

From the Society for Clinical Vascular Surgery

Improved access to health care in Massachusetts after 2006 Massachusetts Healthcare Reform Law is associated with a significant decrease in mortality among vascular surgery patients

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ABSTRACT

Background: Access to medical care, by adequate insurance coverage, has a direct impact on outcomes for patients undergoing vascular procedures. We evaluated in-hospital mortality for patients undergoing index vascular procedures before and after the Massachusetts Healthcare Reform Law (MHRL) in 2006, which mandated insurance for all Massachusetts residents, both in Massachusetts and throughout the United States.

Methods: The National Inpatient Sample was queried to identify patients undergoing interventions for peripheral arterial disease, carotid artery stenosis, and abdominal aortic aneurysms based on *International Classification of Diseases, Ninth Revision, Clinical Modification* procedural and diagnostic codes. The cohort was then divided into patients treated within Massachusetts (MA) and non-Massachusetts (NMA) hospitals. Two time intervals were examined: before (2003-2006, P1) and after the MHRL (2007-2011, P2). The primary outcome of interest included in-hospital mortality. Patients in MA and NMA hospitals were described in terms of demographics and presentation by time interval (P2 vs P1) compared using χ^2 and *t*-tests. Weighted logistic regression with term modeling change in the odds ratio (OR) for P2 was performed to test and to estimate trends in mortality. Time (year of procedure) and region interactions were investigated by inclusion of time-region interactions in our analyses. Subgroup analysis was performed for P2 vs P1 among nonwhite, nonelderly, and low-income patients.

Results: We identified 306,438 patients who underwent repair of abdominal aortic aneurysm, lower extremity bypass, or carotid endarterectomy in MA and NMA hospitals. MA hospital patients had an increase in both Medicaid and private insurance status after the MHRL (P1 = 2.6% and 21% vs P2 = 3.3% and 21.7%, respectively; $P = .034$). In-hospital mortality trended down for all groups across the entire study. In comparing P2 vs P1 trends, MA hospital odds of mortality per year was lowered by 26% (OR, 0.74; 95% confidence interval [CI], 0.56-0.99; $P = .042$) not seen in NMA hospitals (OR, 1.03; 95% CI, 0.97-1.09; $P = .405$). Time and region interaction terms indicated significant time trend difference in both unadjusted ($P = .031$) and adjusted ($P = .033$) analysis in MA hospitals not observed in NMA hospitals. This pattern continued when the samples were stratified by procedure. Patients undergoing vascular procedures in MA hospitals had a significantly lowered OR of mortality, with fewer patients presenting at late disease stages in P2 vs P1. Nonelderly patients in Massachusetts, who benefit from the Medicaid expansion provided by the MHRL, had a profound 92% drop in odds of mortality in P2 vs P1 (OR, 0.08; 95% CI, 0.010-0.641; $P = .017$) compared with the 14% drop in NMA (OR, 0.86; 95% CI, 0.709-1.032; $P = .103$).

Conclusions: The 2006 MHRL is associated with a decrease in mortality for patients undergoing index vascular surgery procedures in MA compared with NMA hospitals. This study suggests that governmental policy may play a key role in positively affecting the outcomes for patients. (J Vasc Surg 2018;■:1-10.)

It is well established that reliable and affordable access to medical care improves medical and surgical outcomes. Uninsured and underinsured patients are less likely to have a primary care physician, to fill

prescriptions, and to participate in preventive or screening services, all of which may result in delay of care and more advanced presentation.¹⁻⁶ Specific to vascular surgery, many studies have shown that

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uninsured patients are more likely to present with more advanced disease with worse outcomes than in adequately insured patients.^{1,4,7-10}

Before the Affordable Care Act (ACA), the rate of uninsured in the United States increased from 17.1% for nonelderly Americans in 2006 to 18.4% by 2010.¹¹ During this same period, the state of Massachusetts implemented the Massachusetts Healthcare Reform Law (MHRL), providing subsidized private insurance, expanding Medicaid, and creating an individual mandate. This resulted in a dramatic drop in uninsured nonelderly adults from 10.9% in 2006 to 6.3% by 2010.¹¹ This change in insurance status was paralleled by improved patient outcomes, most pronounced among patients of lower socioeconomic status.^{2,11,12} In comparing Massachusetts with the surrounding states, Massachusetts patients were found to have a drop in all-cause mortality and emergency department visits.^{2,12}

The purpose of this study was to compare in-hospital mortality after index vascular procedures in Massachusetts compared with the rest of the United States in the period before and after implementation of the MHRL. These comparisons are made for the entire cohort and then stratified by the procedure. In addition, we compared the severity of disease state at presentation for patients undergoing lower extremity bypass (LEB), abdominal aortic aneurysm (AAA) repair, and carotid endarterectomy (CEA) operations. We hypothesized that increased access to care, as made possible by the MHRL in 2006, would decrease in-hospital mortality.

METHODS

The National Inpatient Sample (NIS) database was queried to identify patients who underwent the three vascular operations noted before from 2003 to 2011. As the largest database of its kind, the NIS includes all-payer discharge information from 20% of all nonfederal hospitals nationally. A complete description of NIS database information is available on the website.¹³ The NIS was queried to identify patients undergoing LEB, AAA repair, or CEA by linking the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) procedure codes for all patient discharges associated with primary diagnosis of both intact and ruptured AAA, peripheral arterial disease (PAD), or carotid artery stenosis by ICD-9-CM diagnostic codes (Table 1).¹⁴ We excluded patients younger than 18 years, "trauma" admissions, patients for whom admission designation (elective vs nonelective) was unclear, and those with missing discharge or mortality status. We also excluded patients who had more than two vascular operations during the same index admission. The Institutional Review Board at Boston University School of Medicine has approved the use of deidentified data for this study. This deidentified database has no patient information, and no consent was required or obtained.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected data of the National Inpatient Sample
- **Take Home Message:** Insurance status of 306,438 patients undergoing major vascular procedures was associated with outcomes. Compared with other states without universal insurance, Massachusetts residents had significantly lower mortality after major vascular procedures.
- **Recommendation:** The study suggests that increased insurance coverage by the Massachusetts Healthcare Reform Law significantly decreased mortality in Massachusetts compared with the rest of the United States.

The sample was then divided into two cohorts, Massachusetts (MA) and non-Massachusetts (NMA) hospitals, based on the location of the hospital where these vascular procedures were performed. The study interval was divided into two intervals based on the implementation of the MHRL in 2006: P1 spans 2003 to 2006, including cases before the implementation of this law; and P2 includes cases performed afterward, 2007 to 2011. The primary outcome of interest included in-hospital mortality. We also compared type of initial presentation before and after the MHRL. Types of initial presentation included ruptured vs intact AAA, symptomatic vs asymptomatic carotid stenosis, and advanced PAD (rest pain and nonhealing ulcer) vs patients undergoing LEB for claudication. Comparison of the patients' characteristics in the MA and NMA cohorts was performed on the *actual* NIS data, and no weighting strategy was employed. Statistical analyses of trends were performed accounting for survey design.

Bivariate comparisons of categorical variables between MA and NMA hospitals were performed using χ^2 tests; continuous variables were compared by *t*-tests. Both institutional and surgeons' case volumes have been shown to be an indicator of mortality in many studies, for a variety of different procedures.^{15,16} Unique surgeon identifiers are not available for most NIS states, so no volume analyses were performed in this study. Crude mortality rates were reported with corresponding standard errors. Mortality was compared between time intervals (P1 vs P2) and regions (MA vs NMA hospitals) using Rao-Scott χ^2 test accounting for survey design (PROC SURVEYFREQ; SAS Institute, Cary, NC). Yearly mortality rates were plotted as moving average with sliding window of size 3. The purpose of using moving average is for smoother presentation of the trend based on annual data, allowing a better understanding of the actual trend. Actual estimates and corresponding standard errors are reported in [Appendix 1](#) (online only).

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