In the field of coronary revascularization during the first decade of the 21st century, improvements in surgical techniques and postoperative care have resulted in decreased operative mortality for coronary artery bypass grafting (CABG), despite a greater risk population of patients undergoing operation. Significant changes have occurred in the management of coronary artery disease (CAD) such that far fewer CABG surgeries are being performed now than in the past decades. This is perhaps in part because medical cardiologists have become more confident in using percutaneous coronary intervention (PCI) to manage such previously exclusive surgical situations such as left main and 3-vessel coronary disease. Although current American College of Cardiology Foundation/American Heart Association guidelines continue to recommend CABG over PCI in most patients with complicated disease, it is uncertain whether these guidelines have had a significant impact on “real-life” management of coronary interventions. Public reporting in California of CABG outcomes, but not PCI, was also initiated in 2003. The present study examines trends in the associated time period—the first decade of the 21st century. The analysis includes comparison of in-hospital and 1-year outcomes in cardiovascular morbidity and mortality for CABG, PCI for acute coronary syndrome (PCI-ACS), and all other PCIs (PCI-noACS).
interventions on its website to provide quality improvement data for healthcare givers and other stakeholders.8

All patients who underwent an isolated coronary artery revascularization procedure (CABG or PCI) during 2000 to 2010 were included. Annual follow-up was complete for 99% of patients who underwent PCI and 97% of patients who underwent CABG through 2011. Patients who underwent a concomitant cardiac procedure with coronary revascularization were excluded. In-hospital mortality (IHM) was corrected for “same-day” transfers to another healthcare facility. Documentation of methodology and risk modeling is reported on the CCSIP web site.9 Post-hospital readmission rates within the first year were collected for death, stroke, acute myocardial infarction (MI), and rein- tervention for any other procedure (CABG or PCI); the annual rate of any major adverse cardiac or cerebrovascular event (MACCE) was determined for isolated CABG (emergent or elective), PCI-ACS (ICD-9-CM codes 410.xx [International Classification of Diseases, Ninth Revision], ST elevation MI and non-ST elevation MI), and PCI-noACS (all other PCIs). Before 2006, OSHPD data did not include the number of vessels stented during a single procedure, after that time it was possible to determine if the procedure included single or multiple vessel stenting.

The collection of MACCE data was accomplished using ICD-9-CM codes. Events (i.e., MACCE) were counted as present if they were new discharge diagnoses that occurred within the specified period. Although it was possible to have a patient sustain ≥1 MACCE within the specified period, only the first such event was counted for the combined outcome.

Results

California statewide CABG volume peaked in 2000 and subsequently decreased by 58% in 2010 (27,450 to 11,568); total PCI volume peaked in 2005 and decreased by 20% in 2010 (59,855 to 48,135) (Figure 1, Table 1). This change was entirely because of PCI-noACS, which decreased by 34% (38,731 to 25,453), whereas PCI-ACS increased by 7% (21,124 to 22,682). IHM for CABG decreased from 3.3% (898 of 27,450 in 2000) to 2.0% (234 of 11,568 in 2010); IHM for PCI-ACS has remained in the 3.6% to 3.8% (853 of 22,682 in 2010) range and IHM of PCI-noACS has stayed constant at approximately 0.6% (156 of 25,453 in 2010). The expected risk increased over the study period for all 3 revascularization strategies (Table 1).

Annual hospital readmission rates for adverse events are shown in Figure 2. The major findings are a decrease in CABG 1-year mortality beginning in 2004, and a decrease in reintervention rates for PCI beginning in 2002. There was little change in the incidence of readmission for acute MI or stroke diagnoses during the decade. However, there is a trend upward during the most recent years for PCI procedures.

The annual incidence of any adverse event (MACCE) at 1 year is listed in Table 2. MACCE rate for CABG peaked at approximately 11% early in the decade and was 10% in 2010. MACCE rate peaked at approximately 27% for PCI and was 23% (PCI-ACS) and 19% (PCI-noACS) in 2010. The total number of adverse events for all coronary revascularization procedures peaked >17,000 in 2002 and decreased to <11,000 in 2010.

Reintervention comprises a large portion of the MACCE rate for PCI, and a significant percentage of PCI reinterventions are performed electively for nontarget vessel lesions. Our data source did not identify the vessel site for PCI, so we used nonelective readmissions as a surrogate for “unplanned” PCI. Figure 3 shows the annual incidence of adverse events after revascularization, with and without elective admissions for reintervention. When only mortality, acute MI, and stroke were included as adverse events, excluding reinterventions, the MACCE rate was 8% to 9% for CABG, 13% to 14% for PCI-ACS, and 9% to 10% for PCI-noACS, varying little over the decade (Table 3).

Discussion

After the introduction of drug-eluting stents, the number of percutaneous interventions continued to increase, peaking in 2005, and then elective PCI procedures also decreased precipitously. As a result, the number of coronary revascularization procedures in California has been substantially reduced. The explanation for this change is unclear. Although there is evidence that meticulous medical care followed in patients with stable CAD can reduce or eliminate the need for many coronary interventions, there is little evidence indicating that the patients are being managed differently. It is unlikely that the dramatic change during such a short time can be explained by the decreasing prevalence of CAD in this population. The decrease in PCI procedures is also more than can be explained by a reduction in the need for repeat procedures. A decrease of >12,000 PCI-noACS procedures per year from 2006 to 2010, for example, was accompanied by a decrease of <2,000 reinterventions per year.

In 2010, OSHPD produced a report on the impact of public reporting of CABG mortality in California.9 The report concluded that there was no evidence of outmigration and no change in predicted patient risk after the publication of outcomes. Better performing sites has similar reduction in volume as worse performers. The observed decrease in risk-adjusted mortality was thought to be related to improved operative techniques, better management of postoperative complications, and possibly influenced by patient selection factors not captured by risk adjustment.
The net effect of a decrease in procedure numbers combined with improvements in outcomes has been a decrease of >6,000 adverse events annually. This should translate into substantial unburdening of the fiscal impact of cardiovascular healthcare if the findings are similar elsewhere in the United States.

Despite the utility and effectiveness of PCI in patients with ACS and others with stable CAD, CABG continues to...
be the recommended standard for complete coronary revascularization especially in patients with more complex CAD. Many reports have validated improved outcomes with drug-eluting stents. The incidence of late stent thrombosis, however, remains significant despite aggressive antiplatelet therapy. Saphenous vein graft occlusion thrombosis, however, remains significant despite aggressive antiplatelet therapy. The observational data reported here show that improvements in outcome with PCI are limited to a decrease in the need for reintervention, and the incidence of combined adverse events at 1 year continues to favor CABG. Even when reintervention was removed as an outcome event, patients undergoing PCI had a greater risk of having a major adverse event in 2010 (death, MI, or stroke) compared with CABG.

Little data have been reported that document a decrease in PCI procedures in recent years. The public reports available from New York show little change in PCI volume from 2004 to 2006 (56,000/year) and 2007 to 2009 (53,000/year). In Massachusetts, PCI procedures decreased from approximately 16,000 in 2004 to 2006 to 14,000 in 2007 to 2009. The CCSIP has reported that the number of coronary revascularization procedures performed during 2007 in California (180 of 100,000 population) was much fewer than in Massachusetts (273 of 100,000) or New York (326 of 100,000), and more equivalent to the rate in the United Kingdom (161 of 100,000). Overall, the annual rate of coronary revascularization procedures in the United States decreased during the decade, but this was entirely because of a decrease in CABG procedures. In a recent report reviewing trends in CABG and PCI procedures in New York, PCI volume peaked in 2006 and then began to decrease slightly.

The strengths of this study include the ability to collect data on all procedures, because reporting is mandatory. Outcome information is secure in that data points are actual hospital discharges. The data are limited by the need to use ICD-9-CM codes for diagnoses, but the use of discharge diagnoses should improve discrimination. Risk adjustment is limited by the inability to determine the extent of disease using ICD-9-CM diagnostic codes. We also were unable to validate deaths that occurred outside the hospital for this study.

Disclosures

The authors have no conflicts of interest to disclose.


