Risk Aversion and Public Reporting. Part 1: Observations From Cardiac Surgery and Interventional Cardiology

David M. Shahian, MD, Jeffrey P. Jacobs, MD, Vinay Badhwar, MD, Richard S. D'Agostino, MD, Joseph E. Bavaria, MD, and Richard L. Prager, MD

Department of Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts; Division of Cardiovascular Surgery, Johns Hopkins All Children's Heart Institute, All Children's Hospital, Johns Hopkins University School of Medicine, St. Petersburg, Florida, and Baltimore, Maryland; Division of Cardiothoracic Surgery, West Virginia University, Morgantown, West Virginia; Department of Cardiothoracic Surgery, Lahey Health, Burlington, Massachusetts; Division of Cardiovascular Surgery, University of Pennsylvania, Philadelphia, Pennsylvania; and Cardiac Surgery Department, University of Michigan, Ann Arbor, Michigan

Risk aversion is a potential unintended consequence of health care public reporting. In Part 1 of this review, four possible consequences of this phenomenon are discussed, including the denial of interventions to some high-risk patients, stifling of innovation, appropriate avoidance of futile interventions, and better matching of high-risk patients to more capable providers. We also summarize relevant observational clinical reports and survey results from cardiovascular medicine and surgery, the two specialties from which almost all risk aversion observations have been derived. Although these demonstrate that risk aversion does occur, the empirical data are much more consistent and compelling for interventional cardiology than for cardiac surgery.

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> *For extreme diseases, extreme methods of cure … are most suitable*—Hippocrates, *Aphorisms,* circa 400 BC
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> *Desperate diseases grown, By desperate appliance are relieved, Or not at all*—Shakespeare, *Hamlet,* Act 4 Scene 3, circa 1600 AD

For some severe diseases and conditions, the only hope for cure may be treatments that have a high-risk of failure, complications, or death. Although we may think of this as a phenomenon of 21st century health care, these familiar quotes from Hippocrates and Shakespeare illustrate the perennial nature of this challenging problem.

The concept that some clinicians might not offer treatment to such patients because of the high risk of failure and its potential effect on their reputations—referred to today as risk aversion—is also not a modern phenomenon. More than a century ago, Ernest Amory Codman, a surgeon at the Massachusetts General Hospital and Harvard Medical School, was one of the earliest advocates for transparent reporting of provider outcomes. Dr Codman was subsequently a cofounder of both the American College of Surgeons and its Committee on Hospital Standardization, a forerunner of the Joint Commission, and he is now widely recognized as the father of the American health care quality movement.

Although an ardent advocate for transparency, Codman also presciently reflected on its potential unintended consequences. In 1913 he presented what is probably the earliest, and still one of the most insightful commentaries regarding risk aversion [1]:

> But if we think too much about mortality, shall we not fail to do desperate operations which we should do?
>
> Who should attempt these desperate operations—the man anxious to make a reputation, or the man who has made one?
>
> The operation of gastrectomy for cancer of the stomach is a good example. A mortality even as high as 50 per cent is justifiable, because unfavorable as well as favorable cases should be done. But what surgeon doing private practice has reputation enough to undertake such a mortality? To be successful with this operation a man should have great surgical skill, special training on animals, abundant opportunities to do the operation, and security of reputation, so that his private practice will not be ruined by the necessarily high mortality.
>
> Which of us with cancer of the stomach would not be willing to take a 50 per cent chance in skilled hands?

Like Hippocrates and Shakespeare, Codman notes that serious illnesses sometimes require "desperate" cures, especially when the alternative is almost certain death. But he also observes that not everyone should undertake such risky procedures. Rather, it should be the most experienced and skilled clinicians, with special training and established reputations. He anticipated the value of matching high-risk patients to the most capable

Address correspondence to Dr Shahian, Department of Surgery, Massachusetts General Hospital, 55 Fruit St, Bulfinch 284, Boston, MA 02114; email: dshahian@partners.org.

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surgeons, a potentially positive consequence of risk aversion that will be discussed in the next section.

In the current era of transparency and public reporting of health care outcomes [2, 3], with few standards to ensure the adequacy and accuracy of performance measures [4, 5], the issue of risk aversion has never been more relevant or timely [6–16]. In Part 1 of this two-part review, we describe several potential consequences of risk aversion, some of which, paradoxically, might actually be beneficial to patients. We also review observational and survey studies regarding risk aversion in cardiac surgery and interventional cardiology. Part 2 of this review [17] explores the root cause of risk aversion—lack of provider trust in the risk-adjusted outcomes measures used for public reporting—and a variety of mitigation strategies are discussed.

Potential Consequences of Risk Aversion

Denial of Interventions to High-Risk Patients Who Might Benefit

Risk aversion usually refers to the denial of interventions to high-risk patients who might have benefited, specifically when that decision is motivated by fear that worse outcomes among such patients will affect a provider's reputation, referrals, privileges, or reimbursement. This adverse response to public reporting must be carefully monitored and mitigated for the value of transparency to outweigh its unintended consequences. For the overall population of patients with a particular disease to have optimal outcomes, it is necessary that some very high-risk patients receive interventions, and some will likely not survive [18, 19].

Stifling Innovation

Similar to denial of care to high-risk patients, a related concern is that risk aversion suppresses medical and surgical innovation [20, 21]. Promising new techniques and treatments with substantial potential benefit may initially have a somewhat elevated risk. In a public reporting environment, practitioners may be unwilling to accept this risk even if fully informed patients are willing to do so.

Avoidance of Futile Interventions

Although risk aversion is usually regarded as undesirable provider behavior, heightened risk awareness by providers may sometimes have salutary effects. For example, realistic appreciation of insurmountable risk in some cases, combined with thoughtful shared decision making, might spare some patients and their families the ordeal of a hopeless intervention. However, accurate risk estimation and incorporation of the patient's and family's goals of care may prove challenging even in very high-risk cases [22].

Better Matching of High-Risk Patients to the Most Capable Providers

Another potential benefit of risk aversion in a public reporting environment is improved matching of the highest-risk patients to the highest-performing providers (e.g., lower mortality rates or observed-to-expected [O/E] ratios) [23–29]. For example, recognizing their own limitations, surgeons who are less capable or experienced might decline a very high-risk patient; however, the patient may subsequently be referred to a better-qualified surgeon, thus resulting in a better match of patient and provider. Over time, referral patterns adapt, and high-risk patients are preferentially referred to higher-performing providers.

Glance and colleagues [28] studied coronary artery bypass grafting (CABG) procedures between 1997 and 1999 in the New York Cardiac Surgery Reporting System. Patients at higher risk were more likely to be operated on by surgeons with better outcomes. For each 10% absolute increase in the estimated risk of patient death, there was an absolute decrease of 0.034 in surgeon O/E ratios ($p < 0.001$). Much of this effect seemed to be driven by the hospital where the surgeon practiced, but even within hospitals, the higher-risk patients were more often cared for by higher-quality surgeons.

Risk Aversion in Cardiovascular Practice

Virtually all modern studies of risk aversion and public reporting come from the disciplines of cardiac surgery and interventional cardiology. These fields have the requisite combination of high-acuity patients, risky but potentially life-saving treatments, readily measurable outcomes with standardized definitions, and relatively large volumes. Lessons learned in the domain of cardiovascular care should be readily transferrable to other areas of health care as public reporting becomes more pervasive.

Cardiac Surgery Public Reporting

Federal Transparency Initiatives and the Origins of The Society of Thoracic Surgeons Database

The modern era of public reporting began with the short-lived but seminal publication of hospital mortality rates by the Healthcare Financing Administration (the predecessor of the Centers for Medicare and Medicaid Services) from 1986 to 1993, including mortality rates for CABG. Hospitals complained that the reputations of their cardiac surgery programs were being unfairly impugned because Healthcare Financing Administration analyses had inadequate risk adjustment [30–32]. This led The Society of Thoracic Surgeons (STS) to advocate for the use of robustly risk-adjusted outcomes based on clinical registry data. This was the proximate stimulus for the development of the STS National Database and numerous risk models and performance measures based on these data. In 2010 the STS initiated a voluntary public reporting program that, as of mid 2017, has the enrollment of approximately 60% of participants in the STS Adult Cardiac Surgery Database and 67% of participants in the STS Congenital Heart Surgery Database [2, 3, 33].

Statewide Report Cards

During roughly the same time frame, cardiac surgery public reporting efforts were also initiated in several states

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[25, 34, 35]. New York State Health Commissioner David Axelrod was concerned about high unadjusted CABG mortality rates at some New York hospitals. Recognizing the inadequacy of raw outcomes data, health policy leaders, including Professor Ed Hannan and Dr Mark Chassin, developed a clinical registry, the Cardiac Surgery Reporting System (CSRS), together with risk models and risk-adjusted performance measures to more accurately assess CABG providers in New York State [23–25, 36–38]. Provider results were first made public at the hospital level in 1990, followed by the release of surgeon-level data in 1991. At about the same time, the Pennsylvania Health Care Cost Containment Council also embarked on a CABG public reporting initiative [34], as did New Jersey, and Massachusetts followed in 2003 [35].

Studying the Effects of Public Reporting

Soon after these CABG public reporting initiatives were implemented, investigators began to study their effects [2, 3]. Topics included reductions in risk-adjusted mortality rates [23, 36, 39], the surprising lack of effect of high or low outlier designation on market share [38, 40], the subjective impressions of providers [29, 41, 42] and patients [43], gaming of the reporting system [44], and the specific subject of this review, risk aversion.

Observational Studies of CABG Patient Selection and Outcomes

NEW YORK AND PENNSYLVANIA. Omoigui and colleagues [45] studied 482 New York CABG patients referred to Cleveland Clinic between 1989 and 1993, which they regard as the time period that referral patterns might have been affected by New York public reporting. In the prereport card era (1980 to 1988), 61.4 patients per year transferred from New York to Cleveland Clinic, which increased to 96.2 patients per year between 1989 and 1993, when referrals from other states were decreasing. New York referral patients had a higher prevalence of high-risk characteristics compared with those from other referral areas and with their own historical data. During the study period, New York patients had the highest expected mortality rates of any referral areas to Cleveland Clinic, and they had correspondingly higher morbidity and mortality. However, the authors acknowledged that the expected mortality rates of New York referrals rose only slightly between 1989 and 1993, given that the 4-year model may have underestimated the 1989 expected mortality rates; during the same time period, observed and adjusted mortality rates of New York CABG referrals steadily declined.

The methods and conclusions of this frequently cited study have been challenged. Chassin and colleagues [24, 38] noted that the first New York report card was published in 1990 and the first plausible effect on risk avoidance would likely not have been until 1991, 2 years after the beginning of the post-report card study period as defined by Omoigui and colleagues [45]. The 482 New York patients in their study [45] represented a very small fraction (0.65%) of the 74,359 New York patients who had CABG from 1989 to 1993, most of which (73,877) were performed in New York. Also, there was very modest change in the expected mortality of New York referral patients from 1989 to 1990 (before public reporting) to 1991 to 1993 (after public reporting). In fact, between 1990 and 1992, the number of high-risk (>7.5% expected mortality) patients receiving CABG in New York increased from 804 to 1391 (73%) [24]. Market share data showed no evidence of market shift from high-mortality to low-mortality hospitals [38, 40], which argues against referral pressure on surgeons to avoid high-risk patients. Finally, Chassin and colleagues [24] noted that New York referrals to Cleveland Clinic were largely based on longstanding and often geographically based referral patterns.

Dranove and colleagues [26] studied Medicare acute myocardial infarction (AMI) and CABG patients during the period 1987 to 1994, which includes the introduction of CABG public reporting in New York and Pennsylvania. Several investigators [24, 25] have questioned this study's methods, particularly the idiosyncratic approach (total inpatient hospital expenditures for the year before admission) used to characterize severity of illness. However, with this caveat, the study findings do provide potential insights into the effect of public reporting. After these report cards were published, a shift occurred in CABG demographics in New York and Pennsylvania toward healthier patients (3.7% to 5.3% decrease in illness severity relative to all other states), putatively as a result of risk aversion. In contrast to this overall pattern, CABG illness severity was maintained at New York and Pennsylvania teaching hospitals, which the authors used as a proxy for high-quality institutions. This suggests that teaching hospitals were being sent the sickest CABG patients, who might previously have been cared for at other institutions. The authors also found that the average severity of AMI patients in New York and Pennsylvania teaching hospitals increased markedly, but there was no change at nonteaching hospitals. Similar to the findings of Glance and colleagues [28] and Romano and associates [27], these findings all suggest a potentially beneficial if unintended consequence of public reporting—namely, that the sickest patients are cared for by the most capable referral centers.

Werner and colleagues [46] studied the effect of New York CABG report cards on racial disparities in access to care. Using data from New York as well as Nationwide Inpatient Sample data from comparator states, they found an overall net increase in racial and ethnic disparities in New York CABG use of 2 percentage points (95% confidence interval [CI], 0.7 to 3.4 percentage points; $p = 0.006$) in white compared with black patients and 3.4 percentage points (95% CI, 0.8 to 5.9 percentage points; $p = 0.01$) in white vs Hispanic patients.

Hannan and colleagues [47] studied characteristics of Medicare patients who underwent CABG between 1994 and 1999, comparing those in New York and other states with public reporting or continuous quality improvement programs with those in all remaining states. Overall, New York CABG patients had higher prevalences of AMI, age older than 75 years, and emergency status, and lower

prevalence of chronic obstructive pulmonary disease and peripheral vascular disease than states not involved in public reporting or continuous quality improvement. From 1994 to 1999, there was a 65% increase in patients aged 80 years or older, a 10.4% increase in AMI patients, a 26.3% increase in emergency admissions for CABG, and an 11% increase in multiple comorbidity patients. Out-of-state referrals from New York for CABG were nonsignificantly lower than the rest of the country in 1994 (9.9% vs 10.5%) and in 1999 (10.4% vs 10.5%). In a related study, the percentage of high-risk New York CABG patients with expected mortality of 7.5% or more grew 73% from 1990 to 1992, whereas the number of low-risk patients grew only 11.4% [48]. None of these findings support the hypothesis of widespread or progressive risk aversion.

In a study of Medicare CABG recipients from 1987 to 1992, Peterson and colleagues [49] found that compared with CABG patients from the rest of the United States, those from New York had generally similar prevalences of important risk factors, with a slightly higher percentage of patients aged older than 80 years or with congestive heart failure or diabetes, and a slightly lower percentage of patients with a recent AMI. Rates of AMI (12% vs 8%), age older than 80 years (11% vs 7%), and female sex were higher in 1992 than in 1987, contrary to what would have been expected had there been progressive risk aversion as a result of public reporting.

In the study of Peterson and colleagues [49], referral rates also did not support the premise of risk aversion related to public reporting. Between 1987 and 1992, the percentage of New York patients going out of state for CABG decreased from the 12.5% to 14.3% range in the pre-report card period (1987 to 1989) to 11.3% in 1992, and the overall trend for out-of-state CABG decreased significantly from 1987 to 1992 ($p < 0.001$ for trend). Risk factors for patients referred out of state for CABG were nearly identical to those staying in New York except for lower prevalences of nonwhite and diabetic patients (generally considered high-risk characteristics). Between 1987 and 1992, the overall number of New York Medicare CABG cases increased 57%, from 5,170 to 8,120, the rate of CABG among New York Medicare patients increased 50%, and the rate of CABG among New York MI patients aged 65 to 70 years increased from 3.4% to 8.4% (similar to national trends, although lower absolute rates in New York).

CALIFORNIA. California began public reporting of CABG results in 2003, and the effects on volume, case mix, and expected and observed mortality rates in that state have been studied. Li and colleagues [50] found that between 2003 and 2006, CABG volume decreased 26.5% and was not a function of 2003 performance. There were nonsignificant changes in the case mix for most hospitals and surgeons during that period, and the overall state risk profile for CABG did not change. Overall expected mortality was 3.06% (95% CI, 2.98% to 3.13%) in 2003 and 3.05% (95% CI, 2.97% to 3.14%) in 2006, whereas observed mortality decreased from 2.9% to 2.22% ($p = 0.0001$). The odds ratio for operative mortality was 24% lower in 2006, and the improvements were even greater for the highest-risk patients.

Romano and colleagues [27] studied the potential effect of California CABG report card releases in 2001, 2003, and 2005. Relevant to the question of risk aversion, overall expected mortality in California remained stable, as in the study of Li and colleagues [50]. However, after report card releases, high mortality outliers, on average, operated on less sick patients (adjusted absolute decrease in expected mortality, 0.785%; adjusted relative decrease, 25%). This may reflect intentional risk aversion on the part of these hospitals or selective referral of high-risk patients to more capable programs. Regardless of the mechanism, this finding again illustrates a beneficial if unexpected consequence of risk aversion and public reporting—better matching of high-risk patients to higher-performing providers.

UNITED KINGDOM. Bridgewater and colleagues [51] investigated the effect of CABG public reporting in the United Kingdom using prospectively collected data on 25,730 CABG patients from The North West Quality Improvement Programme in Cardiac Surgery between 1997 and 2005. Although hospital- and surgeon-level public reporting initiatives were progressive and asynchronous during this period, the authors regarded April 1997 to March 2001 as predisclosure and April 2001 to March 2005 as postdisclosure. The additive EuroSCORE (European System for Cardiac Operative Risk Evaluation) was used to estimate expected mortality rates. Observed in-hospital mortality decreased from 2.4% (1997–1998) to 1.8% (2004–2005), $p = 0.014$, while at the same time expected mortality increased from 3% to 3.5% ($p < 0.001$), resulting in a decrease in the O/E ratio from 0.8 to 0.51 ($p < 0.05$). The percentage of low-risk patients decreased from 84.6% (before public reporting) to 81.7% (after public reporting), whereas that of high-risk and very high-risk patients increased from 15.4% to 18.2%. None of these findings suggest substantial risk aversion.

THE STS. Finally, as part of a review of the first 4 years (2010 to 2014) of the STS voluntary public reporting initiative, Shahian and colleagues [33] analyzed risk factor prevalence data from the STS National Database beginning in 2004 (6 years before public reporting began in 2010) through 2014 (4 years after the start of public reporting). Overall expected mortality rates were generally stable during this period, although preoperative rates of dialysis and severe chronic lung disease both rose steadily, including after the start of public reporting. The rates of reoperation progressively declined during this 10-year period, without a major change in trend after 2010. This was thought to result from the continuing evolution of interventional cardiology procedures that provided an alternative to reoperation. Overall, this aggregate level analysis did not find evidence for risk aversion.

Survey Data

Surveys of referring physicians and practicing surgeons are another source of information about risk aversion and public reporting. These surveys generally demonstrate that providers are suspicious of report card accuracy, leery of their potential effect, and disinclined to use them as the basis for referrals.

NEW YORK. Hannan and colleagues [41] surveyed New York cardiologists to assess the effect of report cards on their referral practices. Although most found the reports easy to read and accurate in assessing surgeon performance, 62% of those responding said that report cards had no effect on their referrals to heart surgeons, and 78% of respondents did not routinely discuss report card results with patients.

Using data from 2011, 20 years after the first public release of CABG results in New York, Brown and colleagues [52] resurveyed New York cardiologists about their referral practices. Despite 94% of cardiologists being aware of report cards, 71% said they had not discussed them with any patients, only 25% said report cards had moderate (21%) or substantial (4%) effect on referrals, and 75% said there was minimal or no effect on referrals. These results were quite similar to the earlier findings of Hannan and colleagues [41].

Burack and colleagues [29] surveyed New York cardiac surgeons and found that they were more likely to deny an operation to high-risk CABG patients than to comparably high-risk aortic dissection patients because outcomes for the latter are not publicly reported. Sixty-seven percent of surgeons acknowledged refusing to operate on at least 1 high-risk CABG patient in the past year because of the potential effect on their report card ratings, and many had refused more than 1. The likelihood of refusing patients was greater among surgeons in practice less than 10 years, those with fewer than 100 cases per year, and those with a mixed (<50% adult cardiac) practice. Once again, this suggests that in a public reporting environment, less qualified or experienced surgeons may reject patients but that they may be accepted by more qualified surgeons, a salutary matching of risk and capability.

PENNSYLVANIA. Schneider and Epstein [42] surveyed Pennsylvania cardiologists and surgeons after the introduction of the CABG report card in that state. Although 82% of cardiologists and all cardiothoracic surgeons were aware of this report, 87% of cardiologists reported minimal or no influence on their referral decisions. Cardiologists and surgeons cited concerns regarding the use of mortality as the sole quality indicator (78%), unreliability of the data (53%), and inadequate risk adjustment (79%). Given these findings, it is not surprising that 59% of cardiologists reported increased difficulty finding surgeons to take high-risk patients and that 63% of cardiothoracic surgeons reported less willingness to operate on such patients.

THE UNITED KINGDOM. Jarral and colleagues [53] surveyed consultant cardiac surgeons in the United Kingdom and found that 58% opposed surgeon-level reporting because of concerns, including gaming, risk aversion, and failure of mortality rates to adequately capture overall quality of care.

Conclusions

Observational data, including risk factor prevalence and referral patterns, do not demonstrate compelling evidence of risk aversion in cardiac surgery. However, these aggregate data do not necessarily reflect decision making at the individual patient level. In fact, most of the survey data strongly suggest that heart surgeons and referring physicians do not trust public reporting and that this skepticism may have behavioral ramifications. There is evidence that in a public reporting environment, cardiologists do not use these results in selecting providers and that surgeons may be more likely to decline operating on high-risk patients. An unexpected beneficial effect of reporting may be better matching of high-risk patients to more capable surgeons.

Interventional Cardiology

With the evolution of percutaneous coronary intervention (PCI) techniques, many patients with coronary artery disease are now primarily cared for by interventional cardiologists. The characteristics and outcomes of these patients are quite heterogeneous, including elective patients with a very low procedural mortality rate, patients requiring complex PCI because of prohibitive surgical risk, and patients with AMI, where most PCI deaths occur [8, 9]. The latter group includes patients with ST segment myocardial infarction (STEMI), non-STEMI, cardiogenic shock, and cardiac arrest.

These patient presentations have quite different inherent risk and average mortality rates, and interventional cardiology practices vary in the proportion of such patients they treat. Cardiogenic shock patients have the highest risk, but early revascularization offers their best possibility of survival [54, 55]. MI patients who suffer cardiac arrest and are resuscitated, but who develop postarrest anoxic encephalopathy, are a particularly challenging subgroup. From a cardiac perspective, these patients might benefit from PCI, but their neurologic prognosis is unknown at the time when critical management decisions must be made.

Similar to cardiac surgery, a number of states produce public report cards for PCI, whereas many others do not. The combination of widely variable patient presentations (including those at very high risk, for whom intervention may offer the best or only hope of survival) and a mix of reporting and nonreporting states have created a natural laboratory in which to study risk aversion in the modern era.

PCI has emerged during the past decade as the focus of both clinical studies and spirited debate regarding risk aversion [7–13, 25, 56–69]. Many of these investigations focus on patterns of care and outcomes in states with vs without public reporting, and New York has been the nearly universal exemplar of the former.

Evidence for Denial of Care to High-Risk AMI Patients

Moscucci and colleagues [62] studied 8 PCI centers participating in a Michigan registry, where there is no public reporting, and 34 centers in New York, which has a PCI registry and mandatory public reporting. This study included all PCI patients, not just those with recent MI.

Compared with New York, Michigan patients more often underwent PCI for AMI (14.4% vs 8.7%, $p < 0.0001$) and shock (2.56% vs 0.38%, $p < 0.0001$) and had higher prevalence of some high-risk characteristics, including preprocedural cardiac arrest. The median overall expected mortality rate among Michigan hospitals was 1.63% compared with 0.76% in New York ($p = 0.0002$). Observed mortality rates were lower in New York, but the difference was not statistically significant after risk adjustment, a finding that further substantiates the greater inherent risk of the Michigan patients. Although an early and important work regarding PCI risk aversion and public reporting, this study does have some potential methodologic caveats. For example, Hannan and colleagues [25] note that New York's shock definition was considerably more stringent than that used in Michigan, which could account for some of the apparent differences in patient severity.

Apolito and colleagues [68] compared 220 New York patients in the national SHOCK (SHould we emergently revascularize Occluded coronaries for Cardiogenic shocK) registry to 325 shock patients from other states. Propensity-adjusted analyses showed New York patients were less likely to have coronary angiography (odds ratio [OR], 0.46; 95% CI, 0.31 to 0.68) or PCI (OR, 0.51; 95% CI, 0.33 to 0.77).

Joynt and colleagues [63] studied Medicare AMI patients from 2002 to 2010 in New York, Massachusetts, and Pennsylvania (PCI public reporting states) compared with 7 nonreporting states. Although overall AMI mortality was similar in reporting and nonreporting states, PCI was less likely in 2010 for AMI patients in reporting states (OR, 0.82; 95% CI, 0.71 to 0.93), including high-risk patients with STEMI (OR, 0.73; 95% CI, 0.59 to 0.89), cardiogenic shock or cardiac arrest (OR, 0.79; 95% CI, 0.64 to 0.98), or advanced age (OR, 0.77; 95% CI, 0.66 to 0.91). In a separate analysis of Massachusetts patients, the odds of receiving PCI for AMI were similar to those in nonreporting states before the initiation of public reporting, but thereafter, the odds decreased significantly (OR, 0.81; 95%, CI 0.47 to 1.38), especially for cardiogenic shock or postcardiac arrest patients.

McCabe and colleagues [58] studied PCI in Massachusetts from the onset of public reporting in 2003 through 2010. In the years after report cards were implemented, there was a 37% relative decline in the predicted risk of PCI mortality, perhaps attributable to risk aversion. At various times between 2003 and 2010, four high-volume PCI programs were designated as high mortality outliers. After outlier classification, the predicted risk of PCI mortality at these hospitals was significantly lower than at nonoutlier hospitals (1.08% $\pm$ 0.23% vs 1.58% $\pm$ 0.29%, $p < 0.01$). Compared with their own preoutlier expected mortality rates, and adjusting for temporal trends, outlier hospitals experienced an 18% relative decrease in predicted mortality compared with nonoutliers. Although average illness severity of patients without shock or STEMI decreased significantly after outlier identification (perhaps because these cases are more discretionary), the expected mortality rates of the shock or STEMI subgroup did not differ significantly between outlier and nonoutlier hospitals (possibly because of inadequate sample sizes). As the authors noted, these findings do not account for high-risk shock or STEMI patients who were presumably never offered PCI; the results of that subgroup are essential to understanding the population effect of risk aversion.

Waldo and colleagues [57] used 2005 through 2011 data from the Nationwide Inpatient Sample to compare the management and outcomes of AMI patients in Massachusetts and New York (public reporting states) vs those in Connecticut, Maine, Maryland, Rhode Island, New Hampshire, and Vermont (nonreporting states). The adjusted OR for receiving PCI in public reporting states compared with nonreporting states was 0.81 (95% CI, 0.67 to 0.96), with especially notable differences in elderly, Medicare, STEMI, cardiac arrest, or shock patients. AMI patients in public reporting states had higher adjusted in-hospital mortality (OR, 1.21; 95% CI, 1.06 to 1.37), but those who underwent PCI had lower mortality (adjusted OR, 0.71; 95% CI, 0.62 to 0.83). The latter findings could indicate improved PCI quality in reporting states or, alternatively, more judicious patient selection even within the group of patients offered PCI in these states. The higher overall AMI mortality in reporting states was largely attributable to the worse outcomes of AMI patients who did not undergo PCI (adjusted OR, 1.30; 95% CI, 1.13 to 1.50), a compelling demonstration of the negative effect of risk aversion.

The most comprehensive and nationally representative PCI data are found in the American College of Cardiology's National Cardiovascular Data Registry (NCDR) CathPCI data set, which contains prospectively collected clinical registry data. Cavender and colleagues [60] studied 1,340,213 PCI procedures in the NCDR between mid-2009 and mid-2011, comparing 3 public reporting states—New York, Massachusetts, and Pennsylvania—with all other states, the latter encompassing 88% of patients. Overall predicted mortality rates were similar in reporting and nonreporting states (1.37% vs 1.39%, $p = 0.17$), but observed in-hospital mortality was lower in the former (OR, 0.80; 95% CI, 0.74 to 0.88; $p < 0.001$). Predicted mortality for elective PCI was similar in reporting and nonreporting states, but observed mortality was lower in reporting states (0.25% vs 0.33%, $p = 0.003$; adjusted OR, 0.71; 95% CI, 0.58 to 0.87; $p = 0.001$). Among patients receiving PCI for acute coronary syndromes or cardiogenic shock, the predicted mortality rates were higher in public reporting compared with nonreporting states, but the adjusted odds of in-hospital death were lower in reporting states. Although these results do not show evidence of risk aversion and suggest higher performance in mandatory reporting states, Cavender and colleagues [60] acknowledge that these data only include patients who actually underwent PCI and cannot account for differences in patient selection and possible risk aversion.

Boyden and colleagues [69] used NCDR data to study PCI patients from 2011 to 2012 in New York (a public reporting state) compared with Michigan (formal continuous quality improvement but no public

reporting). New York had a smaller percentage of patients with high-risk characteristics, including STEMI (13.5% vs 15.6%), non-STEMI (16.1% vs 20.5%), cardiogenic shock (1.6% vs 2.4%), or cardiac arrest within 24 hours of PCI (1.2% vs 1.8%). Using propensity-matched cohorts, they found that New York patients were less likely than those in Michigan to need urgent, emergency, or salvage CABG (OR, 0.67; 95% CI, 0.51 to 0.89), to have access site bleeding complications, or to be administered blood transfusions (OR, 0.7; 95% CI, 0.61 to 0.82), and their in-hospital mortality was lower (0.84% vs 1.17%; adjusted OR, 0.72; 95% CI, 0.63 to 0.83). Thus, although these two NCDR-based studies yielded somewhat different inferences regarding patient selection and possible risk aversion, and neither addressed AMI patients who were denied intervention, both were consistent in demonstrating superior outcomes in reporting states for those patients who did receive PCI.

Survey Data

Narins and colleagues [70] surveyed all interventional cardiologists included in the 1998 to 2000 New York PCI reports. Of those who responded:

- 76% disagreed or strongly disagreed that mortality reporting improved patient care;
- 79% felt their decision whether to offer angioplasty in high-risk patients was influenced by report cards;
- 85% disagreed or strongly disagreed that mortality statistics accurately measure physician quality;
- 82% disagreed or strongly disagreed that mortality statistics provide useful information to patients in selecting hospitals or physicians for PCI.
- 83% thought that some patients who might benefit would be denied PCI because of physician-specific reporting,
- 85% felt risk models inadequately protected physicians who performed high-risk procedures, and
- 88% thought gaming or upcoding of risk factors was occurring.

Conclusion

Withholding of high-risk cardiovascular care because of public reporting does occur, although the objective evidence for this practice is much more consistent and compelling for interventional cardiology than for cardiac surgery. An unanticipated salutary effect of heightened risk awareness by providers has been better matching of high-risk patients to the most capable physicians and surgeons, as suggested by Codman [1] more than a century ago.

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