tation of the alert ($P < .001$). Health care professional–level factors were significant predictors of IV compared with oral PPI administration, including the presence of the PPI within an order set (Table). There was improved indication after implementation of the alert, but the findings were not significant (88.0% indicated after vs 74.0% before; $P = .07$). On the basis of the institutional cost differences between IV and oral PPIs and the observed reduction in IV PPI orders during the year after the alert, we estimate a $450,692 annual decrease in institutional costs related to IV PPI use.

Discussion | Intravenous PPIs are frequently given in situations in which oral PPIs would suffice. We found that implementation of an electronic alert for IV PPI orders was associated with a 23.0% relative decrease in the proportion of orders of PPI. This result was significant after adjusting for the trend in the proportion of IV PPIs ordered before implementation of the alert. The decrease in the proportion of IV PPIs ordered was immediate, sustained, accompanied by an overall decrease in IV PPI orders, and associated with significant cost savings.

Few prior data on electronic interventions seeking to improve PPI use are available. In the outpatient setting, pharmacist-based electronic interventions may reduce overall PPI use. Inpatient studies have evaluated the use of computerized decision support in changing IV to oral medication orders but have not targeted IV PPIs. Our findings suggest that, if health care professionals are educated to make a clearly defined change with a simple but focused alert, oral PPIs will frequently be substituted for IV PPIs. Health care professional–level factors were also an important determinant of PPI route of administration. Compared with the medical service, the surgery or obstetrics-gynecology services were more likely to order IV vs oral PPIs. This was true before and after the alert and after adjusting for patient diet status; however, this study was not designed to address the reasons underlying these differences. Notably, presence of the IV PPI within an order set strongly predicted IV compared with oral PPI use before and after alert implementation.

Our study highlights the potential for electronic alerts to alter ordering behavior for IV PPIs. Institutions seeking to decrease IV PPI use should consider removing IV PPIs from order sets, and future studies should test whether additional targeted interventions using clinical decision support systems can improve PPI overuse.

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Population Trends in Rates of Coronary Revascularization

Improvements in prevention have led to declines in rates of myocardial infarction (MD). Simultaneously, evidence from randomized trials has confirmed the role of medical therapy as a first-line treatment for stable coronary disease. Together, these forces could lead to significant declines in population-wide rates of coronary revascularization. We examined recent temporal trends in population rates of coronary revascularization using comprehensive clinical data collected in Massachusetts.
Methods | Approval for the study was granted by the Massachusetts Department of Public Health review committee (RADAR). We conducted a retrospective dynamic cohort study of all Massachusetts residents undergoing coronary revascularization at nonfederal hospitals from April 2003 through September 2012. These residents included patients undergoing inpatient or outpatient percutaneous coronary intervention (PCI) and coronary artery bypass graft surgery (CABG) with and without concomitant valve or aortic surgery. We counted only the first procedure per year per patient. Procedures were classified as “urgent” if done in the setting of MI (within 21 days of MI for CABG) and were classified as “elective” if otherwise. Population denominators were obtained from the US census, stratified by sex and age.3 Direct methods for adjustment were applied using the 2012 population as standard.1 Cochran-Armitage testing was used to assess linear trend.

Results | From April 2003 through September 2012, 171,702 coronary revascularization procedures (PCI, 76.9%; CABG, 23.1%) were included. The mean adult Massachusetts population was 5.2 million. The age- and sex-adjusted rate of coronary revascularization declined from 423 per 100,000 to 258 (P < .001) (Figure 1), a 39.0% decline during the study period. Rates of PCI declined from 318 to 200 per 100,000, while rates of CABG declined from 113 to 63 per 100,000 (P < .001 for both).

Among PCIs, elective PCIs declined from 206 to 109 per 100,000 (P < .001), while urgent procedures declined from 119 to 100 per 100,000 (P < .001) (Figure 2). Elective CABG declined from 82 to 45 per 100,000, while urgent CABG declined from 31 to 18 per 100,000 (P < .001). Isolated CABG rates fell from 90 to 45 per 100,000 (P < .001), while combined CABG and aortic or mitral valve surgery did not change (10 per 100,000 in 2003 vs 10 per 100,000 in 2012).

Discussion | We observed steep declines in population-wide rates of coronary revascularization in Massachusetts over the previous decade. For PCI, reductions in rates were greater in magnitude for elective procedures than for procedures done for MI, declining by nearly 50% between 2003 and 2012 for elective PCI compared with a 16.4% decline for urgent PCI over the same period.

The causes of the observed trends are likely multifactorial. Significant reductions in rates of MI have been observed in multiple populations, likely attributable to improved primary and secondary prevention.4,5 The publication of the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) trial7 comparing PCI with initial medical therapy for stable angina was temporally associated with the steepest 1-year decline in elective PCI rates. Explicit attention to the appropriate use of PCI may also have contributed to more recent declines in PCI.6

This study has several limitations. We cannot know with certainty what has led to the observed trends, and our results may not generalize to other geographic locations. Also, we did...
not capture outcomes of patients who may have been considered for, but did not undergo, coronary revascularization and do not know if overall cardiovascular outcomes in these patients has changed.

In conclusion, we found that rates of coronary revascularization have declined by nearly 40% in Massachusetts since 2003, with the most rapid declines in elective PCI procedures and isolated CABGs. These data have broad implications for regional health policy, training and provider accreditation, hospital resource allocation, and patient outcomes.

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The Value of Clinical Judgment in the Detection of Clinical Deterioration

Hospitals routinely use rapid response teams (RRTs) to treat and triage unstable patients, but early and reliable identification of high-risk patients remains challenging. Objective, vital sign–based risk prediction scores, such as the Modified Early Warning Score (MEWS), have been developed but have limited accuracy. The Patient Acuity Rating (PAR), a subjective 7-point Likert scale assessment of the likelihood of cardiac arrest or intensive care unit (ICU) transfer within the next 24 hours, has been proposed as an alternate risk stratification tool. However, the PAR has not been externally validated or directly compared with objective metrics such as the MEWS.

Methods | This study was approved by the Northwestern University Institutional Review Board (CR3 STU00027683). Hospitalists at an academic medical center prospectively assigned a daily PAR score to consecutive medical in-patients as part of a standardized electronic medical record handoff. Covering physicians were blinded to PAR assignment. A corresponding MEWS was calculated using the closest vital signs. Outcomes were cardiac arrest or ICU transfer, RRT activation, and a composite of any 3, occurring within 24 hours of an observation. These were evaluated using area under the receiver operator characteristics curve (AUC). Logistic regression was used to combine paired PAR and MEWS scores.

Results | Between September 1, 2011, and August 31, 2012, we identified 51 eligible physicians, 34 of whom consented to participate. Participants gave written informed consent. There was no compensation for participation. Among the 34 physicians, 28 provided a total of 7244 PARs in 3249 distinct patients, with a median PAR of 2 (range, 1-7). Among these patients, we observed 2 cardiac arrests, 67 ICU transfers, and 105 RRT activations. In addition, 51 202 MEWS scores were calculated for these patients, with a median of 3 (range, 2-11). There was a median of 84 minutes between corresponding PAR and MEWS scores.