ORIGINAL RESEARCH

Annals of Internal Medicine

The Effects on Hospital Utilization of the 1966 and 2014 Health Insurance Coverage Expansions in the United States

Adam Gaffney, MD; Danny McCormick, MD; David H. Bor, MD; Anna Goldman, MD; Steffie Woolhandler, MD, MPH; and David U. Himmelstein, MD

Background: Persons with comprehensive health insurance use more hospital care than those who are uninsured or have high-deductible plans. Consequently, analysts generally assume that expanding coverage will increase society-wide use of inpatient services. However, a limited supply of beds might constrain this growth.

Objective: To determine how the implementations of Medicare and Medicaid (1966) and the Patient Protection and Affordable Care Act (ACA) (2014) affected hospital use.

Design: Repeated cross-sectional study.

Setting: Nationally representative surveys.

Participants: Respondents to the National Health Interview Survey (1962 to 1970) and Medical Expenditure Panel Survey (2008 to 2015).

Measurements: Mean hospital discharges and days were measured, both society-wide and among subgroups defined by income, age, and health status. Changes between preexpansion and postexpansion periods were analyzed using multivariable negative binomial regression.

Results: Overall hospital discharges averaged 12.8 per 100 persons in the 3 years before implementation of Medicare and Medicaid and 12.7 per 100 persons in the 4 years after (adjusted difference, 0.2 discharges [95% CI, −0.1 to 0.4 discharges] per 100 persons; $P = 0.26$). Hospital days did not change in the first 2 years after implementation but increased later. Effects differed by subpopulation: Adjusted discharges increased by 2.4 (CI, 1.7 to 3.1) per 100 persons among elderly compared with nonelderly persons ($P < 0.001$) and also increased among those with low incomes compared with high-income populations. For younger and higher-income persons, use decreased. Similarly, after the ACA's implementation, overall hospital use did not change: Society-wide rates of discharge were 9.4 per 100 persons before the ACA and 9.0 per 100 persons after the ACA (adjusted difference, −0.6 discharges [CI, −1.3 to 0.2 discharges] per 100 persons; $P = 0.133$), and hospital days were also stable. Trends differed for some subgroups, and rates decreased significantly in unadjusted (but not adjusted) analyses among persons reporting good or better health status and increased nonsignificantly among those in worse health.

Limitation: Data sources relied on participant recall, surveys excluded institutionalized persons, and follow-up after the ACA was limited.

Conclusion: Past coverage expansions were associated with little or no change in society-wide hospital use; increases in groups who gained coverage were offset by reductions among others, suggesting that bed supply limited increases in use. Reducing coverage may merely shift care toward wealthier and healthier persons. Conversely, universal coverage is unlikely to cause a surge in hospital use if growth in hospital capacity is carefully constrained.

Primary Funding Source: None.

Ann Intern Med. 2019;171:172-180. doi:10.7326/M18-2806 **Annals.org**
For author affiliations, see end of text.
This article was published at Annals.org on 23 July 2019.

Gaining health insurance improves access to outpatient care, which may prevent hospitalization (1). However, more or better coverage can also increase hospital use because uninsured and underinsured persons may avoid the hospital, even for emergencies (2). On balance, studies suggest that the latter dynamic predominates (3–5): At least at the individual level, more coverage means more hospital use.

However, the association between large-scale coverage expansions and society-wide hospital use (and hence costs) is more complex. The large regional variation in use of inpatient services cannot be explained by differences in insurance coverage, demographic characteristics, or clinical factors (6, 7). Moreover, the number of hospital beds in a community is an important determinant of hospital use (6, 8, 9), which suggests that limits on the supply of staffed beds may constrain use surges in the wake of coverage expansions; increased hospitalizations among the newly insured may be offset by decreases in use among those who were already covered. However, if expanded coverage were to stimulate hospitals to expand—and regulators were to permit such expansion—use might increase in the long term (10).

In this study, we quantify the association between the 2 largest coverage expansions in U.S. history—the implementations of Medicare and Medicaid in July 1966 and the Patient Protection and Affordable Care Act (ACA) in 2014—and use of hospital care. We hypothesized that the finite supply of beds might constrain short-term increases in overall hospital use, although care might shift to groups that gained coverage. Our findings inform debate over Medicaid expansions or single-payer reform, as well as policies likely to contract coverage, such as repeal of the ACA or imposition of Medicaid work requirements.

METHODS

Data Sources and Population

To investigate the association between the 1966 expansion of Medicare and Medicaid (hereafter the "Medicare expansion") and changes in the use of inpa-

tient services, we did repeated cross-sectional analyses of the National Health Interview Survey (NHIS), an annual survey of the noninstitutionalized, civilian U.S. population. We analyzed the 4 years before and 4 years after expansion, for a total of 8 years of data. During this era, the NHIS transitioned from a data collection period based on the fiscal year (July to June) to one based on the calendar year. Years before expansion were fiscal years 1962 to 1963 through 1965 to 1966; years after expansion were fiscal years 1966 to 1967 and 1967 to 1968 and calendar years 1969 and 1970 (hence, the second half of 1968 was excluded).

For the 2014 expansion, we used data from the Medical Expenditure Panel Survey (MEPS), which collects data on health care use from repeated interviews with a nationally representative panel of households. Although each household is followed for 30 months, MEPS staff provide consolidated full-year files that include all use for each calendar year. Using these files for the 6 years before the ACA's implementation (2008 to 2013) and the 2 years after (2014 and 2015), we did repeated cross-sectional analyses—that is, we did not link individuals across survey years.

Finally, to corroborate our findings in both eras, we used data from the American Hospital Association (AHA) (11–13) and the U.S. Census Bureau (14–16) to calculate per capita hospital use. Unlike NHIS and MEPS, the AHA figures include institutionalized persons and patients who died in the hospital. For the Medicare era, we tabulated AHA figures on admissions to nonfederal, short-term general, and other special-community hospitals. For the ACA era, we tabulated AHA figures on hospitalizations at "community hospitals," which are defined similarly.

Statistical Analysis

Medicare Expansion

Using NHIS participants' reports of their hospitalizations and lengths of stay (Note 1 of the **Appendix**, available at Annals.org), we tabulated hospitalizations and inpatient nights (hereafter "discharges" and "days," respectively) per year for the entire population and for the following 3 subgroups targeted by the 1966 expansion: elderly persons (aged >64 years), virtually all of whom became eligible for Medicare; low-income adults (of any age), many of whom became eligible for Medicaid, Medicare, or both; and low-income elderly persons. Finally, we created a combined "targeted" subgroup (elderly *or* low-income).

We estimated respondents' family income as a proportion of the year-specific federal poverty level (FPL) and categorized respondents in the lowest tertile as "low-income" (**Appendix Tables 1** and **2**, available at Annals.org). Because the 1963 NHIS did not include information on family size (precluding computation of income relative to FPL), we plotted estimates from that year but otherwise excluded it from analyses. Adjusted analyses also excluded persons with missing data (48 332 for income and 9367 for education, out of a total of 928 794).

We estimated mean hospital use (discharges and days) overall and for each targeted population before and after Medicare expansion. We tested for significant changes using univariate negative binomial regression, which is appropriate for analyses of use counts when most persons have zero use.

To account for demographic shifts that might affect health care use, we repeated these analyses with adjustment for age, sex, family size, region, race, marital status, education, and income category (Note 2 of the **Appendix** and **Appendix Table 3**, available at Annals.org). To evaluate whether the Medicare expansion was associated with different effects in targeted and nontargeted subgroups, we added interaction terms to adjusted models to compare changes for each of the 4 targeted populations described earlier to those for nontargeted persons. In each model, we interacted our time variable (pre- vs. postimplementation dummy) with a targeted population indicator variable (Note 2 of the **Appendix**). We also did analyses using models that examined different effects by income confined to the elderly subgroup.

ACA Expansion

Using methods similar to those of the Medicare expansion analysis, we calculated hospital discharges and days per 100 persons and tested differences between pre-ACA and post-ACA periods using univariate negative binomial regression.

For the ACA, we defined the following 4 target populations, 3 of which overlapped and were based on income and 1 of which was based on self-reported health status: adults aged 18 to 64 years earning at most 138% of the FPL, many of whom were eligible for the ACA's Medicaid expansion; adults aged 18 to 64 years earning at most 250% of the FPL, some of whom were eligible for both premium and cost-sharing subsidies in ACA marketplace plans; adults aged 18 to 64 years earning at most 400% of the FPL, some of whom were eligible for premium subsidies; and adults aged 18 to 64 years reporting fair or poor health, a group likely to benefit from the ACA's prohibitions on preexisting condition exclusions and medical underwriting. Persons reporting fair or poor health were compared with those reporting good or better health, and the target populations defined by income and age were compared with persons who were earning more than 400% of the FPL or those aged younger than 18 or older than 64 years.

As in the Medicare expansion analysis, we used multivariable negative binomial regression to assess changes in society-wide use, adjusted for demographic changes (Note 3 of the **Appendix** and **Appendix Tables 4** and **5**, available at Annals.org). We excluded 3641 persons with missing data for 1 or more covariates. To account for the known downward trend in hospital use that preceded the ACA (17), we included a continuous year variable in these models. We then evaluated the differential effects of the ACA according to target population status by adding interaction terms to our adjusted models (Note 3 of the **Appendix**).

Sensitivity Analyses

We repeated our Medicare-era analyses with a different time variable to assess whether the early and late effects of the expansion differed; we hypothesized that short-term constraints on bed supply might have loosened over time. These analyses used the following 3 time categories: a preexpansion period (fiscal years 1963 to 1964 and 1965 to 1966), an early postexpansion period (fiscal years 1966 to 1967 and 1967 to 1968), and a late postexpansion period (calendar years 1969 and 1970). Similarly, for the ACA era, we did sensitivity analyses using shorter prereform periods (2010 to 2013 and 2012 to 2013) to ensure that our results were not sensitive to the baseline period selected.

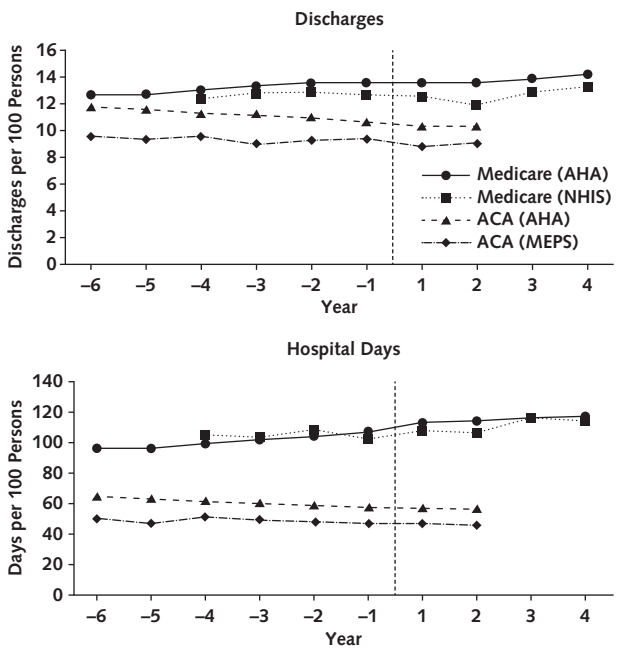
All analyses were done using STATA/SE, version 15.1 (StataCorp), and we used weights provided by the National Center for Health Statistics to produce nationally representative estimates. We used STATA's svy procedure to account for the surveys' complex sample design, with strata and sampling units provided by the National Center for Health Statistics; the nbreg procedure for negative binomial regressions; and the margins commands to produce marginal effect estimates, including for the "treatment effect" of the coverage expansion on targeted versus nontargeted populations (18). Finally, prereform parallel trends for targeted and nontargeted groups were assessed (and supported) using visual inspection of graphs.

The Institutional Review Board of the Cambridge Health Alliance exempted this study from review.

Role of the Funding Source

This study received no external funding.

Figure 1. Hospital use before and after the 1966 and 2014 expansions.



Dashed vertical lines indicate date of implementation of the coverage expansion (July 1966 for Medicare and January 2014 for ACA). For Medicare-era AHA data, year −1 is calendar year 1965 and year 1 is calendar year 1967; calendar year 1966, the year of implementation, is excluded. For Medicare-era NHIS data, year −1 is fiscal year 1965 to 1966 and year 1 is fiscal year 1966 to 1967 (and, as described in the text, year 2 is fiscal year 1967 to 1968, year 3 is calendar year 1969, and year 4 is calendar year 1970; hence, the second half of calendar year 1968 is omitted). For the ACA era (for both AHA and MEPS data), year −1 is calendar year 2013 and year 1 is calendar year 2014. For NHIS data, n = 1 067 226 (with weight >0). For MEPS data, n = 270 337. ACA = Patient Protection and Affordable Care Act; AHA = American Hospital Association; MEPS = Medical Expenditure Panel Survey; NHIS = National Health Interview Survey.

RESULTS

Medicare Expansion

The NHIS samples from fiscal year 1963 to 1964 through calendar year 1970 included 407 651 persons in the preexpansion period and 521 143 in the postexpansion period (the 1963 sample, which was excluded from most analyses as described earlier, included an additional 138 432 persons). **Appendix Figure 1** (available at Annals.org) shows how the cohort was formed, and **Appendix Table 6** (available at Annals.org) provides its demographic characteristics.

Figure 1 shows society-wide trends in hospital use from both the NHIS and AHA data. No inflection coincident with the Medicare expansion is evident. In the NHIS sample, use is flat or down-sloping in postexpansion years 1 to 2 but shows a late up-sloping trend in years 3 to 4. As expected, the AHA-based estimates, which include admissions of institutionalized persons, resemble those from the NHIS but show hospital days increasing slowly and steadily throughout the decade, with no inflection at any point.

Table 1 presents unadjusted and adjusted society-wide hospital use before and after the Medicare expansion. Discharges were unchanged after expansion: The overall population averaged 12.8 discharges per 100 persons before expansion and 12.7 per 100 persons after expansion, with a nonsignificant adjusted difference of 0.2 discharges (95% CI, −0.1 to 0.4 discharges) per 100 persons (P = 0.26). Hospital days increased significantly in the unadjusted analysis from 104.9 to 111.2 per 100 persons, although the adjusted increase was nonsignificant (3.9 days [CI, −0.3 to 8.1 days] per 100 persons; P = 0.068). Sensitivity analyses indicated that any increase in hospital days was confined to the late postexpansion period, 1969 to 1970 (**Appendix Table 7**, available at Annals.org).

Table 1 also presents pre- and postexpansion use for subgroups (**Figure 2** and **Appendix Figures 2** and **3** [available at Annals.org] show year-to-year trends). Use increased in targeted subgroups; nontargeted groups had small decreases, although their use may have rebounded in the late postexpansion period (**Appendix Table 7**). For instance, in unadjusted analyses for elderly persons (aged ≥65 years), rates increased significantly from 18.3 to 22.0 discharges per 100 persons and from 232.1 to 309.8 hospital days per 100 persons; increases were larger among low-income seniors. At the same time, nonelderly persons had a significant de-

Table 1. Hospital Use Before and After the 1 July 1966 Implementation of Medicare and Medicaid*

Population	Unadjusted (n = 928 794)					Adjusted (n = 873 321)†				
	Persons, n	Before (n = 407 651)	After (n = 521 143)	Difference (95% CI)	P Value‡	Persons, n	Before (n = 384 588)	After (n = 488 733)	Difference (95% CI)	P Value
		Discharges per 100 Persons, n					Discharges per 100 Persons, n			
Overall population	928 794	12.8	12.7	−0.1 (−0.4 to 0.2)	0.43	873 321	12.7	12.8	0.2 (−0.1 to 0.4)	0.26
By age§										
<65 y	843 930	12.2	11.7	−0.5 (−0.8 to −0.3)	<0.001	797 593	12.9	12.8	Reference	
≥65 y	84 864	18.3	22.0	3.7 (2.9 to 4.6)	<0.001	75 728	11.0	13.4	2.4 (1.7 to 3.1)	<0.001
By income										
Bottom tertile	307 249	13.2	14.0	0.7 (0.2 to 1.2)	0.005	304 029	12.8	13.6	1.4 (0.7 to 2.1)	<0.001
Middle tertile	297 487	12.9	12.5	−0.5 (−0.9 to −0.1)	0.025	295 283	13.2	12.7	0.1 (−0.4 to 0.7)	0.62
Top tertile	275 736	12.3	11.6	−0.6 (−1.0 to −0.2)	0.002	274 009	12.3	11.7	Reference	
By income, among elderly persons										
Bottom tertile	42 120	17.8	22.6	4.8 (3.5 to 6.1)	<0.001	40 736	17.0	21.8	1.4 (−1.6 to 4.5)	0.36
Middle tertile	19 979	19.5	21.4	1.9 (0.0 to 3.8)	0.056	19 287	19.7	21.6	−1.5 (−4.7 to 1.8)	0.38
Top tertile	16 182	18.5	21.9	3.5 (0.9 to 6.0)	0.009	15 705	20.0	23.4	Reference	
By combined target status‖										
Targeted	349 993	13.9	14.9	1.0 (0.5 to 1.5)	<0.001	534 300	12.8	13.7	1.6 (0.9 to 2.2)	<0.001
Nontargeted	537 062	12.2	11.4	−0.7 (−1.0 to −0.4)	<0.001	339 021	12.8	12.1	Reference	
		Days per 100 Persons, n					Days per 100 Persons, n			
Overall population	928 794	104.9	111.2	6.3 (2.7 to 9.9)	0.001	873 321	104.3	108.2	3.9 (−0.3 to 8.1)	0.068
By age§										
<65 y	843 930	92.1	90.6	−1.4 (−4.9 to 2.1)	0.43	797 593	101.8	102.8	Reference	
≥65 y	84 864	232.1	309.8	77.6 (59.3 to 96.0)	<0.001	75 728	104.5	140.4	35.0 (24.9 to 45.1)	<0.001
By income										
Bottom tertile	307 249	119.3	133.8	14.5 (6.9 to 22.2)	<0.001	304 029	116.0	119.4	5.5 (−5.7 to 16.7)	0.34
Middle tertile	297 487	95.8	100.1	4.3 (−1.3 to 10.0)	0.134	295 283	104.6	102.5	0.0 (−8.8 to 8.8)	1.00
Top tertile	275 736	97.8	96.3	−1.5 (−8.0 to 4.9)	0.64	274 009	96.1	94.1	Reference	
By income, among elderly persons										
Bottom tertile	42 120	221.5	322.7	101.3 (74.7 to 127.8)	<0.001	40 736	208.7	304.3	58.6 (6.4 to 110.7)	0.028
Middle tertile	19 979	241.2	307.5	66.2 (23.0 to 109.5)	0.003	19 287	239.9	306.4	29.5 (−32.9 to 91.8)	0.35
Top tertile	16 182	248.2	275.3	27.1 (−9.0 to 63.2)	0.147	15 705	269.2	306.2	Reference	
By combined target status‖										
Targeted	349 993	134.3	154.7	20.4 (13.0 to 27.8)	<0.001	534 300	114.4	121.5	10.2 (1.1 to 19.2)	0.028
Nontargeted	537 062	86.6	85.0	−1.6 (−6.2 to 2.9)	0.48	339 021	97.8	94.8	Reference	

* Data are from the National Health Interview Survey. Before years are fiscal years 1963 to 1964, 1964 to 1965, and 1965 to 1966; after years are fiscal years 1966 to 1967 and 1967 to 1968 and calendar years 1969 and 1970. Fiscal year 1962–1963 is excluded from all analyses in this table.
† Adjusted estimates and P values are for average marginal effects. Overall population models are adjusted for age, sex, family size, region, race, marital status, education, employment, income, and pre-post dummy variable; subpopulation models also include interaction terms. Appendix Table 3 gives details on covariate treatment and Note 2 of the Appendix gives details on model specification and number of observations in each adjusted analysis.
‡ Unadjusted P values are for pre–post implementation dummy variable coefficient; marginal effect P values are essentially identical.
§ Note that adjustment for covariates, particularly employment status, substantially attenuates the association between elderly age and hospital use, which is reflected in the large difference between unadjusted and adjusted mean discharges and days among elderly persons. However, this is not evident in margins produced in analyses restricted to elderly persons, as reflected in the small differences between unadjusted and adjusted mean use seen in the "by income, among elderly persons" groups.
‖ Combined targeted population includes elderly persons (aged >64 y) and those of any age with low income. Combined nontargeted population includes nonelderly, non–low-income individuals.

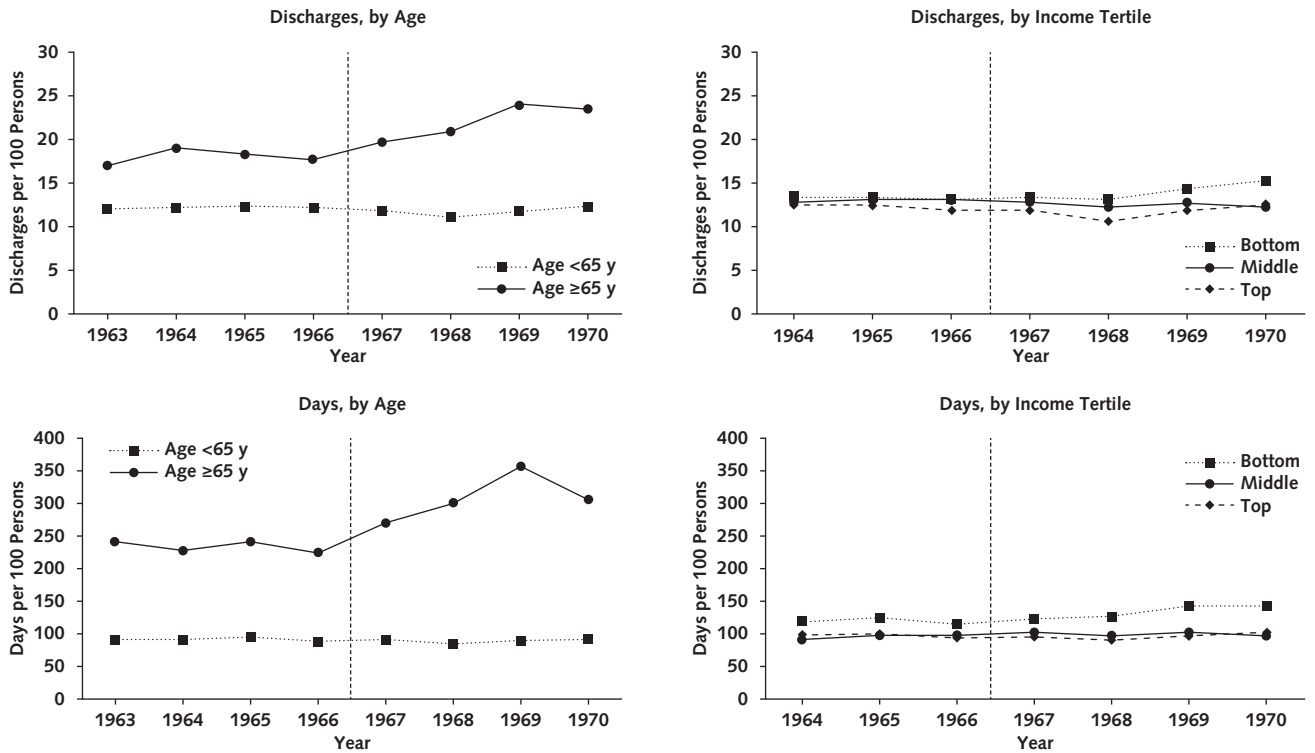
crease in discharges and a nonsignificant decrease in hospital days. In the adjusted analysis, elderly persons had increases of 2.4 discharges (CI, 1.7 to 3.1 discharges) per 100 persons (P < 0.001) and 35.0 days (CI, 24.9 to 45.1 days) per 100 persons (P < 0.001) relative to nonelderly persons.

The 1966 expansion also affected income subgroups differently. In unadjusted analyses, among low-income persons of all ages, discharges increased significantly from 13.2 to 14.0 per 100 persons and days increased from 119.3 to 133.8 per 100 persons. In contrast, among persons in the middle and top income tertiles, discharges (but not days) decreased slightly but significantly. In the adjusted analysis, persons in the bottom income tertile had an increase of 1.4 discharges (CI, 0.7 to 2.1 discharges) per 100 persons compared with those in the top tertile (P < 0.001), although the relative increase in days was not significant. Analyses of the combined targeted group based on age or income yielded similar results.

ACA Expansion

The study population for the ACA expansion included 203 282 persons before the ACA (2008 to 2013) and 67 055 after (2014 to 2015). **Appendix Figure 4** (available at Annals.org) illustrates study popula-

Figure 2. Hospital use per 100 persons before and after the 1966 Medicare and Medicaid expansion, by age and income subgroups.



Dashed vertical lines indicate implementation of the coverage expansion (July 1966). Age <65 y, *n* = 969 631; age ≥65 y, *n* = 97 595; bottom income tertile, *n* = 307 249; middle income tertile, *n* = 297 487; top income tertile, *n* = 275 736.

tion formation, and **Appendix Table 8** (available at Annals.org) provides population characteristics.

We found no evidence that hospital use increased in the wake of the ACA. **Figure 1** shows the steady decline in discharges and hospital days throughout the period that is evident in both the MEPS and AHA data. **Table 2** presents unadjusted and adjusted changes in use after the 2014 expansion. Both discharges (9.4 per 100 persons before vs. 9.0 per 100 persons after expansion) and hospital days (48.5 per 100 persons vs. 46.0 per 100 persons) decreased nonsignificantly in the wake of the ACA in the unadjusted analysis. Similarly, adjusted analyses showed an insignificant decrease in discharges of 0.6 (CI, −0.2 to 1.3) per 100 persons (P = 0.133) and a decrease in days of 7.3 (CI, −0.3 to 14.8) per 100 persons (P = 0.060) after the expansion.

Table 2 (and **Figure 3**) also presents results for subgroups. Unadjusted analyses suggest that the expansion may have affected subgroups defined by health status differently: Persons in fair or poor health had nonsignificant increases in discharges and days, whereas those in good or better health had a significant reduction in discharges of 0.6 (CI, 0.2 to 1.0) per 100 persons (P = 0.006) and a reduction in days of 3.2 (CI, 0.2 to 6.2) per 100 persons (P = 0.040). The adjusted increase in discharges or days for those in fair or poor health relative to those in good health did not reach statistical significance (adjusted difference in discharges, 1.5 discharges [CI, −1.1 to 4.0 discharges]; P = 0.27). Finally, hospital days increased slightly in poorer subgroups and decreased slightly among the nontargeted subgroup, but these changes were small and nonsignificant.

Sensitivity analyses using shorter preimplementation baselines (2010 to 2013 and 2012 to 2013) produced similar results (**Appendix Tables 9** and **10**, available at Annals.org).

DISCUSSION

In the wake of the 2 largest coverage expansions in U.S. history, neither hospital discharges nor, at least initially, hospital days increased society-wide. As expected, some targeted populations increased their use of hospital care, but these increases were offset by reductions among others. For instance, hospital use increased markedly among elderly and low-income persons after the introduction of Medicare and Medicaid but decreased among younger and higher-income persons. Similar but mostly nonsignificant trends occurred after implementation of the ACA. Overall, our findings suggest that major coverage expansions are associated with redistributions, rather than increases, in hospital use.

Our observation that hospital use increased among some subgroups that gained coverage are consistent with the results of previous studies. For instance, older

adults are more likely to be hospitalized, especially for elective surgery, after reaching age 65 years and gaining Medicare eligibility (19, 20). Similarly, employees transitioned from a "free" to a high-deductible health plan reduced their use of inpatient services by 13% (3). The RAND Health Insurance Experiment found that persons randomly assigned to first-dollar coverage had almost 30% more admissions than those assigned to the catastrophic plan with highest cost sharing (5)—although the high dropout rate among those assigned to catastrophic coverage may have exaggerated this difference (21, 22). Similarly, the Oregon Health Insurance Experiment found that Medicaid coverage increased hospital days by 20% (4), an increase that was sustained for at least 2 years (2). None of these studies, however, assessed the effects of large-scale coverage changes on a broad cross-section of persons whose coverage was unaffected.

Previous studies of the Medicare and ACA expansions provide limited insight into the society-wide effects of these reforms. Tabulations of use in the Medicare era published in decades-old reports suggest a redistribution of care from young to old (23), as we found, but they lack formal statistical assessments of differential effects or controls for secular changes in demographics (23–25). Using hospital survey data and pre-Medicare rates of regional population coverage as an instrumental variable, Finkelstein (10) found that Medicare increased overall hospital spending (and use), mainly because of an increase in hospital capacity. However, this analysis included psychiatric, tuberculosis, and long-term care hospitals, many of which were closing during this period, and its results contrast with the actually observed trends for acute care general hospitals.

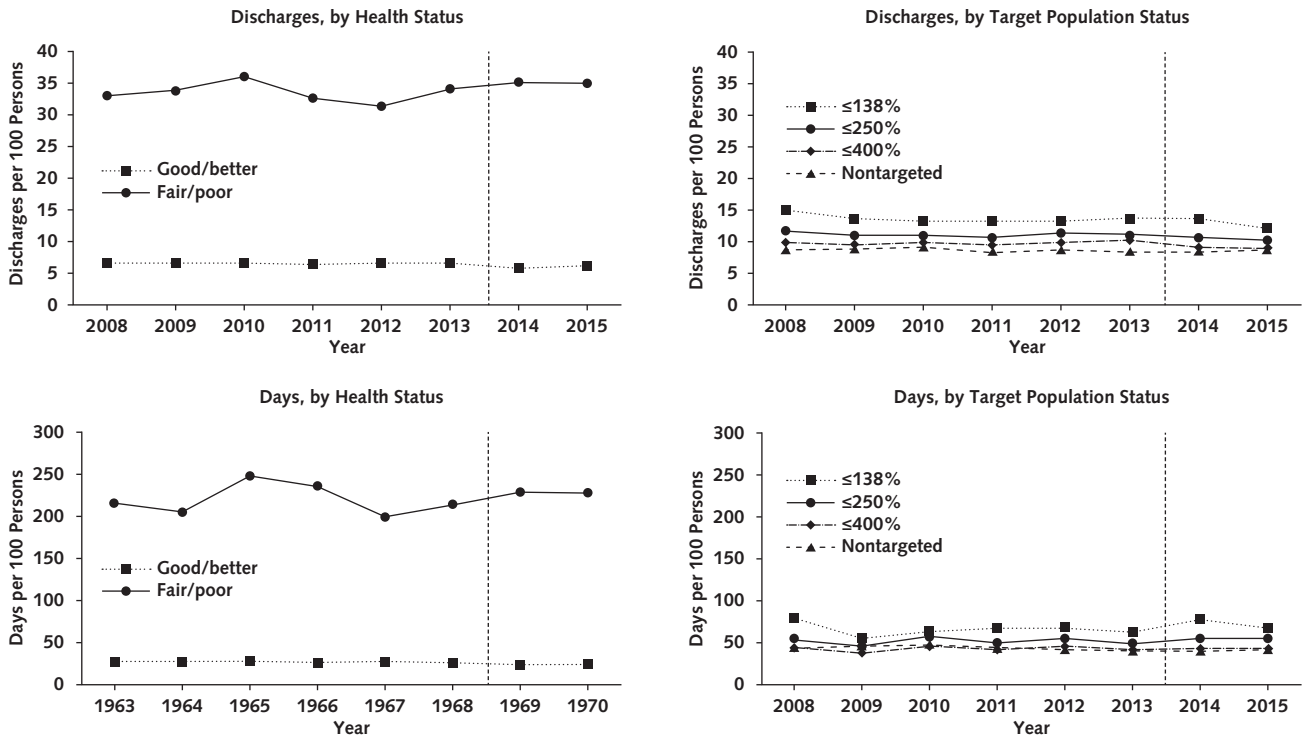
Most previous analyses of the ACA's effect on use of inpatient services have focused on individual states (26–28), specific ACA provisions (especially the Medicaid expansion) (26, 27, 29–32), or particular populations (such as trauma victims or persons with HIV) (28, 29). Two studies using hospital administrative data and difference-in-differences approaches found no state-level association between Medicaid expansion and all-payer inpatient volume (31, 33), and a systematic review concluded that studies of the Medicaid expansion's effects on inpatient use had inconsistent findings (34). In addition, although several studies have found that the ACA changed inpatient payer mix (30, 31, 33, 34), few shed light on society-wide dynamics, shifts between populations, or the overall effect of the law.

Table 2. Hospital Use Before (2008–2013) and After (2014–2015) Implementation of the ACA, Overall and by Subgroup

Population	Unadjusted (n = 270 337)					Adjusted (n = 266 696)*				
	Patients, n	Before (n = 203 282)	After (n = 67 055)	Difference (95% CI)	P Value†	Patients, n	Before (n = 200 481)	After (n = 66 215)	Difference (95% CI)	P Value
		Discharges per 100 Persons, n					Discharges per 100 Persons, n			
Overall population	270 337	9.4	9.0	−0.4 (−1.0 to 0.2)	0.187	266 696	9.1	8.5	−0.6 (−1.3 to 0.2)	0.133
Health status										
Good/better	238 139	6.4	5.8	−0.6 (−1.0 to −0.2)	0.006	235 876	6.7	6.0	Reference	
Fair/poor	31 806	33.4	35.0	1.5 (−2.1 to 5.2)	0.40	30 820	21.8	22.6	1.5 (−1.1 to 4.0)	0.27
Target population or status										
≤138% FPL‡	44 603	13.5	12.8	−0.7 (−2.2 to 0.8)	0.36	44 123	12.1	11.6	−0.5 (−1.7 to 0.8)	0.49
≤250% FPL§	81 677	11.0	10.3	−0.7 (−1.8 to 0.3)	0.177	80 823	10.6	10.0	−0.4 (−1.3 to 0.6)	0.43
≤400% FPL‖	114 924	9.6	8.8	−0.8 (−1.6 to 0.0)	0.056	113 794	9.8	8.9	−0.5 (−1.3 to 0.4)	0.28
Nontargeted¶	153 577	8.6	8.4	−0.1 (−0.8 to 0.6)	0.74	152 902	8.7	8.3	Reference	
		Days per 100 Persons, n					Days per 100 Persons, n			
Overall population	270 337	48.5	46.0	−2.6 (−7.6 to 2.5)	0.33	266 696	47.0	39.7	−7.3 (−14.8 to 0.3)	0.060
Health status										
Good/better	238 139	26.6	23.4	−3.2 (−6.2 to −0.2)	0.040	235 876	27.2	22.5	Reference	
Fair/poor	31 806	218.7	227.8	9.1 (−28.2 to 46.3)	0.63	30 820	139.1	133.7	−0.8 (−34.4 to 32.8)	0.96
Target population or status										
≤138% FPL‡	44 603	65.1	72.1	7.0 (−6.7 to 20.7)	0.30	44 123	63.8	67.3	9.1 (−5.1 to 23.3)	0.21
≤250% FPL§	81 677	50.5	53.1	2.5 (−5.4 to 10.5)	0.52	80 823	55.8	54.7	5.3 (−3.5 to 14.2)	0.24
≤400% FPL‖	114 924	42.8	42.6	−0.2 (−6.1 to 5.7)	0.94	113 794	51.1	46.0	2.7 (−5.5 to 10.9)	0.52
Nontargeted¶	153 577	43.8	40.4	−3.5 (−8.6 to 1.6)	0.187	152 902	44.4	36.6	Reference	

ACA = Patient Protection and Affordable Care Act; FPL = federal poverty level.
* Adjusted results are average marginal effects of the ACA implementation dummy variable or implementation dummy * target population status indicator interaction variable. Overall models are adjusted for age, sex, race, region, family size, education, employment, marital status, family income, health status, and pre-post dummy. "Health status" models are adjusted for age, sex, race, region, family size, education, employment, marital status, family income, health status, year, pre-post ACA dummy variable, and a health status * pre-post interaction term. Target population models are adjusted for age, sex, race, region, family size, education, employment, marital status, health status, year, pre-post dummy, 1 of 3 ACA target population indicator variables, and an ACA target population indicator * pre-post interaction term (see Appendix Table 4 for details on covariate treatment and Note 3 of the Appendix for model specification and n for each adjusted analysis.
† Unadjusted P values are for the coefficient of ACA implementation dummy variable; marginal effect P values are essentially identical.
‡ ACA 138% target population includes adults aged 18–64 y with family income ≤138% of FPL.
§ ACA 250% target population includes adults aged 18–64 y with family income ≤250% of FPL.
‖ ACA 400% target population includes adults aged 18–64 y with family income ≤400% of FPL.
¶ Includes persons aged <18 or >64 y and those of any age with family income >400% FPL. Note that adjusted means for the nontargeted population presented here are from adjusted regressions comparing this group with the ≤400% FPL target population (n = 266 696). Adjusted means for this group produced by the other 2 regressions (i.e., ≤138% FPL vs. nontargeted and ≤250% FPL vs. nontargeted) are similar.

Figure 3. Hospital use per 100 persons before and after ACA implementation, according to target population status.



Dashed vertical lines indicate the January 2014 implementation of the ACA coverage expansion. Good or better health status, *n* = 238 138; fair or worse health status, *n* = 31 806; ≤138% FPL target, *n* = 44 603; ≤250% FPL target, *n* = 81 677; ≤400% FPL, *n* = 114 942; nontargeted, *n* = 153 577. ACA = Patient Protection and Affordable Care Act; FPL = federal poverty level.

Our finding that some nontargeted populations reduced their use of inpatient services in the wake of coverage expansions is consistent with some but not all previous studies. For instance, after Taiwan introduced a universal coverage system in 1995, hospital admissions increased sharply among the newly insured population but seemed to decrease among previously insured persons, suggesting an offset (35). A study of the 2006 Massachusetts health reform suggested some "crowd-out" in hospitals of privately insured persons by those with public insurance (36), although 2 other studies found conflicting evidence about effects on those with Medicare (37, 38). A study of the ACA's Medicaid expansion found no evidence that it reduced health care use among persons with fee-for-service Medicare (39). In contrast, a recent econometric analysis of pre-ACA coverage expansions in some states found that increased coverage resulted in slightly fewer surgical discharges of Medicare beneficiaries (40).

The observation that health care use sometimes decreases for groups not targeted by a coverage expansion—while overall use remains steady, at least in the short term—suggests that supply-side factors constrain increases in society-wide use. As Milton Roemer observed, "hospital beds that are built tend to be used" (41); this dictum has found support in a slew of subsequent investigations (6, 8, 9, 42). Fisher and colleagues (6), for instance, found that regions with more beds used more inpatient services even after adjustment for sociodemographic and health factors. Of note, such constraints on inpatient capacity (at least within the range of bed supply in the United States), or the small offsets produced by coverage expansions, do not seem to harm health or patient satisfaction with care (6, 40). On the contrary, a copious supply of hospital beds has been associated with the overprovision of low-value services (43).

Although our findings suggest that hospital use is unlikely to change substantially when bed supply is constrained, this is not necessarily the case over time. In the longer term, use may increase if a coverage expansion provides more funding for hospital expansion that is not constrained by regulators. For instance, in the latter half of the 1960s, an influx of funds from Medicare and Medicaid stimulated hospital investment that increased the supply of short-stay hospital beds (11), boosting hospital spending (including for younger populations) (10). Our observation of a late increase in hospital days is consistent with this dynamic (10, 44).

These observations suggest that preventing an oversupply of beds and technology may be key to controlling growth of use (and costs) in the face of coverage expansions. At the same time, communities' medical needs, not concerns over cost—or hospitals' desire to expand—should be the primary determinant of investment in new hospital resources.

Our study has limitations. Both the NHIS and MEPS rely on participant recall and exclude institutionalized

persons and those who died in the hospital. However, the AHA data, which are based on hospital reports that include those groups, yielded similar overall estimates. Moreover, any underestimation of hospital use would have occurred both before and after the coverage expansion and is unlikely to bias our results. Although some persons may misreport their income or manipulate it to qualify for premium subsidies or Medicaid, this would not affect society-wide trends in use or our analyses of target groups defined by age or health status.

We could not assess the clinical value of hospital admissions or whether a reduction in preventable hospitalizations due to improved ambulatory care played any role in the trends we observed. Our analysis of the ACA era relied on only 2 years of data (and relatively few respondents) in the postimplementation period, although the consistent trends observed in the AHA data provide reassurance that we were unlikely to miss an overall increase in use in the first few years after reform. On the other hand, our analysis casts no light on the longer-term effects of the ACA, and the small number of patients may have undercut our ability to document disparate trends for targeted and nontargeted groups.

Secular changes in hospital bed supply during the study periods could affect our findings. The 1960s saw sharp reductions in numbers of long-term psychiatric and tuberculosis beds (**Appendix Figure 5**, available at Annals.org) (11). Some patients previously treated in those settings may have returned to the community and intermittently received care at acute care hospitals, increasing use and causing us to overestimate the society-wide effects of the Medicare expansion on health care use. In contrast, during the ACA era, numbers of hospital beds (45), admissions, and inpatient days were decreasing, although our analyses adjusted for the declining trend in use. Confounding by unmeasured variables, or other events that coincided with implementation of the coverage expansions, could affect such observational studies as ours, but it seems unlikely that they account for the nationwide trends we observed. Finally, although the health care landscape was different in the Medicare implementation era, we see little reason to expect that the relationships between coverage, use, and bed supply differ today—a view buttressed by our findings in the ACA era.

Our study has important policy implications. Analysts commonly project that coverage expansion (for example, through Medicaid expansion or Medicare-for-all) will cause costly increases in the use of care. Conversely, some hope that curtailing coverage (such as through Medicaid work requirements or repeal of the ACA) would save costs. Our findings suggest that such projections are probably incorrect. With stable bed supply, coverage changes seem likely to alter the distribution, as opposed to the total quantity, of hospital care. Hence, reducing coverage may merely shift hospital care toward wealthier and healthier persons. Conversely, our results imply that universal coverage is unlikely to cause a surge in hospital use—which accounts for about 30% of national health expenditures (46)—if growth in bed supply is carefully constrained.

From Cambridge Health Alliance and Harvard Medical School, Cambridge, Massachusetts (A.G., D.M., D.H.B.); Harvard T.H. Chan School of Public Health, Boston, and Cambridge Health Alliance, Cambridge, Massachusetts (A.G.); and Cambridge Health Alliance and Harvard Medical School, Cambridge, Massachusetts, and City University of New York at Hunter College, New York, New York (S.W., D.U.H.).

Acknowledgment: The authors thank Jacob Bor for his assistance on several statistical questions.

Disclosures: Dr. Gaffney serves as a leader in Physicians for a National Health Program (PNHP), a nonprofit organization that favors coverage expansion through a single-payer program. He has not received any compensation from that group but is reimbursed for some travel on behalf of the organization. Dr. McCormick reports membership on the national board of PNHP. Dr. Woolhandler reports that she cofounded and remains an active member of PNHP. She receives no financial compensation from that organization. She served as an unpaid advisor to Bernie Sanders' 2016 presidential campaign. Dr. Himmelstein reports that he cofounded and remains an active member of PNHP. He receives no financial compensation from that organization. He served as an unpaid advisor to Bernie Sanders' 2016 presidential campaign. Authors not named here have disclosed no conflicts of interest. Disclosures can also be viewed at www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M18-2806.

Reproducible Research Statement: *Study protocol:* Not available. *Statistical code:* Available from Dr. Gaffney (e-mail, agaffney@challiance.org). *Data set:* All data are publicly available for download from the National Center for Health Statistics.

Corresponding Author: Adam Gaffney, MD, 1493 Cambridge Street, Cambridge, MA 02138; e-mail, agaffney@challiance.org.

Current author addresses and author contributions are available at Annals.org.

References

1. **Weissman JS, Gatsonis C, Epstein AM.** Rates of avoidable hospitalization by insurance status in Massachusetts and Maryland. JAMA. 1992;268:2388-94. [PMID: 1404795]
2. **Finkelstein AN, Taubman SL, Allen HL, et al.** Effect of Medicaid coverage on ED use–further evidence from Oregon's experiment. N Engl J Med. 2016;375:1505-7. [PMID: 27797307]
3. **Brot-Goldberg ZC, Chandra A, Handel BR, et al.** What does a deductible do? The impact of cost-sharing on health care prices, quantities, and spending dynamics. Q J Econ. 2017;132:1261-318.
4. **Finkelstein A, Taubman S, Wright B, et al; Oregon Health Study Group.** The Oregon health insurance experiment: evidence from the first year. Q J Econ. 2012;127:1057-106. [PMID: 23293397]
5. **Manning WG, Newhouse JP, Duan N, et al.** Health insurance and the demand for medical care: evidence from a randomized experiment. Am Econ Rev. 1987;77:251-77. [PMID: 10284091]
6. **Fisher ES, Wennberg JE, Stukel TA, et al.** Associations among hospital capacity, utilization, and mortality of US Medicare beneficiaries, controlling for sociodemographic factors. Health Serv Res. 2000;34:1351-62. [PMID: 10654835]
7. **Fisher ES, Wennberg DE, Stukel TA, et al.** The implications of regional variations in Medicare spending. Part 1: the content, quality,

and accessibility of care. Ann Intern Med. 2003;138:273-87. [PMID: 12585825]
8. **Shwartz M, Peköz EA, Labonte A, et al.** Bringing responsibility for small area variations in hospitalization rates back to the hospital: the propensity to hospitalize index and a test of the Roemer's Law. Med Care. 2011;49:1062-7. [PMID: 22002646] doi:10.1097/MLR.0b013e3182353907
9. **Delamater PL, Messina JP, Grady SC, et al.** Do more hospital beds lead to higher hospitalization rates? A spatial examination of Roemer's Law. PLoS One. 2013;8:e54900. [PMID: 23418432] doi:10.1371/journal.pone.0054900
10. **Finkelstein A.** The aggregate effects of health insurance: evidence from the introduction of Medicare. Q J Econ. 2007;122:1-37.
11. **American Hospital Association.** Hospital Statistics. Chicago: American Hospital Association; 1971.
12. **American Hospital Association.** AHA Hospital Statistics, 2013 Edition. Chicago: Health Forum; 2013.
13. **American Hospital Association.** AHA Hospital Statistics, 2018 Edition. Chicago: Health Forum; 2018.
14. **U.S. Census Bureau.** Historical national population estimates: July 1, 1900 to July 1, 1999. Updated 28 June 2000. Accessed at www2.census.gov/programs-surveys/popest/tables/1900-1980/national/totals/popclockest.txt on 18 August 2018.
15. **U.S. Census Bureau.** Annual Estimates of the Resident Population by Single Year of Age and Sex for the United States, States, and Puerto Rico Commonwealth: April 1, 2010 to July 1, 2017. Accessed at https://factfinder.census.gov/bkmk/table/1.0/en/PEP/2017/PEPSYASEX on 29 May 2019.
16. **U.S. Census Bureau.** Table 1. Intercensal estimates of the resident population by sex and age for the United States: April 1, 2000 to July 1, 2010. 2011. Accessed at www2.census.gov/programs-surveys/popest/tables/2000-2010/intercensal/national/us-est00int-01.xls on 23 September 2018.
17. **McDermott KW, Elixhauser A, Sun R.** Patient trends in hospital inpatient stays in the United States, 2005-2014. Rockville, MD: Agency for Healthcare Research and Quality; 2017. Accessed at www.hcup-us.ahrq.gov/reports/statbriefs/sb225-Inpatient-US-Stays-Trends.jsp on 27 January 2019.
18. **Deb P, Norton EC.** Modeling health care expenditures and use. Annu Rev Public Health. 2018;39:489-505. [PMID: 29328879] doi:10.1146/annurev-publhealth-040617-013517
19. **McWilliams JM, Meara E, Zaslavsky AM, et al.** Use of health services by previously uninsured Medicare beneficiaries. N Engl J Med. 2007;357:143-53. [PMID: 17625126]
20. **Card D, Dobkin C, Maestas N.** The impact of nearly universal insurance coverage on health care utilization: evidence from Medicare. Am Econ Rev. 2008;98:2242-58. [PMID: 19079738]
21. **Nyman JA.** American health policy: cracks in the foundation. J Health Polit Policy Law. 2007;32:759-83. [PMID: 17855716]
22. **Aron-Dine A, Einav L, Finkelstein A.** The RAND health insurance experiment, three decades later. J Econ Perspect. 2013;27:197-222. [PMID: 24610973]
23. **Pettengill JH.** Trends in hospital use by the aged. Soc Secur Bull. 1972;35:3-15.
24. **Lowenstein R.** Early effects of Medicare on the health care of the aged. Soc Secur Bull. 1971;34:3-20, 42.
25. **Gleeson GA.** Age patterns in medical care, illness, and disability. Vital Health Stat 10. 1966;10:1-84. [PMID: 5296103]
26. **Nikpay S, Buchmueller T, Levy H.** Early Medicaid expansion in Connecticut stemmed the growth in hospital uncompensated care. Health Aff (Millwood). 2015;34:1170-9. [PMID: 26153312] doi:10.1377/hlthaff.2015.0107
27. **Cunningham P, Sabik LM, Bonakdar Tehrani A.** Trends in hospital inpatient admissions following early Medicaid expansion in California. Med Care Res Rev. 2017;74:705-22. [PMID: 27624635] doi:10.1177/1077558716669433
28. **Hellinger FJ.** In four ACA expansion states, the percentage of uninsured hospitalizations for people with HIV declined, 2012-14. Health Aff (Millwood). 2015;34:2061-8. [PMID: 26643626] doi:10.1377/hlthaff.2015.0718
29. **Holzmacher JL, Townsend K, Seavey C, et al.** Association of expanded Medicaid coverage with hospital length of stay after injury. JAMA Surg. 2017;152:960-6. [PMID: 28658482] doi:10.1001/jamasurg.2017.1720
30. **Nikpay S, Buchmueller T, Levy HG.** Affordable Care Act Medicaid expansion reduced uninsured hospital stays in 2014. Health Aff (Millwood). 2016;35:106-10. [PMID: 26733707] doi:10.1377/hlthaff.2015.1144
31. **Freedman S, Nikpay S, Carroll A, et al.** Changes in inpatient payer-mix and hospitalizations following Medicaid expansion: evidence from all-capture hospital discharge data. PLoS One. 2017;12:e0183616. [PMID: 28957347] doi:10.1371/journal.pone.0183616
32. **Anderson ME, Glasheen JJ, Anoff D, et al.** Impact of state Medicaid expansion status on length of stay and in-hospital mortality for general medicine patients at US academic medical centers. J Hosp Med. 2016;11:847-52. [PMID: 27535323] doi:10.1002/jhm.2649
33. **Pickens G, Karaca Z, Cutler E, et al.** Changes in hospital inpatient utilization following health care reform. Health Serv Res. 2018;53:2446-69. [PMID: 28664983] doi:10.1111/1475-6773.12734
34. **Mazurenko O, Balio CP, Agarwal R, et al.** The effects of Medicaid expansion under the ACA: a systematic review. Health Aff (Millwood). 2018;37:944-50. [PMID: 29863941] doi:10.1377/hlthaff.2017.1491
35. **Cheng SH, Chiang TL.** The effect of universal health insurance on health care utilization in Taiwan. Results from a natural experiment. JAMA. 1997;278:89-93. [PMID: 9214512]
36. **Kolstad JT, Kowalski AE.** The impact of health care reform on hospital and preventive care: evidence from Massachusetts. J Public Econ. 2012;96:909-29. [PMID: 23180894]
37. **Bond AM, White C.** Massachusetts coverage expansion associated with reduction in primary care utilization among Medicare beneficiaries. Health Serv Res. 2013;48:1826-39. [PMID: 24117239] doi:10.1111/1475-6773.12103
38. **Joynt KE, Chan DC, Zheng J, et al.** The impact of Massachusetts health care reform on access, quality, and costs of care for the already-insured. Health Serv Res. 2015;50:599-613. [PMID: 25219772] doi:10.1111/1475-6773.12228
39. **Carey CM, Miller S, Wherry LR.** The impact of insurance expansions on the already insured: the Affordable Care Act and Medicare. Cambridge, MA: National Bureau of Economic Research; 2018. Accessed at www.nber.org/papers/w25153 on 10 January 2019.
40. **Glied S, Hong K.** Health care in a multi-payer system: spillovers of health care service demand among adults under 65 on utilization and outcomes in Medicare. J Health Econ. 2018;60:165-76. [PMID: 29990674] doi:10.1016/j.jhealeco.2018.05.001
41. **Shain M, Roemer MI.** Hospital costs relate to the supply of beds. Mod Hosp. 1959;92:71-3 passim. [PMID: 13644010]
42. **Ginsburg PB, Koretz DM.** Bed availability and hospital utilization: estimates of the "Roemer effect". Health Care Financ Rev. 1983;5:87-92. [PMID: 10310279]
43. **Zhou M, Oakes AH, Bridges JFP, et al.** Regional supply of medical resources and systemic overuse of health care among Medicare beneficiaries. J Gen Intern Med. 2018;33:2127-31. [PMID: 30229364] doi:10.1007/s11606-018-4638-9
44. **Catlin AC, Cowan CA.** History of health spending in the United States, 1960-2013. Baltimore: Centers for Medicare & Medicaid Services; 2015. Accessed at www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/Downloads/HistoricalNHEPaper.pdf on 29 December 2018.
45. **Statista.** Hospital beds number U.S. 1975-2016. Accessed at www.statista.com/statistics/185860/number-of-all-hospital-beds-in-the-us-since-2001 on 23 August 2018.
46. **Centers for Medicare & Medicaid Services.** National health expenditure data: historical. 2018. Accessed at www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsHistorical.html on 26 August 2018.

Current Author Addresses: Drs. Gaffney and McCormick: Cambridge Health Alliance, 1493 Cambridge Street, Cambridge, MA 02138.
Dr. Bor: Chief Academic Officer, Cambridge Health Alliance, 1493 Cambridge Street, Cambridge, MA 02139.
Dr. Goldman: Harvard T.H. Chan School of Public Health, 677 Huntington Avenue, Kresge Room 430, Boston, MA 02115.
Drs. Woolhandler and Himmelstein: 255 West 90th Street, New York, NY 10024.

Author Contributions: Conception and design: A. Gaffney, D. McCormick, D.H. Bor, S. Woolhandler, D.U. Himmelstein.
Analysis and interpretation of the data: A. Gaffney, D. McCormick, S. Woolhandler, D.U. Himmelstein.
Drafting of the article: A. Gaffney, D.U. Himmelstein.
Critical revision of the article for important intellectual content: A. Gaffney, D. McCormick, D.H. Bor, A. Goldman, S. Woolhandler, D.U. Himmelstein.
Final approval of the article: A. Gaffney, D. McCormick, D.H. Bor, A. Goldman, S. Woolhandler, D.U. Himmelstein.
Statistical expertise: A. Gaffney, S. Woolhandler, D.U. Himmelstein.
Obtaining of funding: D.H. Bor.
Administrative, technical, or logistic support: A. Goldman.
Collection and assembly of data: D.H. Bor, A. Gaffney.

Appendix: Notes

Note 1: Medicare-Era Hospital Use

To calculate hospital use in the Medicare era, we used NHIS hospital event files, which we stacked and merged with person-level files to allow person-level analyses. Following instructions in the NHIS documentation (which provides examples for approaches to tabulations; for example, for fiscal year 1965–66 [47]), we calculated hospital discharges based on participants' report of hospitalizations at "short-stay hospitals" in the previous 6 months. We doubled this semiannual estimate to produce annual estimates. We calculated hospital "days" for each of these hospitalizations using the reported number of nights in the hospital.

Note 2: Details of Models Used in Analyses of the 1966 Medicare Expansion

Overall Population

$Y = ß_0 + ß_1\ age + ß_2\ sex + ß_3\ family\ size + ß_4\ region + ß_5\ race + ß_6\ marital\ status + ß_7\ education + ß_8\ employment + ß_9\ income\ category + ß_{10}\ pre\text{-}post\ dummy + \mu$

Population: Final complete-case study population (n = 873 321 after exclusion of those with missing data on covariates or with zero weight).

Interpretation of reported effect ($ß_{10}$): Marginal effect of Medicare and Medicaid implementation on discharges (or days) for the overall population.

By Age

$Y = ß_0 + ß_1\ sex + ß_2\ family\ size + ß_3\ region + ß_4\ race + ß_5\ marital\ status + ß_6\ education + ß_7\ employment + ß_8\ income\ category + ß_9\ pre\text{-}post\ dummy + ß_{10}\ elderly\ dummy + ß_{11}\ (pre\text{-}post\ dummy * elderly\ dummy) + \mu$

Population: Final complete-case study population (n = 873 321).

Interpretation of reported effect ($ß_{11}$): Marginal effect of Medicare and Medicaid on discharges (or days) in those aged 65 years or older compared with those aged younger than 65 years.

By Income

$Y = ß_0 + ß_1\ age + ß_2\ sex + ß_3\ family\ size + ß_4\ region + ß_5\ race + ß_6\ marital\ status + ß_7\ education + ß_8\ employment + ß_9\ income\ tertile + ß_{10}\ pre\text{-}post\ dummy + ß_{11}\ (pre\text{-}post\ dummy * income\ tertile) + \mu$

Population: Final complete-case study population (n = 873 321).

Interpretation of reported effect ($ß_{12}$): Marginal effect of Medicare and Medicaid on discharges (or days) for persons in the low (or middle) income tertile compared with those in the top income tertile.

By Income, Among Elderly Persons

$Y = ß_0 + ß_1\ age + ß_2\ sex + ß_3\ family\ size + ß_4\ region + ß_5\ race + ß_6\ marital\ status + ß_7\ education + ß_8\ employment + ß_9\ income\ tertile + ß_{10}\ pre\text{-}post\ dummy + ß_{11}\ (pre\text{-}post\ dummy * income\ tertile) + \mu$

Population: Individuals aged 65 years or older in complete-case population (n = 75 728).

Interpretation of reported effect ($ß_{11}$): Marginal effect of Medicare and Medicaid on discharges (or days) for elderly persons in the low (or middle) income tertile compared with elderly persons in the top income tertile.

By Combined Target Status

$Y = ß_0 + ß_1\ sex + ß_2\ family\ size + ß_3\ region + ß_4\ race + ß_5\ marital\ status + ß_6\ education + ß_7\ employment + ß_8\ pre\text{-}post\ dummy + ß_9\ combined\ target\ indicator\ dummy + ß_{10}\ (pre\text{-}post\ dummy * combined\ target\ status\ indicator\ dummy) + \mu$

Population: Final complete-case study population (n = 873 321).

Interpretation of reported effect ($ß_{10}$): Marginal effect of Medicare and Medicaid on discharges (or days) for elderly persons (aged ≥65 years) *or* those in the low tertile of income compared with nonelderly persons in the middle or high income tertile.

Notes for All Models

Y = Discharges or days

Note that the continuous age variable was excluded from models that controlled for the elderly dummy variable, and the income category variable was excluded from models including the income tertile variable (including the "combined target status" analyses).

Pre–post Medicare implementation dummy variable = 0 for fiscal year 1965–1966 and earlier and 1 for fiscal year 1966–1967 and later.

Elderly dummy = 0 for age <65 years and 1 for age ≥65 years.

Income category: See Appendix Tables 1 and 2 for construction.

Income tertile = 1 for bottom tertile, 2 for middle tertile, and 3 for high tertile.

Note 3: Details of Multivariable Models Used in Analyses of the 2014 ACA Expansion

Overall Population

$Y = ß_0 + ß_1\ age + ß_2\ sex + ß_3\ race + ß_4\ region + ß_5\ family\ size + ß_6\ education + ß_7\ employment + ß_8\ marital\ status + ß_9\ income + ß_{10}\ year + ß_{11}\ health\ status + ß_{12}\ pre\text{–}post\ ACA\ dummy + \mu$

Population: Final "complete-case" study population: n = 266 696 (n = 201 338 for year 2010–2015 sensitivity analysis; n = 137 423 for year 2012–2015 sensitivity analysis).

Interpretation of reported treatment effect ($ß_{12}$): Marginal effect of ACA implementation on discharges (or days) after ACA compared with before ACA for the overall population.

By Health Status

$Y = ß_0 + ß_1\ age + ß_2\ sex + ß_3\ race + ß_4\ region + ß_5\ family\ size + ß_6\ education + ß_7\ employment + ß_8\ marital\ status + ß_9\ income + ß_{10}\ year + ß_{11}\ health\ status + ß_{12}\ pre\text{–}post\ ACA\ dummy + ß_{13}\ (pre\text{–}post\ ACA\ dummy * health\ status) + \mu$

Population: Final "complete-case" study population: n = 266 696 (n = 201 338 for year 2010–2015 sensitivity analysis; n = 137 423 for year 2012–2015 sensitivity analysis).

Interpretation of reported treatment effect ($ß_{13}$): Marginal effect of ACA on discharges (or days) for those with fair or poor health status compared with those with good or better health status.

By Target Population Status

$Y = ß_0 + ß_1\ age + ß_2\ sex + ß_3\ race + ß_4\ region + ß_5\ family\ size + ß_6\ education + ß_7\ employment + ß_8\ marital\ status + ß_9\ year + ß_{10}\ health\ status + ß_{11}\ pre\text{–}post\ ACA\ dummy + ß_{12}\ target\ population\ indicator + ß_{13}\ (pre\text{–}post\ ACA\ dummy * target\ population\ indicator) + \mu$

Population: There were 3 income-defined ACA target populations, thus 3 income-defined target population dummy variables. However, each target population was compared with a single nontargeted population (income >400% FPL, age <18 years, or age ≥65 years), as described in the main article. This produced 3 separate models for each outcome; Appendix Table 11 shows numbers of observations.

Interpretation of reported effect ($ß_{13}$): Marginal effect of ACA on discharges (or days) for those in the target population compared with the nontargeted population.

Notes for All Models

Y = discharges or days

Year was a continuous variable indicating year before or after implementation of ACA.

Pre–post ACA implementation dummy variable = 0 for years 2013 and earlier and 1 for year 2014 and later.

All target population indicator variables = 0 for nontargeted population and 1 for target population.

Appendix Table 1. NHIS 1963–1969, Family Income Categorization*

NHIS Income Category, $	Fiscal Years 1963–1964, 1964–1965, and 1965–1966†		Fiscal Years 1966–1967 and 1967–1968 and Calendar Year 1969		Calendar Year 1970	
	Income Assigned (for Tertile Assignment), $	Income Category Assigned, $	Income Assigned (for Tertile Assignment), $	Income Category Assigned, $	Income Assigned (for Tertile Assignment), $	Income Category Assigned, $
Unknown	Missing	Missing	Missing	Missing	Missing	Missing
<500	250	<1000	–	–	–	–
500–999	750	<1000	–	–	–	–
<1000	–	–	500	<1000	500	<1000
1000–1999	1500	1000–1999	1500	1000–1999	1500	1000–1999
2000–2999	2500	2000–2999	2500	2000–2999	2500	2000–2999
3000–3999	3500	3000–3999	3500	3000–3999	3500	3000–3999
4000–4999	4500	4000–4999	4500	4000–4999	4500	4000–4999
5000–5999	–	–	5500	5000–6999	5500	5000–6999
5000–6999	6000	5000–6999	–	–	–	–
6000–6999	–	–	6500	5000–6999	6500	5000–6999
7000–9999	8500	7000–9999	8500	7000–9999	8500	7000–9999
10 000–14 999	12 500	10 000–14 999	12 500	10 000–14 999	12 500	10 000–14 999
≥15 000	30 000	≥15 000	30 000	≥15 000	–	–
15 000–24 999	–	–	–	–	20 000	≥15 000
≥25 000	–	–	–	–	50 000	≥15 000

NHIS = National Health Interview Survey.
* To divide the population into income tertiles, we first assigned each individual an income at the midpoint of their reported income category, as indicated in the column "Income Assigned (for Tertile Assignment)." The highest top-coded income category was ≥$15 000 for every year except 1970; individuals in this category were assigned an income of $30 000. The highest top-coded income category for 1970 was ≥$25 000; individuals in this category were assigned an income of $50 000. We then used family size and year-specific federal poverty level (FPL) thresholds (Appendix Table 2) to define family income as a proportion of the FPL. Finally, we divided each year's population into income tertiles using family income as a proportion of FPL. For regression equations, however, family income was retained as a "dollar value" categorical variable; for consistency over years, we recategorized this variable into a smaller number of categories (i.e., the "Income Category Assigned" column).
† Note that for fiscal years 1963–1964 and 1964–1965, income refers to that of the head of the family. However, for 1965–1966 and onward, it denotes combined family income.

Appendix Table 2. Federal Poverty Thresholds Used for Analysis of NHIS Data, 1963–1970

Family Size*	Fiscal Year 1963–1964 (Used Census Calendar Year 1964 Thresholds), $/y	Fiscal Year 1964–1965 (Used Census Calendar Year 1965 Thresholds), $/y	Fiscal Year 1965–1966 (Used Census Calendar Year 1966 Thresholds), $/y	Fiscal Year 1966–1967 (Used Census Calendar Year 1967 Thresholds), $/y	Fiscal Year 1967–1968 (Used Census Calendar Year 1968 Thresholds), $/y	Calendar Year 1969 (Used Census Calendar Year 1969 Thresholds), $/y	Calendar Year 1970 (Used Census Calendar Year 1970 Thresholds), $/y
1	1558	1582	1628	1675	1748	1840	1954
2	2105	2048	2107	2168	2262	2383	2525
3	2473	2514	2588	2661	2774	2924	3099
4	3169	3223	3317	3410	3553	3743	3968
5	3732	3797	3908	4019	4188	4415	4680
6	4193	4264	4388	4516	4706	4958	5260
≥7	5156	5248	5395	5550	5789	6101	6468

NHIS = National Health Interview Survey.
* Top-coded at 7 for all years (48).

Appendix Table 3. NHIS 1963–1970, Variable Definitions and Treatment

Variable	Code	Treatment	Treatment of Missing
Age	age_85 (1962/63–1966/65) age85 (1966/67–1967/68) age (1969) per53 (1970)	Retained as a continuous variable, in years. Top-coded at age 85 y for all years.	None
Sex	Sex (1963/4–1969) Per52 (1970)	Left as a binary variable (female or male).	None
Family size	famsizer (1963/4) famsize (1962/3, 1964/65–1965/6) sizer (1966/67–1967/68) famsize (1969) per97 (1970)	Top-coded at 7 for computing income as a percentage of federal poverty level. Top-coded at 4 for regressions and descriptive statistics.	None
Region	Region (1963/64–1969) Per29 (1970)	Left as a 4-category variable.	None
Race	Race (1963/64–1969) Per50 (1970)	Left as a 3-category variable (white, black, or other).	None
Marital status	Marstat (1963/64–1969) Per60 (1970)	Converted to a 3-category variable: aged <17 y, married, and not married/other (includes widowed, divorced, separated, and never married).	None
Education	educpx (1963/64–1967/68) educr (1969) per63 (1970)	The education variable changed slightly over the years. A simpler variable was created for consistency over the years: <9 y (includes persons younger than 17 y, those reporting no education, and those reporting 1–8 y of education), 9–12 y (includes those with a high school degree), and any college.	Those with "unknown" education (n = 9367 in main study population, or n = 7151 after exclusion of those with missing income) were excluded from adjusted regressions (see Appendix Figure 1)
Income	Income (1963/4–1969) Per68 (1970)	See the second footnote of Appendix Table 1. As described, this was used with federal poverty thresholds to assign poverty ratio thresholds, which allowed the study population to be divided into income tertiles within each year. However, for regressions, a consistent categorical income variable was used.	Those with missing income (n = 48 322 from main study population) were excluded from income-adjusted regressions (see Appendix Figure 1).
Employment	Curact2 ("Current activity during past 2 weeks") (1963/64–1969) Per75 (1970)	Until 1969, this was a 6-category variable ("1. Yes worked; 2. Not working, has job, not looking nor on layoff; 3. Not working, has job, on layoff; 4. Not working, no job, looking for work or on layoff; 5. Not working, no job, not on lay-off nor looking for work; 6. Under 17 years of age" [48]). This was simplified into a 3-category variable: worked (those in category 1), not working for whatever reason (those in categories 2–5), and aged <17 y (those in category 6). For year 1969–1970, the variable was a 9-category variable, which again was simplified into 3 categories: worked, did not work for whatever reason (including not in labor force but aged ≥17 y), and aged <17 y.	None

NHIS = National Health Interview Survey.

Appendix Table 4. Treatment of Covariates Used in Analyses of the MEPS Data for the ACA Expansion (2008–2015)

Description	Variable Name in MEPS	Notes on Treatment	Missing Treatment
Age	AGE	Treated as a continuous variable.	1836 inapplicable observations in main study population were dropped from adjusted regression (100% of these individuals were "out-of-scope in RU during this round," "RU non-response," or "not in MEPS RU previously a member").
Sex	SEX	Retained as a binary variable: 1 = male 2 = female	No missing. (Imputed by MEPS.)
Race	RACEX (2008–2011); RACEV1X (2012–2015); HISPANX (all years)	Created a 4-category variable: 1 = Hispanic of any race (HISPANX = 1) 2 = Non-Hispanic white 3 = Non-Hispanic black 4 = Non-Hispanic other/multiple races	No missing. (Race variables are edited/imputed by MEPS.)
Region	REGION08, REGION09, etc.	Retained as a categorical variable: 1 = Northeast 2 = Midwest 3 = South 4 = West	1836 observations in main study population with "inapplicable" results (same as those with "inapplicable" age, as above); these individuals were dropped from adjusted regressions.
Family size	FAMS1231	Converted into a 5-category variable: 0 = "Inapplicable" result 1 = 1 family member 2 = 2 family members 3 = 3 family members 4 = ≥4 family members	9671 observations coded as "inapplicable" (occurred when family was no longer part of the civilian noninstitutionalized population at the end of the year) were retained as a separate category for regressions.
Education	EDRECODE for years 2011–2015; HIDEG for years 2008–2010 (EDRECODE not available until 2011; HIDEG not available for 2013 and 2014)	Converted into a consistent 4-category variable (see Appendix Table 5 for details): 1 = Less than high school (could be up to grade 12 but without high school degree) 2 = GED or high school ± some college 3 = 4-y college degree 4 = Postgraduate degree (includes "other" degree)	Individuals with missing (i.e., "not ascertained," "don't know," or "refused") education status were treated as missing and dropped from adjusted regressions (n = 1771 in main study population).
Employment status	EMPST53 For those with "not ascertained," "don't know," or "refused" response to EMPST53, we used data from the previous round unless previous round was missing or inapplicable (e.g., if EMPST53 was missing, we used EMPST42; if EMPST53 and EMPST42 were both missing, we used EMPST31).	Converted into a 3-category variable: 1 = Aged <16 y (scored as "inapplicable" for EMPST53) 2 = Employed ("employed at round . . .", "job to return to at round . . .", or "job during round . . .") 3 = Unemployed ("not employed during round . . .") Note that almost all individuals with missing age were also categorized as "inapplicable," accounting for the slightly different proportions of individuals characterized as aged <16 y for employment vs. marital status in Appendix Table 8. However, all such individuals (i.e., those with missing age) were excluded from all adjusted regressions.	Individuals with missing (i.e., "not ascertained," "don't know," or "refused") response to EMPST53 (and also without any nonmissing or inapplicable responses to EMPST42 or EMPST31) were treated as missing and dropped from adjusted regressions (n = 131 from main study population).
Marital status	MARRY08, MARRY09, etc.	1 = Inapplicable (aged <16 y) 2 = Married 3 = Unmarried (i.e., combined responses for never married, divorced, separated, and widowed)	Individuals with "not ascertained," "don't know," or "refused" responses were treated as missing and dropped from regressions (n = 2 from main study population). Note that this variable is edited/imputed by MEPS.
Family income	FAMINC08, FAMINC09, etc.	Retained as a continuous variable; adjusted for inflation using the 2015 Consumer Price Index.	None missing. Note that this variable is constructed and imputed by MEPS.
Health status	RTHLTH53 If missing or inapplicable, we used data from the previous round (e.g., RTHLTH 42, and if this was missing, RTHLTH 31).	Health status was converted from a 5-category to a 2-category variable: good or better (includes good, very good, and excellent) and fair or poor.	Individuals with missing (i.e., "not ascertained," "don't know," "refused," or "inapplicable") status in all 3 rounds (n = 392 from main study population) were treated as missing and dropped from regressions.
Year	Year	Year number before or after ACA expansion was left as a continuous variable to account for pre-ACA trends.	None.

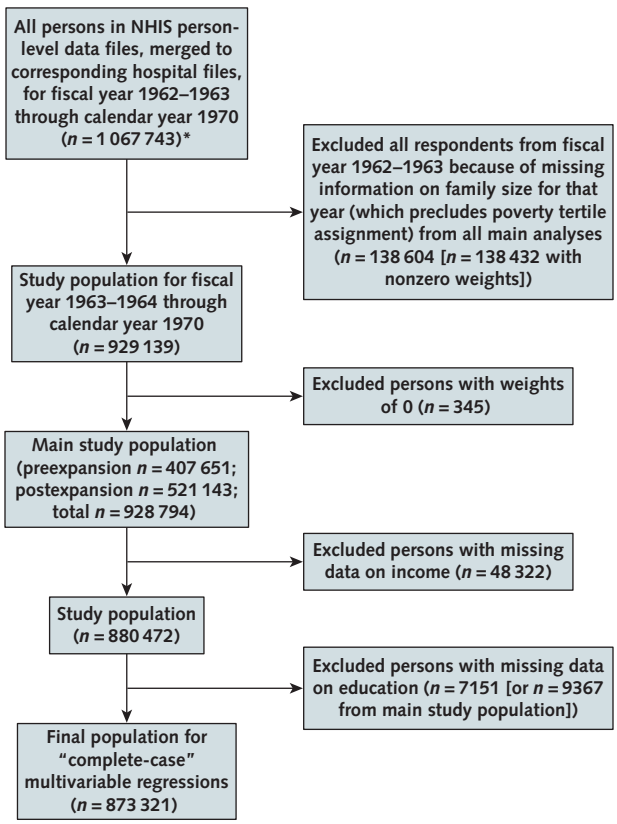
ACA = Patient Protection and Affordable Care Act; MEPS = Medicare Expenditure Panel Survey; RU = reporting unit.

Appendix Table 5. Consistent Education Variable Generation for MEPS, 2008–2015

New Education Variable	HIDEG (Years 2008–2010)	EDRECODE (Years 2011–2012)	EDRECODE (Years 2013+)
Missing	−9: Not ascertained	−9: Not ascertained	−9: Not ascertained
Missing	−8: DK	−8: DK	−8: DK
Missing	−7: Refused	−7: Refused	−7: Refused
1: Less than HS	1: No degree	−1: Inapplicable or aged <5 y*	−1: Inapplicable or aged <5 y*
1: Less than HS	8: Under 16 – inapplicable	0: <1st grade	–
1: Less than HS	–	1: 1st grade	1: ≤8th grade
1: Less than HS	–	2: 2nd grade	2: 9th–12th grade, no HS diploma or GED
1: Less than HS	–	3: 3rd grade	–
1: Less than HS	–	4: 4th grade	–
1: Less than HS	–	5: 5th grade	–
1: Less than HS	–	6: 6th grade	–
1: Less than HS	–	7: 7th grade	–
1: Less than HS	–	8: 8th grade	–
1: Less than HS	–	9: 9th grade	–
1: Less than HS	–	10: 10th grade	–
1: Less than HS	–	11: 11th grade	–
1: Less than HS	–	12: 12th grade, no HS diploma or GED	–
2: GED or HS ± some college	2: GED	13: GED or HS graduate	13: GED or HS graduate
2: GED or HS ± some college	3: HS diploma	14: Beyond HS, college (no 4-y degree), associate's degree	14: Beyond HS, college (no 4-y degree), associate's degree
3: 4-y college	4: Bachelor's degree	15: 4-y college degree, bachelor's degree	15: 4-y college degree, bachelor's degree
4: Postgraduate	5: Master's degree	16: Master's, doctorate, or professional degree	16: Master's, doctorate, or professional degree
4: Postgraduate	6: Doctorate degree	–	–
4: Postgraduate	7: Other degree	–	–

DK = don't know; EDRECODE = "Education Recode (edited)"; HIDEG = "Highest degree when first entered"; HS = high school; MEPS = Medical Expenditure Panel Survey.
* Note that for EDRECODE, individuals were coded in MEPS as −1 if "inapplicable or aged <5 y." All but a small number of these individuals were aged ≤6 y; the remaining individuals were children as well. Hence, all individuals with this code were characterized as "less than HS."

Appendix Figure 1. Flow chart of study population formation for the 1966 expansion.



* Includes fiscal year 1962–1963, fiscal year 1963–1964, fiscal year 1964–1965, fiscal year 1965–1966, fiscal year 1966–1967, fiscal year 1967–1968, calendar year 1969, and calendar year 1970. Hence, the second half of calendar year 1968 is not included. NHIS = National Health Interview Survey.

Appendix Table 6. Study Population Characteristics Before and After Medicare (Weighted) (*n* = 928 794)*

Characteristic	Before Medicare (1963/64–1965/66) (*n* = 407 651)	After Medicare (1966/67–1970) (*n* = 521 143)
Mean age (range), *y*	30.9 (0–85)	31.2 (0–85)
Female sex, %	48.5	48.2
Family size, %		
1 person	6.9	7.5
2 persons	17.2	18.0
3 persons	16.0	16.1
≥4 persons	59.8	58.4
Region, %		
Northeast	24.9	24.7
Midwest	28.3	28.0
South	30.6	30.6
West	16.2	16.6
Race, %		
White	88.2	87.8
Black	10.8	11.1
Other	1.0	1.1
Marital status, %		
Aged <17 y	35.3	34.1
Married	45.9	45.8
Unmarried/other	18.9	20.0
Education, %†		
<9 y	53.8	50.3
9–12 y	34.2	35.6
Any college	12.0	14.0
Income, %‡		
<$1000	4.0	1.8
$1000–$1999	7.1	3.9
$2000–$2999	7.6	5.6
$3000–$3999	8.8	6.3
$4000–$4999	10.1	6.5
$5000–$6999	21.7	20.2
$7000–$9999	21.6	22.6
$10 000–$14 999	13.4	21.4
≥$15 000	5.8	11.8
Employed, %		
Aged <17 y	35.3	34.1
Not working	28.3	28.1
Working	36.5	37.7

* Data are from the National Health Interview Survey. Before years are fiscal years 1963–1964, 1964–1965, and 1965–1966; after years are fiscal years 1966–1967 and 1967–1968 and calendar years 1969 and 1970. Fiscal year 1962–1963 is excluded from this table. Note that a similar population was analyzed by the authors in a separate unpublished study (Gaffney A, McCormick D, Bor D, et al. Do coverage expansions cause surges in the utilization of physician care? Evidence from the implementation of Medicare and the Affordable Care Act. Unpublished data.); characteristics of this population are also presented in the appendix of that unpublished manuscript and are the same for the "Before Medicare" group.
† Missing for 9367 persons.
‡ Missing for 48 322 persons.

Appendix Table 7. Hospital Use in the Early Postimplementation Period (Fiscal Years 1966/67 and 1967/68) and Late Postimplementation Period (1969–1970) Versus a Preimplementation Period (Fiscal Years 1963/64 and 1965/66) of Medicare/Medicaid (n = 928 794)*

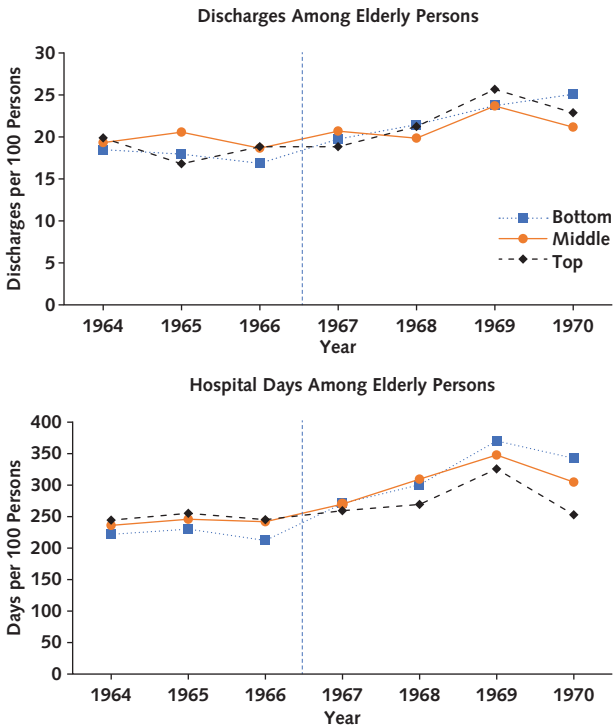
Population	Patients, *n*	Early Postimplementation Period (*n* = 273 102) vs. Preimplementation Period (*n* = 407 651) of Medicare/Medicaid							
		Unadjusted				Adjusted†			
		Before	After (Early Post)	Difference From Before (95% CI)	*P* Value‡	Before	After (Early Post)	Difference From Before (95% CI)	*P* Value
		Discharges per 100 Persons, *n*							
Overall	928 794	12.8	12.3	−0.5 (−0.8 to −0.2)	<0.001	12.6	12.4	−0.3 (−0.6 to 0.0)	0.066
By age§									
<65 y	843 930	12.2	11.4	−0.8 (−1.1 to −0.5)	<0.001	12.9	12.4	Reference	
≥65 y	84 864	18.3	20.3	2.0 (0.9 to 3.0)	<0.001	11.1	12.4	1.8 (1.00 to 2.6)	<0.001
By income									
Bottom tertile	307 249	13.2	13.2	0.0 (−0.6 to 0.6)	0.95	12.8	13.1	1.3 (0.5 to 2.1)	0.002
Middle tertile	297 487	12.9	12.5	−0.4 (−0.9 to 0.1)	0.089	13.2	12.8	0.6 (−0.1 to 1.3)	0.070
Top tertile	275 736	12.3	11.2	−1.1 (−1.5 to −0.6)	<0.001	12.3	11.3	Reference	
By income, among elderly persons§									
Bottom tertile	42 120	17.8	20.7	2.9 (1.3 to 4.5)	<0.001	17.0	19.9	1.9 (−1.3 to 5.2)	0.24
Middle tertile	19 979	19.5	20.3	0.8 (−1.5 to 3.1)	0.48	19.7	20.6	0.0 (−3.7 to 3.7)	1.00
Top tertile	16 182	18.5	19.9	1.4 (−1.4 to 4.1)	0.32	20.1	21.0	Reference	
By combined target status‖									
Targeted	349 993	13.9	14.1	0.1 (−0.4 to 0.7)	0.60	12.8	13.1	1.1 (0.4 to 1.8)	0.002
Nontargeted	537 062	12.2	11.3	−0.9 (−1.2 to −0.5)	<0.001	12.8	11.9	Reference	
		Days per 100 Persons, *n*							
Overall	928 794	104.9	107.1	2.2 (−2.3 to 6.7)	0.33	104.2	104.3	0.1 (−4.5 to 4.7)	0.97
By age§									
<65 y	843 930	92.1	88.7	−3.3 (−7.5 to 0.9)	0.121	101.8	99.6	Reference	
≥65 y	84 864	232.1	286.1	54.0 (30.6 to 77.4)	<0.001	104.5	132.4	30.1 (17.5 to 42.7)	<0.001
By income									
Bottom tertile	307 249	119.3	125.3	5.9 (−3.2 to 15.1)	0.20	116.0	113.9	4.2 (−7.2 to 15.7)	0.47
Middle tertile	297 487	95.8	100.4	4.6 (−1.4 to 10.6)	0.133	104.6	104.1	5.8 (−4.8 to 16.4)	0.28
Top tertile	275 736	97.8	92.9	−4.9 (−13.4 to 3.7)	0.27	96.1	89.8	Reference	
By income, among elderly persons§									
Bottom tertile	42 120	221.5	287.0	65.6 (34.5 to 96.6)	<0.001	208.6	273.1	31.3 (−30.3 to 93.0)	0.32
Middle tertile	19 979	241.2	288.1	46.9 (−7.1 to 100.9)	0.079	239.9	291.2	18.2 (−61.9 to 98.3)	0.66
Top tertile	16 182	248.2	263.6	15.4 (−28.1 to 58.8)	0.48	269.3	302.5	Reference	
By combined target status‖									
Targeted	349 993	134.3	145.5	11.3 (2.2 to 20.4)	0.015	114.4	116.2	6.6 (−2.8 to 16.0)	0.169
Nontargeted	537 062	86.6	84.2	−2.4 (−7.8 to 2.9)	0.37	97.8	93.1	Reference	

* Data are from the National Health Interview Survey. Preimplementation years are fiscal years 1963–1964, 1964–1965, and 1965–1966; early postimplementation years are fiscal years 1966–1967 and 1967–1968; and late postimplementation years are calendar years 1969 and 1970. Fiscal year 1962–1963 is excluded from all analyses in this table.
† Adjusted estimates and *P* values are for average marginal effects. Overall population models are adjusted for age, sex, family size, region, race, marital status, education, employment, income, and pre–post dummy variable; subpopulation models also include interaction terms. See Appendix Table 3 for details on covariate treatment and Note 2 of the Appendix for details on model specifications and number of observations in each adjusted analysis.
‡ Unadjusted *P* values are for pre–post implementation dummy variable coefficient; marginal effect *P* values are essentially identical.
§ Note that adjustment for covariates, particularly employment status, substantially attenuates the association of elderly age with hospital use, which is reflected in the large difference between unadjusted and adjusted mean discharges and days among the elderly. However, this is not evident in margins produced in analyses restricted to the elderly, as reflected in the small differences between unadjusted and adjusted mean use seen in the "by income, among elderly persons" groups.
‖ Combined targeted population includes elderly persons (aged >64 y) and those of any age with low income. Combined nontargeted population includes nonelderly, non–low-income individuals.

Appendix Table 7–Continued

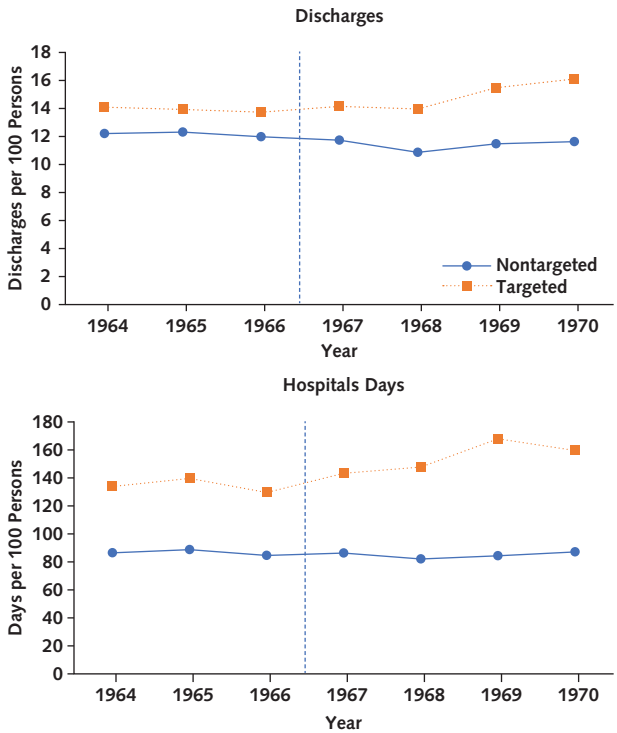
Late Postimplementation Period (n = 248 041) vs. Preimplementation Period (n = 407 651) of Medicare/Medicaid							
Unadjusted				Adjusted†			
Before	After (Late Post)	Difference (95% CI)	*P* Value‡	Before	After (Late Post)	Difference (95% CI)	*P* Value
Discharges per 100 Persons, *n*							
12.8	13.1	0.3 (0.0 to 0.6)	0.054	12.6	13.3	0.6 (0.3 to 1.0)	0.001
12.2	12.0	−0.2 (−0.6 to 0.1)	0.174	12.9	13.2	Reference	
18.3	23.7	5.4 (4.3 to 6.5)	<0.001	11.1	14.4	3.0 (2.1 to 3.9)	<0.001
13.2	14.7	1.5 (0.9 to 2.1)	<0.001	12.8	14.2	1.5 (0.6 to 2.4)	0.001
12.9	12.4	−0.5 (−1.0 to 0.0)	0.060	13.2	12.7	−0.4 (−1.1 to 0.4)	0.32
12.3	12.1	−0.2 (−0.7 to 0.3)	0.52	12.3	12.2	Reference	
17.8	24.4	6.6 (4.9 to 8.3)	<0.001	17.0	23.5	0.6 (−3.5 to 4.6)	0.79
19.5	22.4	2.9 (0.6 to 5.3)	0.014	19.7	22.4	−3.2 (−7.3 to 0.9)	0.124
18.5	24.2	5.7 (2.4 to 9.1)	0.001	20.1	26.0	Reference	
13.9	15.8	1.9 (1.3 to 2.5)	<0.001	12.8	14.3	2.0 (1.2 to 2.7)	<0.001
12.2	11.6	−0.6 (−1.0 to −0.2)	0.003	12.8	12.2	Reference	
Days per 100 Persons, *n*							
104.9	115.3	10.3 (6.2 to 14.5)	<0.001	104.2	112.1	7.9 (2.6 to 13.2)	0.004
92.1	92.5	0.5 (−4.0 to 4.9)	0.83	101.8	106.1	Reference	
232.1	332.4	100.2 (78.1 to 122.4)	<0.001	104.5	148.2	39.4 (26.5 to 52.2)	<0.001
119.3	142.3	23.0 (14.0 to 32.1)	<0.001	116.0	124.9	6.2 (−10.2 to 22.6)	0.46
95.8	99.9	4.1 (−3.8 to 12.1)	0.31	104.6	101.1	−6.1 (−19.2 to 7.0)	0.36
97.8	99.9	2.1 (−5.4 to 9.6)	0.57	96.1	98.8	Reference	
221.5	356.4	134.9 (98.5 to 171.3)	<0.001	208.6	333.4	83.6 (14.0 to 153.3)	0.019
241.2	325.8	84.5 (32.0 to 137.1)	0.001	239.9	320.8	39.7 (−40.5 to 119.8)	0.329
248.2	288.2	40.0 (−12.0 to 92.0)	0.124	269.3	310.5	Reference	
134.3	163.8	29.5 (20.9 to 38.1)	<0.001	114.4	126.7	13.7 (1.3 to 26.2)	0.031
86.6	85.8	−0.8 (−0.67 to 5.1)	0.78	97.8	96.4	Reference	

Appendix Figure 2. Hospital use per 100 persons before and after the 1966 expansion, by income tertile, among elderly adults (aged ≥65 y) (n = 78 281).



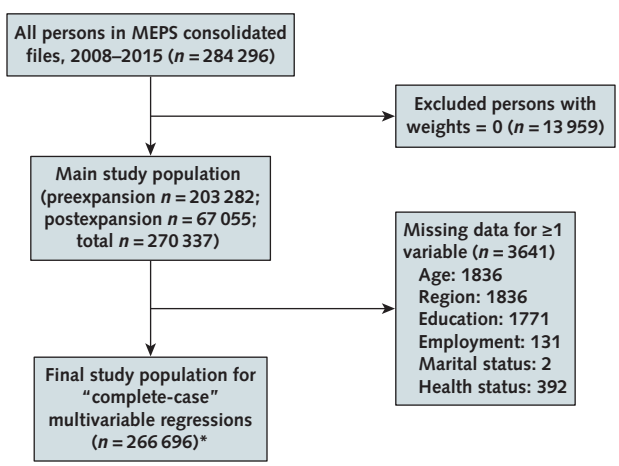
Dashed vertical lines indicate the date of the implementation of Medicare and Medicaid (July 1966). Fiscal year 1962–1963 and data for the second half of calendar year 1968 are excluded. Bottom income tertile: n = 42 120; middle income tertile: n = 19 979; top income tertile: n = 16 182.

Appendix Figure 3. Hospital use per 100 persons before and after the 1966 expansion, by income and age target status (n = 887 055).



Dashed vertical lines indicate the date of the implementation of Medicare and Medicaid (July 1966). Combined targeted population includes elderly persons (aged >64 y) and those of any age with low income. Combined nontargeted population includes nonelderly, non–low-income individuals. Nontargeted: n = 537 062; targeted: n = 349 993.

Appendix Figure 4. Flow chart of study population formation for the 2014 ACA expansion.



ACA = Patient Protection and Affordable Care Act; MEPS = Medical Expenditure Panel Survey.
* 2010–2016 "complete-case" sensitivity analysis: n = 201 338; 2012–2016 "complete-case" sensitivity analysis: n = 137 423.

Appendix Table 8. Study Population Characteristics Before and After ACA (Weighted) (n = 270 337)

Characteristic*	Before ACA (2008–2013) (n = 203 282)	After ACA (2014–2015) (n = 67 055)
Mean age (range), *y*	37.4 (0 to 85)	38.2 (0 to 85)
Female sex, %	51.0	51.1
Family size, %		
1 person	15.7	15.9
2 persons	26.1	26.0
3 persons	17.7	18.0
≥4 persons	40.5	40.1
Region, %		
Northeast	17.9	17.6
Midwest	21.6	21.2
South	37.1	37.5
West	23.5	23.7
Race, %		
Hispanic	16.6	17.6
White	63.9	60.7
Black	12.1	12.3
Other/multiple	7.4	9.4
Marital status, %		
Aged <16 y	21.0	20.2
Married	40.2	40.4
Unmarried	38.8	39.4
Education, %		
Less than high school	35.6	33.8
High school	40.2	43.6
College	13.7	14.0
Postgraduate	10.5	8.6
Mean family income (range), $†	73 100 (−262 700 to 614 400)	75 700 (−134 700 to 543 400)
Employment status, %		
Aged <16 y	21.9	21.0
Employed	50.5	51.9
Unemployed	27.7	27.2
Health status, %		
Good/better	89.2	89.3
Fair/poor	10.8	10.7

ACA = Patient Protection and Affordable Care Act.
* Missing data: age, n = 1836; region, n = 1836; education, n = 1771; employment, n = 131; marital status, n = 2; and health status, n = 392. Family size excludes 9671 individuals in families no longer characterized as part of the noninstitutionalized, civilian population at end of year. See Appendix Table 4 for details on variable treatment.
† Adjusted for inflation using 2015 Consumer Price Index.

Appendix Table 9. Hospital Use Comparing a 4-Year Preimplementation Period (2010–2013) With a Postimplementation Period (2014–2015) of the ACA (n = 204 155)

Population	Unadjusted (n = 204 155)					Adjusted (n = 201 338)*				
	Patients, n	Pre (n = 137 100)	Post (n = 67 055)	Difference (95% CI)	P Value†	Patients, n	Pre (n = 135 123)	Post (n = 66 215)	Difference (95% CI)	P Value
		Discharges per 100 Persons, n					Discharges per 100 Persons, n			
Overall population	204 155	9.4	9.0	−0.4 (−1.0 to 0.3)	0.24	201 338	9.1	8.5	−0.7 (−1.6 to 0.2)	0.140
Health status										
Good/better	179 844	6.4	5.8	−0.6 (−1.0 to −0.2)	0.007	178 089	6.7	6.0	Reference	
Fair/poor	24 003	33.4	35.0	1.5 (−2.3 to 5.4)	0.42	23 249	22.1	22.6	1.2 (−1.4 to 3.8)	0.36
Target population or status										
≤138% FPL‡	34 447	13.2	12.8	−0.4 (−2.0 to 1.1)	0.58	34 044	11.9	11.5	−0.3 (−1.7 to 1.1)	0.68
≤250% FPL§	62 559	10.9	10.3	−0.7 (−1.7 to 0.4)	0.25	61 862	10.6	10.0	−0.4 (−1.4 to 0.6)	0.45
≤400% FPL‖	87 487	9.7	8.8	−0.8 (−1.7 to 0.0)	0.056	86 578	9.9	8.9	−0.6 (−1.5 to 0.3)	0.21
Nontargeted¶	115 311	8.5	8.4	−0.1 (−0.8 to 0.7)	0.84	114 760	8.7	8.2	Reference	
		Days per 100 Persons, n					Days per 100 Persons, n			
Overall population	204 155	48.6	46.0	−2.6 (−8.1 to 3.0)	0.36	201 338	47.6	41.4	−6.2 (−16.0 to 3.6)	0.21
Health status										
Good/better	179 844	26.4	23.4	−3.0 (−6.2 to 0.2)	0.066	178 089	26.8	23.1	Reference	
Fair/poor	24 003	222.8	227.8	4.9 (−35.1 to 44.9)	0.81	23 249	145.9	135.7	−6.5 (−47.1 to 34.2)	0.75
Target population or status										
≤138% FPL‡	34 447	64.6	72.1	7.5 (−6.9 to 22.0)	0.29	34 044	62.1	68.1	10.7 (−4.7 to 26.1)	0.172
≤250% FPL§	62 559	51.3	53.1	1.8 (−6.4 to 10.0)	0.66	61 862	56.0	56.1	5.2 (−4.9 to 15.3)	0.31
≤400% FPL‖	87 487	44.2	42.6	−1.6 (−8.0 to 4.9)	0.64	86 578	52.5	47.8	1.1 (−8.4 to 10.6)	0.82
Nontargeted¶	115 311	43.5	40.4	−3.2 (−8.9 to 2.6)	0.28	114 760	44.2	38.3	Reference	

ACA = Patient Protection and Affordable Care Act; FPL = federal poverty level.

* Adjusted results are average marginal effects of ACA implementation dummy variable or implementation dummy * target population status indicator interaction variable. Overall models are adjusted for age, sex, race, region, family size, education, employment, marital status, family income, health status, and pre–post dummy. "Health status" models are adjusted for age, sex, race, region, family size, education, employment, marital status, family income, health status, year, pre–post ACA dummy variable, and a health status * pre–post interaction term. Target population models are adjusted for age, sex, race, region, family size, education, employment, marital status, health status, year, pre–post dummy, 1 of 3 ACA target population indicator variables, and an ACA target population status * pre–post interaction term (see Appendix Table 4 for details on covariate treatment and Note 3 of the Appendix for model specification and n for each adjusted analysis).

† Unadjusted P values are for the coefficient of ACA implementation dummy variable; marginal effect P values are essentially identical.

‡ ACA 138% target population includes adults aged 18–64 y with family income ≤138% of FPL.

§ ACA 250% target population includes adults aged 18–64 y with family income ≤250% of FPL.

‖ ACA 400% target population includes adults aged 18–64 y with family income ≤400% of FPL.

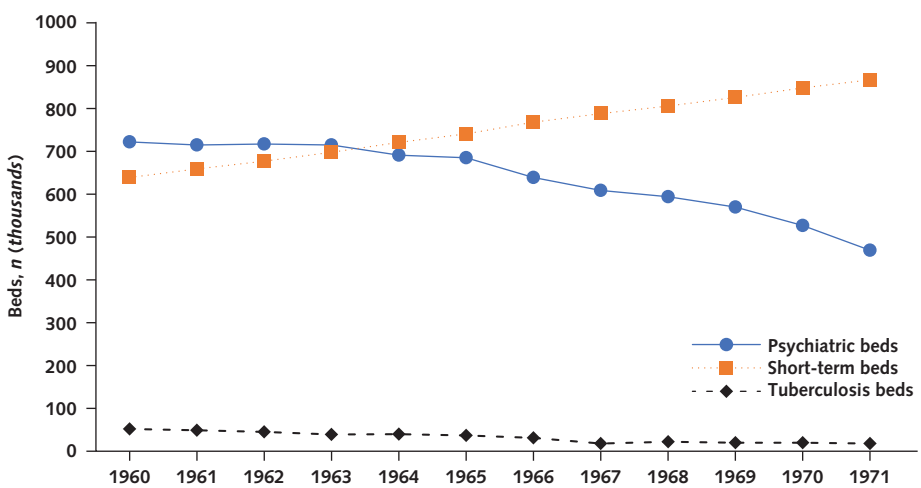
¶ Includes those aged <18 or >64 y and those of any age with family income >400% FPL. Note that adjusted means for the nontargeted population presented here are from adjusted regressions comparing this group with the ≤400% FPL target population (n = 201 338). Adjusted means for this group produced by the other 2 regressions (i.e., ≤138% FPL vs. nontargeted and ≤250% FPL vs. nontargeted) are similar.

Appendix Table 10. Hospital Use Sensitivity Analysis Comparing a 2-Year Preimplementation Period (2012–2013) With a Postimplementation Period (2014–2015) of the ACA (n = 139 305)

Population	Unadjusted (n = 139 305)					Adjusted (n = 137 423)*				
	Patients, n	Pre (n = 72 250)	Post (n = 67 055)	Difference (95% CI)	P Value†	Patients, n	Pre (n = 71 208)	Post (n = 66 215)	Difference (95% CI)	P Value
		Discharges per 100 Persons, n					Discharges per 100 Persons, n			
Overall population	139 305	9.4	9.0	−0.4 (−1.1 to 0.3)	0.24	137 423	9.4	8.4	−1.0 (−2.1 to 0.2)	0.093
Health status										
Good/better	122 415	6.5	5.8	−0.7 (−1.2 to −0.2)	0.006	121 235	6.9	5.9	Reference	
Fair/poor	16 694	32.6	35.0	2.4 (−1.6 to 6.4)	0.24	16 188	22.0	22.4	1.4 (−1.5 to 4.2)	0.34
Target population or status										
≤138% FPL‡	23 649	13.4	12.8	−0.6 (−2.4 to 1.2)	0.53	23 376	12.3	11.4	−0.6 (−2.2 to 1.1)	0.52
≤250% FPL§	43 014	11.1	10.3	−0.8 (−2.0 to 0.4)	0.192	42 540	11.0	10.0	−0.7 (−2.0 to 0.5)	0.25
≤400% FPL‖	59 794	10.0	8.8	−1.1 (−2.0 to −0.2)	0.024	59 179	10.5	8.9	−1.1 (−2.2 to 0.1)	0.069
Nontargeted¶	78 617	8.4	8.4	0.1 (−0.8 to 0.9)	0.89	78 244	8.7	8.1	Reference	
		Days per 100 Persons, n					Days per 100 Persons, n			
Overall population	139 305	47.2	46.0	−1.2 (−7.8 to 5.3)	0.71	137 423	46.8	42.8	−4.0 (−16.5 to 8.5)	0.53
Health status										
Good/better	122 415	26.5	23.4	−3.1 (−7.1 to 0.8)	0.118	121 235	26.3	23.7	Reference	
Fair/poor	16 694	205.6	227.8	22.1 (−23.0 to 67.2)	0.33	16 188	139.5	141.0	4.0 (−47.8 to 55.9)	0.88
Target population or status										
≤138% FPL‡	23 649	64.8	72.1	7.3 (−7.4 to 22.0)	0.32	23 376	65.7	71.4	10.4 (−5.9 to 26.7)	0.21
≤250% FPL§	43 014	50.4	53.1	2.6 (−5.8 to 11.0)	0.54	42 540	60.5	58.2	3.0 (−8.6 to 14.5)	0.61
≤400% FPL‖	59 794	44.2	42.6	−1.6 (−8.4 to 5.2)	0.65	59 179	56.9	51.1	−2.5 (−13.3 to 8.2)	0.64
Nontargeted¶	78 617	41.4	40.4	−1.1 (−8.0 to 5.8)	0.76	78 244	41.9	38.7	Reference	

ACA = Patient Protection and Affordable Care Act; FPL = federal poverty level.
* Adjusted results are average marginal effects of ACA implementation dummy variable or implementation dummy * target population status indicator interaction variable. Overall models are adjusted for age, sex, race, region, family size, education, employment, marital status, family income, health status, and pre-post dummy. "Health status" models are adjusted for age, sex, race, region, family size, education, employment, marital status, family income, health status, year, pre-post ACA dummy variable, and a health status * pre-post interaction term. Target population models are adjusted for age, sex, race, region, family size, education, employment, marital status, health status, year, pre-post dummy, 1 of 3 ACA target population indicator variables, and an ACA target population status * pre-post interaction term (see Appendix Table 4 for details on covariate treatment and Note 3 of the Appendix for model specification and n for each adjusted analysis.
† Unadjusted P values are for the coefficient of ACA implementation dummy variable; marginal effect P values are essentially identical.
‡ ACA 138% target population includes adults aged 18–64 y with family income ≤138% of FPL.
§ ACA 250% target population includes adults aged 18–64 y with family income ≤250% of FPL.
‖ ACA 400% target population includes adults aged 18–64 y with family income ≤400% of FPL.
¶ Includes those aged <18 or >64 y, and those any age with family income >400% FPL. Note that adjusted means for the nontargeted population presented here are from adjusted regressions comparing this group to the ≤400% FPL target population (n = 137 423). Adjusted means for this group produced by the other 2 regressions (i.e., ≤138% FPL vs. nontargeted and ≤250% FPL vs. nontargeted) are similar.

Appendix Figure 5. Hospital bed supply, 1960–1971.



Short-term beds refer to nonfederal, short-term general, and other special-community beds. Data from reference 11.

Appendix Table 11. Total Population for Adjusted Analyses, 2014 Coverage Expansion

Target Population	Nontargeted Population (Reference)	Total Population for Adjusted Analyses, *n*		
		Main Analysis (2008–2015)	Sensitivity Analysis (2010–2015)	Sensitivity Analysis (2012–2015)
Income ≤138% FPL *and* Age ≥18 and <65 y	Income >400% FPL *or* Age <18 or ≥65 y	197 025	148 804	101 620
Income ≤250% FPL *and* Age ≥18 and <65 y	Income >400% FPL *or* Age <18 or ≥65 y	233 725	176 622	120 784
Income ≤400% FPL *and* Age ≥18 and <65 y	Income >400% FPL *or* Age <18 or ≥65 y	266 696	201 338	137 423

FPL = federal poverty level.

Web-Only References

47. **National Health Interview Survey.** Tabulating data for fiscal year 1966 NHIS current estimates tables - examples. 2008. Accessed at ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/1966/1966_fiscal_CE_tables_tabulation_examples.pdf on 21 June 2018.

48. **U.S. Census Bureau.** Historical poverty tables: people and families - 1959 to 2016. 2018. Accessed at www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-people.html on 8 August 2018.

49. **National Center for Health Statistics.** 2000 National Health Interview Survey (NHIS) Public Use Data Release: NHIS Survey Description. 2002. Accessed at ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/1968 on 29 May 2019.