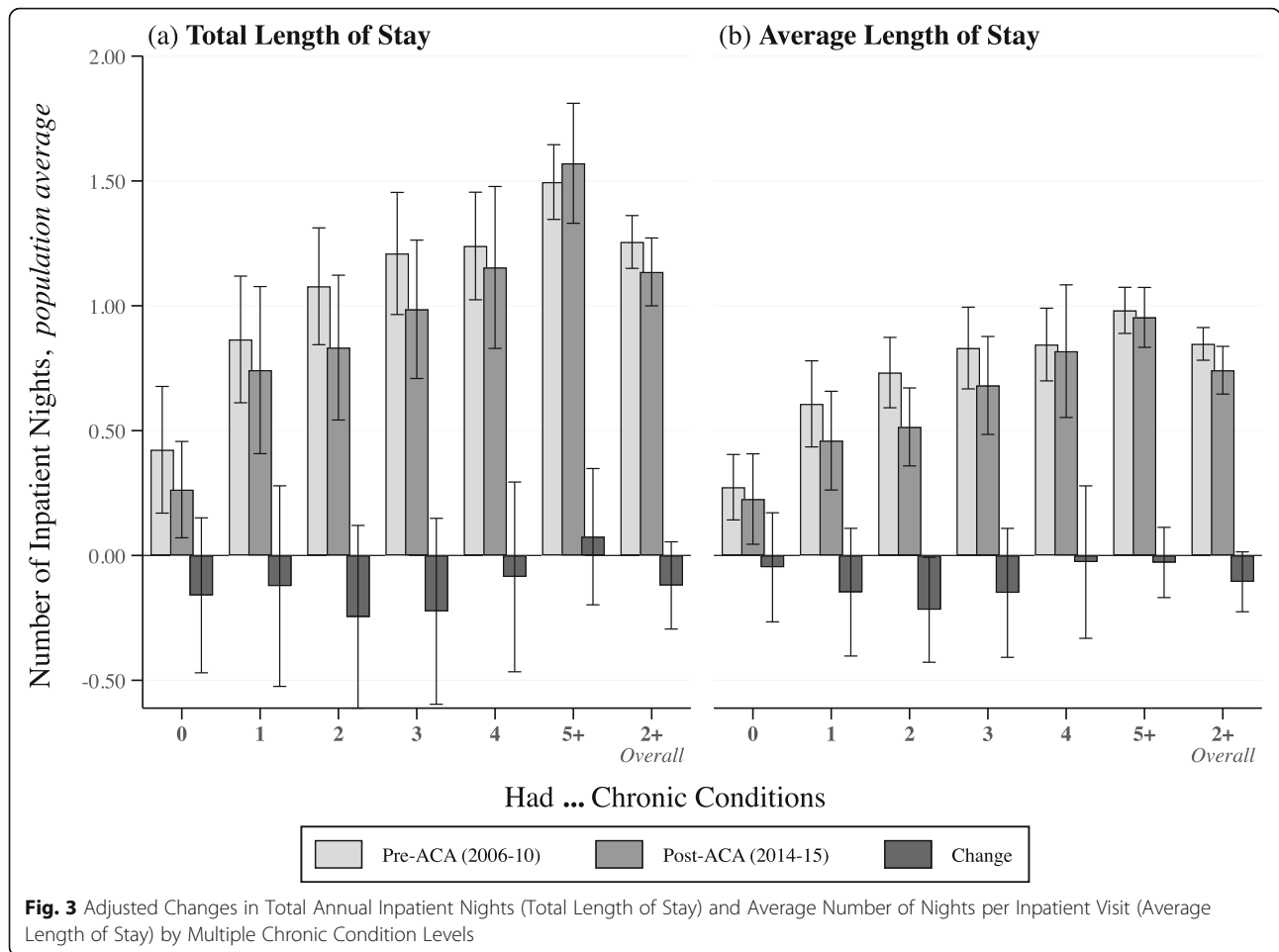


After multivariable adjustment, ED visit rates (having  $\geq 1$  visits) in 2014–2015 were overall higher than the pre-ACA period among all beneficiaries with  $\geq 2$  conditions by 4.3 percentage points (95% confidence interval [CI]: 2.5, 6.1) (Fig. 2a). For inpatient visits, we detected a drop in rates among all beneficiaries, especially those with just 2 chronic conditions who experienced a decrease in the probability of having at least 1 visit by 3.3 percentage points (95%CI: -6.1, -0.5) (Fig. 2b). Overall, those with  $\geq 2$  conditions saw a marginal drop by 1.4 percentage points (95%CI: -2.9, 0.2) in inpatient visit rates in 2014–2015. Changes in LOS (inpatient nights) also followed a similar pattern (Fig. 3). Finally, we assessed the sensitivity of our findings by dropping education, self-rated general and mental health status, and having a usual source of care from our models. Dropping these four confounders serves to re-include most of the excluded participants from the eligible sample. The sensitivity analyses were less conservative than the main findings because they did not adjust for the confounders (Additional file 1: Table S6).

**Discussion**

In the first 2 years following the ACA (2014–2015), we detected sizable increases in ED use and nontrivial decreases in inpatient visits among older Medicare beneficiaries with MCCs. To our knowledge, this is the first study to take a big-picture view and document the overall changes in hospital utilization by MCC status among older Medicare beneficiaries in the context of recent healthcare reform using a large, nationally representative dataset. The ACA was designed to primarily improve access to care among nonelderly and low-income populations, and has been associated with a reduction in the total number of the uninsured from 18.2% in 2010 to 10.4% in 2016 [31]. The reduction in the number of the uninsured was primarily centered on younger age groups: adults ages 19–34 by 42% (8.7 million), 35–54 by 33% (5.6 million), and 55–64 by 33% (2.0 million) [32]. Simultaneously, the total number of Medicare beneficiaries increased by 13.5% from 48.9 million in 2011 to 55.5 million in 2015 [31]. However, there is little evidence about how hospital utilization among older Medicare beneficiaries with MCCs has changed since the ACA was introduced.





Our analysis shows that over time, inpatient visits showed a nontrivial decrease among older Medicare beneficiaries. Such decrease is consistent with existing evidence showing decreasing expenditure on hospital inpatient stays by 6.6%, from 37.8 million in 2005 to 35.4 million in 2014 [33]. There are a couple of plausible explanations for these decreases. First, inpatient visits may have decreased because of the ACA’s enhanced coverage of preventive services under Medicare Part B [34], which eliminated patients’ cost-sharing and introduced free Annual Wellness Visits [24]. The second probable reason would be the introduction of the Hospital Readmissions Reduction Program (HRRP), which penalizes hospitals with above-average readmissions for Medicare patients with preventable conditions, including myocardial infarction, pneumonia, and heart failure [35]. The significant penalty (i.e., 3% of Medicare payments) likely prompted hospitals to proactively avert repeated admissions [23] while potentially motivating hospitals to use observation status [36]. Naturally, hospitals spent a great amount of resources to develop and strengthen care coordination [37], transitional care [38], and adopt voluntary value-based reforms [39] to avoid unnecessary readmissions. Further studies are warranted to

investigate the associations of enhanced coverage of preventive services and HRRP with decreased inpatient care.

Our second main finding is the increase in the probability of having ≥1 ED visit by 4.3 percentage points in the post-ACA period among older Medicare beneficiaries with 2+ MCCs. This is a sizable increase of ~25% from pre-ACA levels (17%). Interestingly, ED visits showed an increasing pattern despite most study participants had a usual source of care (overall, 93.9%), while only a few participants reported problems accessing needed care (1.1%) or prescription drugs (1.7%). Previous studies found that more ED visits were sensitive to health insurance status [40, 41] or having a usual source of care [42]. Other studies found that ED visits were affected by the severity of patients’ illness or comorbidity [43, 44]. Despite this, the demand for ED might remain relatively inelastic, regardless of having urgent health conditions [45] or a usual source of care [46, 47]. Further studies are warranted to investigate how having a usual source of care could affect ED visits among older Medicare beneficiaries with MCCs. We also postulate that hospital responses to the HRRP might offer an explanation for this pattern as well. The previous literature



speculated that the HRRP may have encouraged hospitals to “game the system” by holding more patients in ED or admitting them for observation [23]. Observation stays significantly increased after the HRRP went into effect for target conditions, but not for the non-target conditions [48]. Another study confirmed that the top 10% of hospitals with the largest drop in hospital readmission increased the use of observation status by 25% among Medicare patients returning within 30 days [49].

Our study has key strengths, including providing nationally representative estimates over policy-relevant time periods, and using a validated scheme for identifying and counting chronic conditions among older adults. However, one key limitation deserves comment. While our goal was to document the changes in ED/inpatient use potentially driven by all ACA reforms relevant to older adults with MCCs, our findings do not necessarily have a causal interpretation as exclusively being due to the ACA. This is because of the lack of an appropriate control group that was not exposed to all of the reforms we discussed. While the non-MCC group in our analysis was arguably the least affected by the ACA, the fact that the non-MCC group is much healthier than their MCC counterparts suggests that they are a different population in terms of other important observable and unobservable ways. Additionally, while 2 years following ACA may be insufficient to detect stable post-reform outcome levels, 2015 is the most recently available year of MEPS data for which chronic conditions can be identified using ICD-9 codes.

## Conclusions

Our evaluation permits a better understanding of overall hospital use patterns among older Medicare beneficiaries with MCCs throughout the course of the ACA. We documented an increase in ED visits but a decrease in inpatient utilization among the population following the ACA. This seemingly paradoxical relationship warrants further examination over longer post-ACA periods, as well as identification of the underlying patient- and system-level causes of such change, in order to improve the access to care and quality of care while containing the healthcare cost among older adults.

## Supplementary information

Supplementary information accompanies this paper at <https://doi.org/10.1186/s12913-020-4902-7>.

**Additional file 1: Table S1.** Study Covariates with Missing Data. **Table S2.** Characteristics of Excluded vs. Included Respondents. **Table S3.** Adjusted levels and changes in emergency department visits among older adults with multiple chronic conditions (2006–2015). **Table S4.** Adjusted levels and changes in inpatient visits among older adults with multiple chronic conditions (2006–2015). **Table S5.** Adjusted levels and changes in inpatient length of stay among older adults with multiple chronic conditions (2006–2015). **Table S6.** Changes in ED/Inpatient

Utilization Around the ACA Estimated in the Main Sample versus in a Full Sample Excluding 4 Key Covariates with Missing Data.

## Abbreviations

ACA: Affordable care act; CI: Confidence intervals; ED: Emergency department; FPL: Federal poverty line; HRRP: Hospital Readmission Reduction Program; ICD-9: International Classification of Diseases 9th Revision; LOS: Length of stay; MCC: Multiple chronic conditions; MEPS: Medical Expenditure Panel Survey; QALY: Quality-adjusted life years

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## Authors' contributions

SA planned the study and wrote the paper. MH performed all statistical analyses and contributed to revising the paper. AM helped to critically revise the manuscript. MS helped to plan the study, including the instrumentation, and to revise the manuscript. All authors reviewed and edited the manuscript and approved the final version.

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## Availability of data and materials

The Medical Expenditure Panel Survey dataset are publicly available in the Agency for Healthcare Research and Quality: Medical Expenditure Panel Survey webpage in [https://meps.ahrq.gov/mepsweb/data\\_stats/download\\_data\\_files.jsp](https://meps.ahrq.gov/mepsweb/data_stats/download_data_files.jsp).

## Ethics approval and consent to participate

Not applicable.

## Consent for publication

Not application.

## Competing interests

The authors declare that they have no competing interests.

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