The Effect of Massachusetts Health Care Reform on Racial and Ethnic Disparities in Hospitalizations for Ambulatory Care-Sensitive Conditions: A Retrospective Analysis of Hospital Episode Statistics

<table>
<thead>
<tr>
<th>Journal:</th>
<th>BMJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuscript ID:</td>
<td>BMJ.2014.022293</td>
</tr>
<tr>
<td>Article Type:</td>
<td>Research</td>
</tr>
<tr>
<td>BMJ Journal:</td>
<td>BMJ</td>
</tr>
<tr>
<td>Date Submitted by the Author:</td>
<td>03-Sep-2014</td>
</tr>
<tr>
<td>Complete List of Authors:</td>
<td>McCormick, Danny; Cambridge Health Alliance, Medicine; Harvard Medical School, Hanchate, Amresh; Boston University School of Medicine, General Internal Medicine Lasser, Karen; Boston Medical Center, Manze, Meredith; City University of New York, School of Public Health</td>
</tr>
<tr>
<td>Keywords:</td>
<td>Health Reform, Access to Care, Racial and ethnic disparities, preventable hospitalizations</td>
</tr>
</tbody>
</table>

Note: The following files were submitted by the author for peer review, but cannot be converted to PDF. You must view these files (e.g. movies) online.

What is already known-Box Final.docm
The Effect of Massachusetts Health Care Reform on Racial and Ethnic Disparities in Hospitalizations for Ambulatory Care-Sensitive Conditions: A Retrospective Analysis of Hospital Episode Statistics

Danny McCormick, MD MPH, Associate Professor of Medicine
Amresh D. Hanchate, PhD, Assistant Professor of Medicine
Karen E. Lasser, MD MPH, Associate Professor of Medicine
Meredith G. Manze, PhD MPH, Visiting Assistant Professor
Mengyun Lin, MA, Data Analyst
Chieh Chu, MA, Data Analyst
Nancy R. Kressin, PhD Professor of Medicine, Senior Veterans Affairs Health Services Research and Development Research Career Scientist

1. Harvard Medical School, Department of Medicine. Cambridge Health Alliance, 1493 Cambridge, MA, 02139, USA
2. Veterans Affairs Boston Healthcare System, Boston, MA 02130, USA
3. Section of General Internal Medicine, Boston University School of Medicine, Boston, MA 02118

Word count
Text: 4,256
Abstract: 300
Corresponding Author: Danny McCormick, MD, MPH, Harvard Medical School, Department of Medicine, Cambridge Health Alliance, Cambridge MA, 02139: (617) 665-1032, Fax: (617), email: danny_mccormick@hms.harvard.edu
Abstract

Objectives To examine the impact of Massachusetts health care reform on changes in hospitalization rates for ambulatory care sensitive conditions (ACSCs) – those potentially preventable with good access to outpatient medical care - and racial and ethnic disparities in such rates, using complete inpatient discharge data (hospital episode statistics) from Massachusetts and three control states.

Design Difference-in-differences analysis to identify the change, overall and according to race/ethnicity, adjusted for secular changes unrelated to reform.

Setting US hospitals in Massachusetts, New York, New Jersey and Pennsylvania.

Participants Adults aged 18-64 (those most likely to have been affected by the reform) admitted for any of 13 ACSCs in the 21 months preceding and following the period of reform implementation (July 2006 to December 2007).

Main outcome measures Admission rates for a composite of all 13 ACSCs, and composites of acute and chronic ACSCs.

Results After adjustment for known confounders, including age, race and ethnicity, sex, income and county unemployment rate, we found no evidence of a change in the overall composite ACSC admission rate (0.1%, 95% Confidence Interval [CI], -2.3 to 2.6) or of composites of acute and chronic ACSCs; nor did we find a change in black-white (-4.45%, 95% CI, -10.8 to 2.3) or Hispanic-white (1.0%, 95% CI, -6.4 to 8.9) disparities in overall composite ACSC admission rates that existed in Massachusetts prior to reform. In analyses limited to Massachusetts only, we found no evidence of a change in overall composite ACSC admission rate between counties with higher and lower baseline uninsurance rates (1.5%, 95% CI, -2.2 to 5.2).
**Conclusions** Our findings do not suggest that Massachusetts reform significantly lowered overall or racial and ethnic disparities in hospitalization rates for ACSCs. In the United States, and Massachusetts in particular, additional efforts may be needed to improve access to outpatient care and preventable hospitalizations.
INTRODUCTION

In 2006, the state of Massachusetts enacted a health care reform law that served as the template for the 2010 national health reform law in the United States, the Patient Protection and Affordable Care Act (ACA). The Massachusetts reform was designed to achieve “near-universal” coverage, to improve access to care, and to decrease racial and ethnic disparities in both coverage and access\(^1,2\) that characterize the United States health care system\(^3\). In addition to extending coverage to the lowest income individuals--disproportionately comprised of racial and ethnic minorities--the Massachusetts reform made reducing disparities an explicit goal of its Health Care Quality and Cost Council.\(^4\) It also established a Health Disparities Council tasked with monitoring and making recommendations regarding racial and ethnic disparities in access to high quality care and health outcomes.\(^5\) According to data from the US Census Bureau, the percentage of uninsured non-elderly Massachusetts residents fell from approximately 12% in the pre-reform period (2004-2006) to approximately 6% in the post reform period (2008-2009),\(^6\), with larger declines among racial and ethnic minorities and lower income individuals.\(^7\) Prior studies on the impact of this expansion on access to care have predominantly come from population based survey data with most showing modest population-wide improvements in access to outpatient care such as inability to see a physician due to cost\(^6,8,10\) and receipt of some\(^6,11,12\) outpatient services but little evidence of improvement in disparities after reform.\(^9,10,12,13\) Studies based on survey data, however, rely on respondent self-report and are therefore potentially subject to recall, cognitive and non-response biases\(^14\). Few studies have used objective data to examine access\(^6,15-17\) and only one\(^6\) examined a well-established
measure of access to outpatient care – rates of hospitalization for ambulatory care sensitive conditions (ACSCs)\textsuperscript{18,19}, those that are preventable with good access to outpatient care. That study demonstrated mixed results overall: no change was noted in the number of admissions for ACSCs in the primary analysis but after adjustment for measures of inpatient severity of illness, a 2.7 percentage point decline was noted\textsuperscript{6}. However, that study examined a fraction (20\%) of admissions in Massachusetts that occurred in only a subset of Massachusetts hospitals (48 out of 70), potentially leading to both non-representativeness of the study sample and selection bias if insurance obtained under the reform led to a change in hospitals to which patients were admitted. In addition, that study did not examine racial and ethnic disparities in preventable hospitalizations.

The landmark Massachusetts health reform law expanded insurance coverage in three ways. First, it included an “individual mandate” that requires most Massachusetts adults who can afford health insurance to have coverage or pay a tax-penalty of up to $1272 per year (in 2013)\textsuperscript{20}, depending on an individual’s income, age, and family size. Second, the reform expanded publicly sponsored coverage through an extension of Medicaid (health insurance for Massachusetts residents with the lowest income) to previously ineligible residents, and the creation of Commonwealth Care, a publicly subsidized plan for residents with incomes below 300\% of the U.S. federal poverty level ($23,550 per year for a family of four in 2013)\textsuperscript{21}. Finally, the law created a health insurance exchange (the Massachusetts Health Connector)\textsuperscript{22} offering both subsidized plans (Commonwealth Care) and unsubsidized private plans (Commonwealth Choice) at lower cost than was available before the reform. All health insurance products
available through the Connector were required to offer benefit packages that met standards for “minimal creditable coverage,” and included preventive and primary care, emergency services, hospital stays, outpatient services, prescription drugs, and mental health services. Patterned closely on the Massachusetts reform, the ACA also includes an individual mandate, a Medicaid expansion and publicly subsidized plans available for purchase through state based health benefit exchanges for those who do not qualify for Medicaid. The ACA requires that health insurance covers a range of services comparable to those covered by Massachusetts reform, but offers subsidized plans for those with incomes up to 400% of the federal poverty levels rather than up to 300% under the Massachusetts reform.

Understanding whether Massachusetts’ coverage expansion translated into actual improvements in access to outpatient care for racial and ethnic minorities and for the overall state population could help inform health reform in Massachusetts, the current roll-out of national health care reform under the ACA, and similar health reforms that may be implemented in other countries in the future. In order to examine changes in access using objective data and to overcome potential limitations of prior studies, we assessed the impact of Massachusetts health care reform on rates of preventable hospitalizations (for ACSCs) using complete hospitalization data. We employed a quasi-experimental design to compare longitudinal changes (pre- to post- reform) in hospital admission rates for ACSCs in Massachusetts with concurrent trends in three control states not undergoing health care reform. We examined these ACSC changes for the Massachusetts population as a whole as well as among racial and ethnic subgroups. Finally, we evaluated whether the Massachusetts insurance expansion had differential
effects related to the geographically varying baseline uninsurance rates within Massachusetts.
METHODS

General Approach

Comprehensive state-wide data on objective measures of access to outpatient medical care are not available due to the lack of all-payer state outpatient utilization databases spanning the reform period. Since comprehensive statewide data are available on all hospitalizations, we examined changes in hospitalization rates for ACSCs, a well-validated and widely used method to indirectly evaluate changes in access to outpatient care, particularly in relation to health insurance and racial and ethnic disparities. The Agency for Healthcare Research and Quality (AHRQ) has defined and the National Quality Forum has endorsed a set of ACSCs to be used for this purpose, which we use here.

Data Sources and Population

We obtained patient-level data on all hospital admissions to non-federal acute care hospitals occurring in Massachusetts and three control states: New York (NY), New Jersey (NJ) and Pennsylvania (PA), from 2004-2009, obtained directly from the relevant state agency. These data include information on patient age, race and ethnicity, sex, insurance type, diagnosis (International Classification of Diseases-Ninth Edition diagnostic codes) and dates of hospital admission. We used US Census Bureau data to assess community characteristics and obtained county-level population estimates according to age, sex and race and ethnicity and zip-code median income. The Area Resource File was used to obtain data on county unemployment rates.
To compare ACSC admission rates in counties with the highest baseline uninsured rate (greatest potential for insurance gains post-reform) to those with the lowest baseline uninsured rates (lowest potential for insurance gains post-reform), we obtained county-level insurance rates from the US Census Bureau’s Small Area Health Insurance Estimates (SAHIE)\textsuperscript{37}.

We included patients with a hospitalization for any one of 13 adult ACSCs as the admitting diagnosis, identified using the AHRQ’s Prevention Quality Indicators criteria\textsuperscript{38} and who were age 18-64, as nearly all residents of the US age 65 and older are and were, prior to the reform, covered by government insurance (Medicare).

**Study Variables**

Our outcomes were three composite measures of ACSCs defined by AHRQ: acute composite ACSCs (dehydration, urinary tract infection and bacterial pneumonia), chronic composite ACSCs (diabetes, diabetes complications, chronic obstructive lung disease, hypertension, heart failure, and angina) and overall composite ACSCs (acute and chronic measures combined). See Table 1 for a list of all individual and composite ACSC definitions. Hospitalization rates were calculated per 100,000 population per year and per quarter in the county of patient residence, overall and for racial and ethnic sub-groups.

The primary independent variables were time (whether the admission occurred in the pre- vs. post- reform period), state (Massachusetts vs. control states) and the interaction between these two variables (to obtain a difference-in-differences estimate of
the net percent change, i.e., the excess post-reform change in Massachusetts over that in the control states). See below for additional detail on this approach. Massachusetts' reform implementation began 7/1/2006 with Medicaid expansion to cover eligible low-income individuals, and ended with a tax penalty-enforced mandate to acquire insurance coverage 1/1/2008\(^\text{39}\). Thus, we considered the pre-reform period to be the 21 months (10/1/2004 to 6/30/2006) prior to reform and the post-reform period to be 21 months (1/1/2008 to 9/30/2009) following full implementation.

Covariates included patient race and ethnicity, categorized as Hispanic, non-Hispanic white (subsequently referred to as “white”), non-Hispanic black (subsequently referred to as “black”) and “other,” age, categorized as 18-39, 40-49, 50-59 and 60-64, sex, and quarter of the year. County-level variables were categorized in the following manner: low/medium income (lowest two tertiles) vs. high income (highest tertile) based on county median income, unemployment rate (lowest two tertiles vs. highest tertile).

**Analytic Data Structure:**

To estimate pre- and post-reform hospital admission rates, we produced an analytic dataset by stratifying the state population into cohorts according to race and ethnicity, age, sex, state (Massachusetts vs. control), time period (pre-reform vs. post-reform) and quarter of the year. To adjust for geographic heterogeneity (within states) in factors determining admission rates, we further stratified each state into counties, as this is the finest sub-state level for which annual census population counts were available.\(^\text{35}\) With each county stratified into cohorts, there were a total of 6,272
observations for the pre- and post-reform periods in Massachusetts combined and 67,200 observations for the pre- and post-reform periods in control states.

Analysis:

We used a naturally occurring quasi-experimental design, treating Massachusetts as the exposed group and states without health reform as the control group. We first calculated admission rates over time as the moving averages of four quarters to smooth out seasonal variation in visual representations of data. We then estimated pre- and post-reform admission rates for the acute, chronic and overall composite measures. We adjusted these rates for compositional differences in sex and age by direct standardization. We then estimated the unadjusted percent change in admission rates following reform by subtracting the change in rates among control states from that observed in Massachusetts. We then used a difference-in-difference approach to estimate the adjusted percent change in ACSC admission rates in Massachusetts by accounting for contemporaneous changes in admission rates in control states and all other covariates, in multivariate models. This method allows for comparison of two groups (exposed and unexposed) over time, and when used in a regression framework, can adjust for confounders while controlling for unobserved individual differences and for common trends. We used Poisson regression models with ACSC admission count as the outcome measure and census population count as the population at risk.
In addition, to examine racial and ethnic disparities in ACSCs, we conducted a “difference-in-difference-in-differences” analysis using the same modeling approach and covariates to estimate whether admission rates for ACSCs had changed for black or Hispanic relative to white residents in Massachusetts for each composite outcome measure.

We also compared changes in ACSC rates in the seven counties that had the lowest with the seven counties that had the highest pre-reform uninsurance rates and thus potentials for gains in insurance as a result of the reform (Appendix Exhibit 2). As expected, when grouped by actual gains in insurance coverage post-reform, this resulted in the same two groups. We used a difference-in-differences approach employing Poisson regression models identical to those described above except that rather than conducting comparisons with control states, we compared two groups of counties with the highest and lowest potential for gains in insurance within Massachusetts.

We performed two sensitivity analyses. To determine whether our results were sensitive to the length of time of observation in the pre and post-reform periods, we repeated our analysis including only the 12 months directly preceding and following reform implementation, rather than 21 months. Then, to assess the robustness of our results to selection of control states, models were re-estimated excluding one control state at a time.
Statistical significance was assessed at the level of $p<0.05$ (two-tailed) and all estimations were performed using SAS software, version 9.2. This study was approved by the Boston University Medical Campus Institutional Review Board.
RESULTS

Patient Sample

We studied 894,292 hospitalizations for ACSCs, 102,739 in Massachusetts and 791,553 in control states. Prior to reform, patients admitted in control states were more likely to be black or “other” race or ethnicity and to reside in counties with lower median incomes (Table 2).

Preventable Hospitalization Rates

Figure 1 shows plots of age- and sex-standardized rates (Panel A) and moving 4-quarter averages for the overall composite ACSC hospital admission rate, smoothed for seasonal variation (Panel B). These plots demonstrate that rates were higher in control states than in Massachusetts but that little change occurred over the entire study period for either.

Age- and sex-standardized rates for the overall composite ACSC hospitalization measure declined slightly in Massachusetts (-2.1%) but did so to a greater degree in control states (-3.5%; Table 3). Difference-in-difference analyses for the overall composite measure found no evidence of a significant change in Massachusetts hospital admission rates versus control states in either unadjusted analyses or those including adjustment for changes in hospital admission rates in control states and multiple individual and county-level baseline patient characteristics (+0.1%, 95% Confidence Interval [CI], -2.3 to 2.6). We obtained similar findings for both the acute composite and chronic composite ACSC measures.
Preventable Hospitalization Rates by Race and Ethnicity

Point estimates for pre-reform hospital admission rates/100,000 for the overall composite ACSC hospitalization measure varied by race and ethnicity in both Massachusetts and control states. For example, in pre-reform Massachusetts, the admission rate/100,000 for whites was 667, for Hispanic people was 1,258 and for black people was 1,713 (Table 3). However, in multivariate analyses we found no evidence from our difference-in-difference-in-differences analysis of a change in white-black (-4.5%, 95%CI, -10.8 to 2.3) or white-Hispanic (1.0%, 95% CI, -6.4 to 8.9) disparities in the overall composite ACSC admission rate following reform. Similarly, for the acute and chronic measures, we found no evidence of significant changes in white-black and white-Hispanic disparities that had existed prior to reform in Massachusetts.

The pre-reform overall composite preventable hospitalization rate was higher for older, female patients, those with lower incomes or living in counties with higher unemployment levels (data not shown). However, no statistically significant changes in admission rates were observed for any patient subgroup (data not shown).

We also found no evidence that the overall composite ACSC hospitalization rate in Massachusetts counties having the greatest potential (and actual) gains in coverage was different from those having the lowest potential (and actual) gains, in multivariate analyses (1.5%, 95% CI, -2.2 to 5.2; where a point estimate above 1 indicates a higher post reform admission rate in Massachusetts counties with greater gains in insurance
coverage), as shown in Table 5. Again, similar results were obtained for the acute and chronic measures.

Sensitivity analyses demonstrated that neither redefining the pre-and post-reform periods as 12 rather than 21 months nor excluding each control state individually from the analysis changed the difference-in-difference estimates.
DISCUSSION

Using complete inpatient hospital records data we found no evidence that hospital admission rates for ACSCs changed in Massachusetts following implementation of health care reform, in comparison with states not undergoing health care reform. We also found no evidence that admission rates for ACSCs declined to a greater degree in Massachusetts counties with the highest baseline uninsurance rates (and largest post-reform gains in insurance) compared with those with the lowest baseline uninsurance rates (and smallest post-reform gains). Lastly, we failed to find evidence of a statistically significant narrowing of pre-existing racial and ethnic disparities in this outcome (white-black or white-Hispanic) in comparison with control states. Admission rates for ACSCs are indicative of access to outpatient care \(18,19,26-29,34,43\). Hence, our results using this measure do not suggest that overall access to outpatient care, or racial and ethnic disparities in access to such care, improved to a significant degree following implementation of Massachusetts health care reform.

Limitations and Strengths

Several limitations of this study should be noted. First, while assessment of rates of hospital admissions for ACSCs is a well-validated method of assessing changes in access to care, they do so indirectly; we were not able to assess actual outpatient utilization or patient experiences of access to care. Second, control states in our analyses had lower baseline insurance rates, larger minority populations and a lower median income than in Massachusetts. While we controlled for multiple variables by which Massachusetts and control states differed, including population demographics
and measures of economic conditions (county-level income and unemployment rates), we could not control for other potential unmeasured factors that could have influenced our results. In addition, in order to assess the impact of the reform on racial and ethnic disparities in access, a key objective of our study, it was necessary to use comparator states that have sizable minority populations. Hence, we selected three control states in the northeast US, identical to control states used in prior work on Massachusetts health reform\textsuperscript{11,15,44}, that balance geographic proximity to Massachusetts with adequacy of the size of minority populations. The fact that sequential individual elimination of each control state had no impact on the results suggests that our findings were not simply due to the particular control states selected. A third limitation is a potential lack of generalizability; Massachusetts’s pre-reform insured rate was slightly higher than most other states (1.1 percentage points higher than the median US state rate\textsuperscript{6}) and thus there was less room for improvement than in some other states. However, the six percentage point gain in insurance following Massachusetts reform is only slightly lower than the average expected gain in insurance of 7.1\%\textsuperscript{45} nationally under the ACA. Massachusetts also has a larger ratio of physicians to state residents than other states, which could suggest better access to care before and after reform, with uncertain effects on the magnitude of access improvement. Thus, our results may only be generalizable to states similar to Massachusetts. Lastly, while we found no evidence of a change in ACSC admission rates or disparities therein, we cannot rule out small, but potentially meaningful reductions. The lower bound of the 95\% CIs for our composite overall ACSC measure is compatible with an overall reduction of 2.3 percentage points, and black-white and Hispanic-white reductions of 10.8 and 6.4 percentage points.
respectively. Several strengths of our study should also be noted. First, our study relied on an objectively measured outcome and was therefore not subject to potential biases due to patient recall or cognitive factors that could have influenced patient responses in survey studies that comprise most of the evidence base on the impact of the Massachusetts reform on access to care. Second, our study did not rely on statistical sampling during the study period—we used the universe of every hospital admission occurring in Massachusetts and control states during this time. Therefore, concerns about potential non-representative sampling that can lead to poor generalizability do not apply. Lastly, our study is the first of which we are aware to examine the impact of the reform on racial and ethnic disparities in preventable hospitalizations.

Comparison with Other Studies

Most of what is known about the Massachusetts reform’s impact on access to care comes from population-based surveys which have found small to moderate population-wide improvements in measures of access to care, such as having a personal physician (1.3-6.6 percentage point improvement)\(^6,8,12\), inability to see a physician due to cost (1.5- 3.1 percentage point improvement)\(^6,8-10\), and out-of-pocket medical spending at 10% or more of family income (3.7 percentage point improvement)\(^46\). Some studies have also found increases in utilization of appropriate outpatient care such as receiving a flu shot (1.6 to 3.0 percentage point improvement)\(^6,11\) and screening colonoscopy (5.5 percentage point improvement)\(^12\). For other services, such as cholesterol checks\(^6,12\) and PAP smears\(^9,12\), evidence is conflicting, and for others, such as mammography, no improvements were
demonstrated.\textsuperscript{9,12,47} In contrast, most of the few of these studies that examined racial and ethnic disparities in access failed to find a narrowing post-reform, similar to our results. One prior study found greater improvements in having a personal physician for Hispanic compared with white residents (although among Spanish speaking only individuals, this outcome substantially worsened following reform)\textsuperscript{13} while two other studies found no improvement in racial and ethnic disparities in this outcome.\textsuperscript{10,12} Still other studies found no change in racial and ethnic disparities in being unable to see a physician due to cost \textsuperscript{9,10,12} or receipt of preventive services.\textsuperscript{12} Self-reported outcomes, however, are subject to potential biases that could have influenced survey responses. For example, it is possible that simply having insurance coverage provided a sense of well-being and security that positively influenced answers to subjective questions in the absence of objective changes in health or access to care, as was noted in a recent randomized expansion of Medicaid in the state of Oregon in the US\textsuperscript{48,49}. Even small effects due to this could explain much of the modest effect sizes noted in these prior studies. The few studies using objective data to examine overall changes in access to care reveal a mixed picture. For example, emergency department use declined following reform according to one study\textsuperscript{50}, but increased according to another.\textsuperscript{17} The only prior study of preventable hospitalizations showed a post-reform decline in ACSC admission rates only after adjustment for measures of severity of illness (predominantly the numbers of co-morbidities and inpatient diagnoses)\textsuperscript{6}. However, as its authors noted, incorporating diagnoses from administrative data in risk adjustments could introduce over-adjustment if the co-morbid conditions are a product of the same access to care barriers that result in hospitalizations for ACSCs. Controlling for co-morbidities could
also lead to erroneous results if, for example, the average number of comorbidities increased post-reform as a result of increased detection\textsuperscript{51} in even a single office-based physician visit made possible by gaining insurance, or from more aggressive or complete inpatient coding to maximize hospital revenue (so called, “upcoding”)\textsuperscript{52} among Massachusetts hospitals, rather than as a result of a true increase in the prevalence of chronic conditions among Massachusetts inpatients post-reform. Prior studies using objective data to examine post-reform changes in disparities have found no improvement in disparities in hospital readmission rates\textsuperscript{15} and access to inpatient cardiovascular procedures\textsuperscript{16} while access to inpatient surgical procedures improved for Hispanic but not black residents. Our study is generally consistent with these results but is the first to examine this question using preventable hospitalizations as a measure of access to outpatient care.

**Conclusion and Policy Implications**

Why might Massachusetts health reform have failed to affect preventable hospitalizations or narrow pre-existing racial and ethnic disparities in this outcome? First, although estimates vary somewhat, the absolute decline in the number of uninsured residents was modest, approximately 6% of the non-elderly population; this still left 6% of the non-elderly population uninsured after full implementation of the reform\textsuperscript{6}. While gains were larger for racial and ethnic minorities, so too were the proportion uninsured post-reform. Second, prior to reform, Massachusetts had a robust health care safety-net system that provided free care to many of the uninsured,\textsuperscript{53} who were disproportionately from minority backgrounds, through the state’s Uncompensated
Care Pool program. Third, the public insurance (Medicaid) and publicly subsidized (Commonwealth Care) and unsubsidized (Commonwealth Choice) exchange-based private insurance that residents received under the reform may not have provided optimal access to outpatient care due to patient cost-sharing\textsuperscript{54,55} or to low provider reimbursement. The Massachusetts Medical Society found that only 60% of Massachusetts internist physicians accepted Medicaid and 40% accepted Commonwealth Care in 2009\textsuperscript{56} and anecdotal evidence suggests that finding a physician after reform became more difficult.\textsuperscript{57} Lastly, there may have been insufficient capacity of outpatient primary care providers to fully accommodate the influx of newly insured residents, irrespective of insurance type. Recent data regarding this possibility are mixed.\textsuperscript{11,58} The persistence of racial and ethnic disparities despite increased insurance coverage has been demonstrated in multiple other settings\textsuperscript{59,60} and in our study may be due to office-based barriers faced by racial and ethnic minorities such as a lack of available interpreters\textsuperscript{61} or discrimination\textsuperscript{3}, persistent inability to afford care despite being insured due to cost-sharing\textsuperscript{62} or to the enduring independent effects of socioeconomic factors\textsuperscript{63} that we were unable to account for in our analysis. In addition to being a key measure of access, preventable hospitalizations represent a clinical failure for patients and a needless expenditure of scarce healthcare resources.

Therefore, our findings have important policy implications. A large body of evidence suggests that insurance substantially improves access to care across many settings, medical conditions, and populations.\textsuperscript{64} In fact, recent US longitudinal studies provide strong evidence that acquiring public forms of insurance such as Medicaid and Medicare improves a broad array of health outcomes\textsuperscript{48,65} including mortality\textsuperscript{66}. The fact
that we found no evidence that the Massachusetts reform diminished either preventable hospitalizations or disparities in such admissions, suggests that particular features of the Massachusetts reform may need to be optimized in order to realize improvements in access to outpatient care. Although our results do not point to specific modifications, they might include: continued expansion of insurance to the remaining uninsured, reduction in cost-related barriers to outpatient care among those with insurance, more comprehensive outreach efforts to the insured and uninsured to ensure adequate knowledge of the processes for applying for and effectively utilizing insurance, particularly among residents with limited English language proficiency and low health literacy. Future studies will need to define which of these or other improvements will maximize outpatient access to care. In Massachusetts and many other states, the major provisions of the ACA went into effect January 1st, 2014. Because the ACA was closely modeled on the Massachusetts reform, our results could provide important lessons for those charged with the design and roll out of health reform under the ACA in Massachusetts and other similar states as well as in other countries that may implement similar reforms.
Contributors: I/we attest that all authors contributed to the data analysis and interpretation of the results, and reviewed and approved the final manuscript. DM had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. He is guarantor.

Funding: This research has been funded by US National Institutes of Health grants (1U01HL105342-01, NRK, principal investigator) and a grant from the Rx foundation. NRK is supported in part by a senior research career scientist award from the Department of Veterans Affairs, Health Services Research and Development Service (RCS 02-066-1). The views expressed in this article are those of the authors and do not necessarily represent the views of the National Institutes of Health, the Rx foundation, Boston University, or the Department of Veterans Affairs. The funders had no role in conducting the research or writing of the manuscript.

I/We have read and understood BMJ policy on declaration of interests and declare the following interests: none.

All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.
Ethical approval: This study was approved by the Boston University Medical Campus institutional review board.

Data sharing: Inpatient data files were restricted for this project and cannot be shared because of restrictions on use of data. Statistical code files are available from the corresponding author (danny_mccormick@hms.harvard.edu).

Transparency: I, Danny McCormick (the manuscript’s guarantor), affirm that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, an exclusive licence (or non exclusive for government employees) on a worldwide basis to the BMJ Publishing Group Ltd to permit this article (if accepted) to be published in BMJ editions and any other BMJPGL products and sublicences such use and exploit all subsidiary rights, as set out in our licence.
I, Danny McCormick, The Corresponding Author of this article contained within the original manuscript which includes any diagrams & photographs within and any related or stand alone film submitted (the Contribution”) has the right to grant on behalf of all authors and does grant on behalf of all authors, a licence to the BMJ Publishing Group Ltd and its licencees, to permit this Contribution (if accepted) to be published in the BMJ and any other BMJ Group products and to exploit all subsidiary rights, as set out in our licence set out at: http://www.bmj.com/about-bmj/resources-authors/forms-policies-and-checklists/copyright-open-access-and-permission-reuse. I am not a US Federal Government employee, but some or all of my co-authors are.
References


Table 1. Ambulatory Care Sensitive Conditions Defined by Agency for Healthcare Research and Quality (AHRQ) Prevention Quality Indicators (PQIs).

Individual PQIs

- PQI 01 Diabetes Short-term Complications Admission Rate
- PQI 02 Perforated Appendix Admission Rate
- PQI 03 Diabetes Long-term Complications Admission Rate
- PQI 05 Chronic Obstructive Pulmonary Disease or Asthma in Older Adults Admission Rate
- PQI 07 Hypertension Admission Rate
- PQI 08 Congestive Heart Failure (CHF) Admission Rate
- PQI 09 Low Birth Weight Rate (EXCLUDED)
- PQI 10 Dehydration Admission Rate
- PQI 11 Bacterial Pneumonia Admission Rate
- PQI 12 Urinary Tract Infection Admission Rate
- PQI 13 Angina without Procedure Admission Rate
- PQI 14 Uncontrolled Diabetes Admission Rate
- PQI 15 Asthma in Younger Adults Admission Rate (EXCLUDED)
- PQI 16 Rate of Lower-Extremity Amputation among Patients with Diabetes

Composite PQIs

- PQI 90 Overall Composite (includes 01, 03, 05, 07, 08, 10, 11, 12, 13, 14, 15, and 16)
- PQI 91 Acute Composite (includes 10, 11, and 12)
- PQI 92 Chronic Composite (includes 01, 03, 05, 07, 08, 13, 14, 15, and 16)
<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Massachusetts Pre Reform (N=50,385)</th>
<th>Massachusetts Post Reform (N=52,354)</th>
<th>Control States Pre Reform (N=393,997)</th>
<th>Control States Post Reform (N=397,556)</th>
<th>P-value for Comparison of Pre-reform MA with pre-reform Control States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>Mean ±SD 49.2±11.9 49.3±11.9 49.2±11.5 49.1±11.6</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category</td>
<td>18-29 9.2% 9.5% 8.2% 8.9%</td>
<td>18-29 9.5% 10.2% 11.4% 10.7%</td>
<td>18-29 9.2% 10.2% 11.4% 10.7%</td>
<td>18-29 9.5% 10.2% 11.4% 10.7%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>30-39 10.8% 10.2% 11.4% 10.7%</td>
<td>30-39 10.2% 11.4% 10.7% 9.6%</td>
<td>30-39 10.8% 11.4% 10.7% 9.6%</td>
<td>30-39 10.2% 11.4% 10.7% 9.6%</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>40-44 10.1% 9.4% 10.4% 9.6%</td>
<td>40-44 9.4% 10.4% 9.6% 8.9%</td>
<td>40-44 10.1% 9.4% 10.4% 9.6%</td>
<td>40-44 9.4% 10.4% 9.6% 8.9%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>45-49 13.1% 12.9% 13.7% 13.8%</td>
<td>45-49 12.9% 13.7% 13.8% 13.8%</td>
<td>45-49 13.1% 12.9% 13.7% 13.8%</td>
<td>45-49 12.9% 13.7% 13.8% 13.8%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>50-54 15.6% 16.7% 16.1% 17.1%</td>
<td>50-54 16.7% 16.1% 17.1% 17.1%</td>
<td>50-54 15.6% 16.7% 16.1% 17.1%</td>
<td>50-54 16.7% 16.1% 17.1% 17.1%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>55-59 19.2% 18.4% 18.9% 18.6%</td>
<td>55-59 18.4% 18.9% 18.6% 18.6%</td>
<td>55-59 19.2% 18.4% 18.9% 18.6%</td>
<td>55-59 18.4% 18.9% 18.6% 18.6%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>60-64 22.1% 23.0% 21.4% 21.3%</td>
<td>60-64 23.0% 21.4% 21.3% 21.3%</td>
<td>60-64 22.1% 23.0% 21.4% 21.3%</td>
<td>60-64 23.0% 21.4% 21.3% 21.3%</td>
<td>NS</td>
</tr>
<tr>
<td>Gender</td>
<td>Female 53.5% 52.8% 53.4% 53.0%</td>
<td>Female 52.8% 53.4% 53.0% 53.0%</td>
<td>Female 53.5% 52.8% 53.4% 53.0%</td>
<td>Female 52.8% 53.4% 53.0% 53.0%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Male 46.5% 47.2% 46.6% 47.0%</td>
<td>Male 47.2% 46.6% 47.0% 47.0%</td>
<td>Male 46.5% 47.2% 46.6% 47.0%</td>
<td>Male 47.2% 46.6% 47.0% 47.0%</td>
<td>NS</td>
</tr>
<tr>
<td>Race</td>
<td>Non-Hispanic Black 11.5% 12.3% 27.8% 29.4%</td>
<td>Non-Hispanic Black 12.3% 27.8% 29.4%</td>
<td>Non-Hispanic Black 11.5% 12.3% 27.8% 29.4%</td>
<td>Non-Hispanic Black 12.3% 27.8% 29.4%</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Hispanic 9.2% 10.0% 11.7% 11.8%</td>
<td>Hispanic 10.0% 11.7% 11.8% 11.8%</td>
<td>Hispanic 9.2% 10.0% 11.7% 11.8%</td>
<td>Hispanic 10.0% 11.7% 11.8% 11.8%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Other 4.7% 4.7% 6.6% 6.3%</td>
<td>Other 4.7% 6.6% 6.3% 6.3%</td>
<td>Other 4.7% 4.7% 6.6% 6.3%</td>
<td>Other 4.7% 6.6% 6.3% 6.3%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Non-Hispanic White 74.6% 73.0% 53.9% 52.5%</td>
<td>Non-Hispanic White 73.0% 53.9% 52.5%</td>
<td>Non-Hispanic White 74.6% 73.0% 53.9% 52.5%</td>
<td>Non-Hispanic White 73.0% 53.9% 52.5%</td>
<td>NS</td>
</tr>
</tbody>
</table>

Income (Zip-code median)
<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Massachusetts Pre Reform (N=50,385)</th>
<th>Massachusetts Post Reform (N=52,354)</th>
<th>Control States Pre Reform (N=393,997)</th>
<th>Control States Post Reform (N=397,556)</th>
<th>P-value for Comparison of Pre-reform MA with pre-reform Control States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>47,343 ± 16,261.6</td>
<td>46,988 ± 15,930.2</td>
<td>41,018 ± 16,968.9</td>
<td>40,872 ± 16,953.1</td>
<td>*</td>
</tr>
<tr>
<td>Category</td>
<td>Low</td>
<td>38.8%</td>
<td>39.4%</td>
<td>40.0%</td>
<td>40.4%</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>24.0%</td>
<td>24.5%</td>
<td>24.9%</td>
<td>25.0%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>37.2%</td>
<td>36.1%</td>
<td>35.1%</td>
<td>34.6%</td>
</tr>
</tbody>
</table>

Control States include NY, NJ, and PA. Pre-Reform Period was defined as 10/01/2004-06/30/2006. Post-Reform Period was defined as 01/01/2008-09/30/2009. P-values are for the comparison of pre-reform MA with pre-reform control states.

NS=not significant

*p<0.001
Figure 1. Time-trends in hospital admission rates / 100,000 population for a composite of 12 ambulatory care sensitive conditions in MA and control states (NY, NJ and PA) from the pre-reform through the post-reform time periods. The transition period represents the time period during which the reform was being implemented. Age and sex adjusted admission rates are shown in Panel A and as 4-quarter rolling averages (Panel B) to smooth seasonal variation.
Table 3. Changes in Preventable Hospitalization Rates* per 100,000 Residents / year in Massachusetts and Control States in Pre-reform and Post-reform Time Periods.

<table>
<thead>
<tr>
<th>Preventable Hospitalization Measure</th>
<th>Massachusetts</th>
<th>Control States</th>
<th>Differences-in-Differences Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-reform Rate</td>
<td>Post-reform Rate</td>
<td>% change</td>
</tr>
<tr>
<td>Overall Composite ACSC</td>
<td>745</td>
<td>730</td>
<td>-2.1</td>
</tr>
<tr>
<td>Acute Composite ACSC</td>
<td>300</td>
<td>279</td>
<td>-7.0</td>
</tr>
<tr>
<td>Chronic Composite ACSC</td>
<td>445</td>
<td>451</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Control States include NY, NJ, and PA. Pre-Reform Period was defined as 10/01/2004-06/30/2006. Post-Reform Period was defined as 01/01/2008-09/30/2009. Pre- and post-reform hospitalization rates were adjusted for age and sex using the method of direct standardization. Ambulatory Care Sensitive Conditions (ACSCs) are a set of conditions, defined by the Agency for Health Care Research and Quality, for which access to outpatient care should reduce the risk of hospitalization. The Acute composite measure includes dehydration, urinary tract infection and bacterial pneumonia. The
Chronic composite measure includes diabetes, complications from diabetes, chronic obstructive pulmonary disease, hypertension, heart failure and angina. The overall composite measure includes all individual ACSCs in the acute and chronic composite measures. Adjusted difference-in-differences estimates and 95% confidence intervals were obtained from Poisson regression models controlling for sex, age, race/ethnicity, county income level, county unemployment rate and quarter.
Table 4. Changes in Preventable Hospitalization Rates per 100,000 Residents / year in Massachusetts and Control States in Pre-reform and Post-reform Time Periods According to Race and Ethnicity.

<table>
<thead>
<tr>
<th>Preventable Hospitalization Measures</th>
<th>Massachusetts</th>
<th>Control States</th>
<th>D-in-D Estimates</th>
<th>D-in-D-in-D Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-reform Rate</td>
<td>Post-reform Rate</td>
<td>% change</td>
<td>Pre-reform Rate</td>
</tr>
<tr>
<td>Overall Composite ACSC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>667</td>
<td>647</td>
<td>-3.0</td>
<td>716</td>
</tr>
<tr>
<td>Black</td>
<td>1713</td>
<td>1744</td>
<td>1.8</td>
<td>2188</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1258</td>
<td>1203</td>
<td>-4.4</td>
<td>1126</td>
</tr>
<tr>
<td>Acute Composite ACSC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>285</td>
<td>263</td>
<td>-7.5</td>
<td>277</td>
</tr>
<tr>
<td>Black</td>
<td>496</td>
<td>470</td>
<td>-5.3</td>
<td>482</td>
</tr>
<tr>
<td>Hispanic</td>
<td>393</td>
<td>362</td>
<td>-7.8</td>
<td>297</td>
</tr>
<tr>
<td>Chronic Composite ACSC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>383</td>
<td>384</td>
<td>0.3</td>
<td>440</td>
</tr>
<tr>
<td>Black</td>
<td>1217</td>
<td>1274</td>
<td>4.7</td>
<td>1706</td>
</tr>
<tr>
<td>Hispanic</td>
<td>865</td>
<td>840</td>
<td>-2.8</td>
<td>829</td>
</tr>
</tbody>
</table>
Adjusted difference-in-difference-in-difference (D-in-D-in-D) estimates express the post reform change in black-white and Hispanic-white disparities in ACSC (preventable hospitalization) rates after accounting for trends in control states. D-in-D-in-D estimates and 95% confidence intervals were obtained from Poisson regression models controlling for sex, age, county income level, county unemployment rate and quarter.
Table 5. Changes in Preventable Hospitalization Rates per 100,000 Residents/Year in Massachusetts Counties with Highest and Lowest Potential Insurance Coverage Gains following Reform.

<table>
<thead>
<tr>
<th>Preventable Hospitalization Measure</th>
<th>Counties with Highest Potential Insurance Coverage Gains</th>
<th>Counties with Lowest Potential Insurance Coverage Gains</th>
<th>Differences-in-Differences Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-reform Rate</td>
<td>Post-reform Rate</td>
<td>% change</td>
</tr>
<tr>
<td>Overall Composite ACSC</td>
<td>711.7</td>
<td>696.5</td>
<td>-2.1%</td>
</tr>
<tr>
<td>Acute Composite ACSC</td>
<td>282.0</td>
<td>265.3</td>
<td>-5.9%</td>
</tr>
<tr>
<td>Chronic Composite ACSC</td>
<td>429.7</td>
<td>431.2</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

Data from study states and Small Area Health Insurance Estimates (SAHIE) produced by the U.S. Census Bureau.

Counties with highest potential (and actual) insurance coverage gains were those above the median and counties with lowest potential (and actual) gains were those below the median for baseline uninsurance rates pre-reform, according to SAHIE Estimates. Adjusted difference-in-difference estimates express the post reform change in counties with highest insurance coverage gains compared with counties with lowest gains in coverage after adjustment in Poisson regression.
models controlling for sex, age, race/ethnicity, county income level, county unemployment rate and quarter. Statistically significant positive values would indicate an increase in the admission rate in counties with highest potential coverage gains and negative values would indicate a decrease in the admission rate in counties with highest potential coverage gains.