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2016 Revision of the SCAI Position Statement on Public Reporting

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The public reporting of institutional and individual operator results of percutaneous coronary interventions (PCIs) is intended to provide meaningful information to the public and enhance the delivery of superlative health care. By giving consumers specific outcome data [1], patients will be empowered to participate more fully in decisions concerning their medical care. The influence that public reports wield could increase if publicly reported information proves to be an accurate representation of “value” in health care delivery, and if third-party payers use this information to allocate reimbursement in a value-based system [2].

Despite these well-intended goals, there is uncertainty whether existing programs correctly identify high- and low-performing PCI centers and operators. Moreover, there is emerging evidence that public reporting can deleteriously influence case selection by encouraging risk avoidance behaviors. Thus, potentially beneficial procedures might be withheld from high-

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risk patients who can derive the greatest benefit, because operators and facilities fear being labeled as outliers [3–8].

This position statement updates the prior Society for Cardiac Angiography and Interventions (SCAI) Policy on Public Reporting [1]. SCAI continues to endorse public reporting, provided the reports are not misleading, deliver meaningful information to consumers to help inform their choices, and facilitate quality improvement. Offering the public accurate and understandable metrics, including measures to assess the appropriateness of case selection, are essential to achieve this aim.

DATA CURRENTLY RELEASED IN PUBLIC REPORTING STATES

Mandatory public reporting highlights the dilemma of balancing the provision of necessary revascularization procedures to high-risk patients with the consequences of negative outcomes. Table I summarizes the data presented to the public in 4 states with active programs [5–9]. Other states (e.g., Pennsylvania [PA], California [CA]) have rudimentary programs. A summary of the experience of the two states with the most established programs follows.

NEW YORK

New York State's (NY) annual reports contain every hospital's and operator's PCI volume, unadjusted (observed) in-hospital/30-day mortality rate (OMR), expected mortality rate (EMR), risk-adjusted mortality rate (RAMR), and outlier status (significantly higher, lower, or not different from the statewide mortality rate), calculated on a rolling 3-year basis. The OMR is the observed number of deaths divided by the total number of cases, whereas the EMR is the sum of the predicted probabilities of death (as a function of patients' own risk factors) for all patients divided by the total number of patients. The RAMR is then obtained as the OMR/EMR ratio of the provider multiplied by the registry's overall mortality rate.

MASSACHUSETTS

Non-federal hospitals in Massachusetts (MA) performing PCIs annually report Standardized Mortality Incidence Rates (SMIR), using a Bayesian hierarchical modeling approach (see below) analogous to using OMR/EMR. However, in lieu of OMR, the predicted mortality rate is used instead. By employing hierarchical modeling, fewer hospitals are identified as outliers than in NY. SMIR is also reported separately for patients presenting with ST-elevation myocardial infarction (STEMI) or cardiogenic shock. In the future, the state will shift to reporting risk-adjusted 30-day mortality.

PRINCIPLES OF PUBLIC REPORTING

For public reporting to be effective, the information reported should (1) address the consumer's important questions and priorities; (2) present credible information that is interpretable by the consumer; (3) stimulate the consumer to act on the information; and (4) avoid generating false perceptions regarding individual and/or institutional quality of care.

Although public reporting is intended to assist patients in making better choices and support the identification of outliers with poor performance [10], there are few data to confirm this actually occurs [11]. The reasons include an apparent lack of consumer interest, difficulty interpreting the presented information, perceived inaccuracies, and a lack of opportunity for patients to act on public reports (e.g., in emergent clinical situations or when care is directed by payers).

LIMITATIONS OF RISK ADJUSTMENT AND RAMR

RAMR after 30 days has been the principal metric presented in public reports. Although patients are understandably concerned about procedural mortality, SCAI believes that the RAMR is insufficient as a summary measure of quality. The primary reason is that mortality after PCI depends more on the clinical acuteness at presentation and comorbidities than on technical proficiency or operator judgment; that is, the variation between providers is much smaller than the variation between patients. Patient severity of illness and comorbidities are highly predictive of mortality after PCI, especially acute myocardial infarction (AMI), cardiogenic shock, and other high-risk settings.

The principle underlying risk adjustment is that correcting for confounding factors can mathematically equalize these factors. In theory, RAMR should provide complete correction and be used to identify “outliers” above an arbitrary (e.g., >95th) percentile in order to identify variations in interventional program quality [12]. Many interventionists lack confidence that risk adjustment is precise at the high end of risk [5,7]. They have doubts about whether risk adjustment models include some factors frequently used to make clinical decisions (unmeasured confounders). Clinicians are concerned that misinterpretation by the public and regulators will lead to unwarranted damage to professional and institutional reputations. This could result in some excellent operators and hospitals with apparently higher mortality rates being perceived as having poor quality and outcomes because of a high-risk case mix or referrals to their facility [11,13]. Notably, when a complex PCI concludes without mortality, no additional “credit” for high technical competence is assigned to the operator; yet, when a death occurs related to the seriousness of the underlying condition, it is imputed to be a flaw of the operator [14].

Reliance on RAMR as the sole or predominant measure of PCI quality has several drawbacks, including:

- Exclusion of measures of quality related to considerations important from the patient’s perspective [15]. PCI registries do not collect data concerning frailty, patient preferences, or extenuating circumstances that might be relevant to the decisions made concerning revascularization [16,17].
- RAMR focuses exclusively on mortality when a procedure **is** performed, and ignores comparative outcomes if the procedure **is not** performed; that is, RAMR is procedure-oriented, not disease-oriented. Thus, poor outcomes resulting from risk-averse behaviors are not considered in the overall context of health care delivery.

- RAMR relies on accurate death reporting within the 30 days following PCI, which is most commonly obtained from administrative databases or the National Death Index. These databases include noncardiac causes of death, which might have no relationship to the PCI [18,19].

DO EXISTING RISK ADJUSTMENT APPROACHES ADEQUATELY CAPTURE RISK?

Each dataset identifies predictive variables based on its own modeling and weights them according to their population, which might not be applicable to all data-sets. Their predictive accuracy when applied to a validation subset is frequently omitted [20].

Although 1.3% is the median RAMR for PCI nationally, individual facility values above or below the median might not be significantly different. Notably, it has never been demonstrated that programs identified in this manner have demonstrably lower quality compared with other hospitals. Additionally, because RAMR is low for most institutions, it is a weak discriminator of programs and operators. This occurs because the low mortality achieved with PCI requires large numbers of patients to reduce variance and narrow the confidence intervals (CIs). Even when a hospital's OMR greatly exceeds its EMR, it is unclear if it can be appropriately labeled an outlier hospital that delivers poor quality care [12].

Using National Cardiovascular Data Registry (NCDR) data, Sherwood et al. [21] found that hospitals performing PCIs in a greater number of high-risk cases did not have a poorer RAMR than facilities treating lower-risk patients. The risk adjustment model used was well calibrated even among very high-risk patients. In fact, hospitals treating the highest risk patients actually had better RAMR than facilities treating patients with a lower severity of illness. However, it is critical to recognize that this study assessed risk through measured variables; unmeasured factors are not assessed by published risk scores and might result in penalization by RAMR statistics.

LIMITATIONS OF RISK ADJUSTMENT MODELING

Risk adjustment is performed with logistic regression models or hierarchical multilevel models. The advantages and disadvantages of these methods have been debated [22,23], but both types of models might be suboptimal discriminators between good and poor performers.

Hierarchical versus Nonhierarchical Models

Hierarchical modeling is currently the preferred method for both hospital and physician quality comparisons because it accounts for the "clustered" nature of observations. When comparing hospitals, individual procedures within a particular hospital are not truly independent from one another. Rather, they are related because of the characteristics associated with the particular facility. Hierarchical models are given this nomenclature because they account for the fact that the data are organized in tiered fashion: procedures are

clustered within patients, patients are clustered around physicians, and physicians are clustered around institutions.

Another advantage is that these models can limit widely varying estimates that can occur due to small sample size. Hierarchical models that use “Bayesian” or “empirical Bayesian” methods employ “shrinkage,” in which point estimates for RAMR are moved closer toward the mean. The rationale is to reduce wide fluctuations in RAMR that might occur due to chance, and to mitigate potential type I error due to multiple hypothesis testing. Consequently, Bayesian hierarchical modeling approaches tend to identify fewer statistically significant differences than classical modeling, but it is uncertain whether this correction is an accurate reflection of risk. If an outlier is identified, however, it is more likely that the observation is real; conversely, this type of model makes it very unlikely for a low-volume hospital or provider to be identified as an outlier. Because RAMR using hierarchical models might preferentially identify larger volume facilities as outliers, a “level playing field” might not exist if such statistics are used to compare hospitals with one another.

Reporting of Point Estimates Rather Than 95% cis

Some models report only point estimates because the 95% CIs are wide (due to low death rates). Point estimates can mislead the public by appearing to delineate differences in RAMR, when in reality; showing statistical significance might be nearly impossible when sample sizes are small. Rank ordering or categorization of provider quality is misleading when based on uncertainly associated RAMR point estimates and should be discouraged because it falsely implies a high level of precision.

Performance of RAMR Models in Lower Volume Databases Relating to Individual Hospitals or Individual Operators

An important reason why very high-risk patients are not removed from most risk adjustment models is that, if allowed, there would be considerably fewer deaths remaining in the dataset to evaluate. Censoring deaths at the high end of risk could render the models nonpredictive, causing the regression equations to lose stability. It is possible that there might be no remaining statistical differences among programs or operators. For example, the mortality in AMI is nearly 10 times higher than all other patient subgroups, largely driven by poor outcomes in cardiogenic shock. If these cases are excluded, residual mortality becomes very low, and the number of lower-risk patients needed is too large to allow meaningful discrimination among institutions.

CAN THE PUBLIC ACCURATELY INTERPRET RAMR?

It is unusual for the public to possess the statistical background necessary to accurately interpret RAMR and to use the data to choose the best provider. One reason is that they are unable to identify optimal outcomes for a particular dataset (Table II). Once a death occurs, regardless of the clinical circumstances, the correction factor does not adjust the RAMR to zero. It is unlikely that the public understands the proper context of nonzero values, and might misperceive that >0 mortality necessarily signifies poor quality. It is crucial to

recognize that patient mortality might occur despite the best clinical decision-making and technical skill.

In current public reporting programs, the guidelines that inform consumers how to interpret the data are difficult to comprehend due to the complexity of statistical methodology; the fact that crude mortality rate depends strongly on case mix is not clarified. The public does not appreciate the limitations of risk adjustment to completely correct for differences in patient populations [5,7,24].

DOES PUBLIC REPORTING LEAD TO RISK AVOIDANCE?

Experience in states that have implemented reporting programs confirms that facilities and operators develop risk-averse behaviors to avoid being identified as outliers. This reaction can lead to poorer patient outcomes when patients who have the most to gain from a high-risk procedure do not receive treatment. Reluctance to perform high-risk procedures that might save lives, based on apprehension of reported outcomes, is an unintended detrimental consequence of public reporting.

In comparing PCI outcomes in the states of Michigan (a state with collaborative quality improvement [CQI]) and NY (which mandates public reporting) using NCDR registry data, Boyden et al [25] found that patients undergoing PCI in NY had a lower-risk profile, with a lower proportion of patients with AMI and cardiogenic shock, compared with Michigan. In a propensity-matched analysis, patients in NY who had PCI were less likely to be referred for emergent, urgent, or salvage procedures (odds ratio [OR] 0.67; 95% CI 0.51–0.88; $P < 0.0001$), and had lower in-hospital mortality (OR 0.72; 95% CI 0.63–0.83, $P < 0.0001$). Thus, mandated public reporting in NY was associated with fewer high-risk patients undergoing PCI compared with CQI in Michigan.

Moscucci et al. [26] compared the pre-procedural severity of illness of PCI patients in NY with eight Michigan hospitals. These investigators found that NY patients were less likely to undergo PCI for AMI, cardiogenic shock, and cardiac arrest. The unadjusted in-hospital mortality rate was significantly lower in NY than in Michigan (0.8% vs. 1.5%; $P < 0.0001$), whereas there was no significant difference in RAMR between the two regions (adjusted OR 1.05; $P = 0.70$). These results could be suggestive of risk avoidance of high-risk patients driven by the fear of public reporting of procedural mortality rates in NY.

In contrast, Cavendar et al. [27] used the NCDR to evaluate over 1.3 million PCIs in a 2-year period, comparing outcomes from three states that had mandated public reporting (MA, NY, PA) with those that did not. They found that, relative to patients treated in nonpublic reporting states, those who underwent PCI in public reporting states had similar *predicted* in-hospital mortality (1.39% vs. 1.37%; $P = 0.17$) but lower *observed* in-hospital mortality (1.19% vs. 1.41%; adjusted OR 0.80; 95% CI 0.74–0.88; $P < 0.001$). Fewer patients in states with mandated public reporting underwent PCI for cardiogenic shock or salvage procedures, suggesting risk avoidance in PCI case selection. However, 47% of included PCIs were elective; because risk is low in such patients, risk avoidance behavior is less. Only 2.2% had shock in reporting states, and few were high-risk. None of these studies [25–27] were able to

assess risk avoidance directly, since the study populations were limited to only those patients undergoing PCI; patients not undergoing PCI were not assessed.

Additional evidence of risk avoidance comes from physician surveys. Narins et al. [28] reported that a survey of interventional cardiologists showed that 79% “agreed” or “strongly agreed” that publication of statewide PCI report cards has, in certain instances, influenced their decision to perform PCI. Furthermore, 83% of interventionists “agreed” or “strongly agreed” that patients who might benefit from PCI might not receive the required procedure as a result of public reporting of physician-specific mortality rates.

Risk avoidance is also suggested through an analysis of patients with AMI that includes both those undergoing and not undergoing PCI. Joynt et al. [6] evaluated almost 100,000 Medicare patients with AMI in 10 Northeastern states and found that in three states with public reporting of outcomes, 12% fewer PCI procedures were performed, with the greatest difference in STEMI and cardiogenic shock/arrest patients, compared with seven nonreporting states. In MA, the odds of receiving PCI for AMI were comparable to the odds in non-reporting states prior to public reporting (40.6% vs. 41.8%; OR 1.00; 95% CI 0.71–1.41). However, after implementation of public reporting, odds of undergoing PCI in MA decreased compared with nonreporting states (41.1% vs. 45.6%; OR 0.81; 95% CI 0.47–1.38; $P=0.03$ for difference in differences). There was a significant decline in the proportion of patients presenting with AMI who were treated with PCI in MA, which began concurrently with the onset of public reporting (Fig. 1), with the differences most pronounced in those with cardiogenic shock or cardiac arrest. However, 30-day mortality in PCI patients did not differ between public reporting and non-reporting states; the unadjusted rates were 12.8% vs. 12.1%, respectively. This study shows that public reporting does not result in improved outcomes or quality-of-care, but may lead to avoidance of high-risk cases.

Additional evidence of risk-avoidance in the setting of public reporting comes from analyses of patients presenting with emergent and high-risk conditions such as AMI, shock, and cardiac arrest. Apolito et al. [4] analyzed the prospectively collected SHOCK (Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock) Trial registry dataset. After propensity score adjustment, NY patients were less likely than non-NY patients to undergo coronary angiography (OR 0.46; 95% CI 0.31–0.68; $P<0.001$) and PCI (OR 0.51; 95% CI 0.33–0.77; $P=0.002$) for shock. Although post-PCI and post-CABG mortality was numerically lower for centers in NY (the only public reporting state), compared with centers in other states, RAMR was significantly higher in NY (Fig. 2). The RAMR of non-revascularized patients was >2-fold greater in NY patients versus non-NY patients. Moreover, NY patients waited longer to receive CABG: only 32.3% of NY patients vs. 75.5% of non-NY patients ($P<0.001$) had CABG within 3 days of shock onset.

Most recently, Waldo et al. (8) analyzed data from the Nationwide Inpatient Sample in patients presenting with AMI and found that states with public reporting (NY and MA) tended to have lower adjusted rates of PCI, particularly for STEMI and cardiac arrest/shock. Although adjusted mortality was lower in patients with AMI undergoing PCI in reporting states (confirming Cavender et al), the *overall* adjusted mortality for patients with MI was significantly *higher* in reporting states (adjusted OR 1.21; 95% CI 1.06–1.37). Consistent

with the concern for risk avoidance, any mortality advantage gained by PCI with public reporting appeared to be offset by the increased mortality in those patients who did not undergo PCI for AMI in public reporting states (Fig. 3).

SHOULD THERE BE EXCEPTIONS FOR HIGH-RISK PATIENTS?

Two approaches have been suggested to mitigate risk avoidance behavior: removing very high-risk patients from the reported statistics; or creating separate models, one for routine cases and one for high-risk cases [29]. Ideally, neither ought to be necessary; the strength of the model depends on the numbers of cases in each risk category, the value of the variables entered into the model, and whether the models adequately account for case mix. Unfortunately, there is often insufficient discrimination in the intermediate and high-risk ranges of most databases, especially when high-risk patients are underrepresented in the sample used to construct the model [30]. This problem is exacerbated when high-risk patients are excluded from reporting. Many registries contain patients at the low and the high ends of risk but are not well populated in the intermediate range, primarily because such patients are typically referred for CABG or are treated medically. Because the discrimination in this range is low, the model would be invalid for these patients.

Although excluding subgroups of patients can be problematic, NY now excludes patients with refractory cardiogenic shock and those with post-AMI cardiac arrest and hypoxic brain injury from RAMR calculations. This exclusion was granted specifically so operators could use their clinical judgment and treat such patients without fear of being labeled an outlier in a public report. In MA, two additional variables were created using clinical information that was not collected in the standard data collection process and that are used in the determination of RAMR. The first, the compassionate use variable, is defined based on presentation with coma, ongoing CPR at the time of initiation of the procedure, or high-risk anatomy/presentation, including left main stenoses in conjunction with AMI or PCI of the last remaining patent coronary vessel [5]. A second group of high-risk cases, called exceptional risk, is defined as (1) having extremely high-risk features not captured by current risk adjustment covariates; or (2) procedures for which PCI was the only or best option for improving chances of survival. Exceptional risk cases are excluded from public reporting. Patients who underwent PCI for compassionate use were found to have a 27-fold increase in the odds of in-hospital death *after* adjustment for other risk factors and comorbid conditions [29]. Although these cases comprised only 1.7% of all PCIs, the inclusion of a variable to reflect their risk increased the predictive accuracy of the risk model (c-statistic increased from 0.87 to 0.90; $P < 0.01$).

McCabe et al. [31] used the Nationwide Inpatient Sample 2002–2012 hospitalization data to compare data from NY with several other states, including MA, CA, and Michigan (Figs. 4 and 5). The results demonstrated that, since the exclusion of shock in 2006 in the NY program, PCI for patients presenting with AMI and shock increased by 28% compared with only 9% in other states ($P < 0.001$). Simultaneously, adjusted overall in-hospital mortality in patients with MI presenting with shock decreased by 24% in NY compared to 9% in comparator states. Similarly, Bangalore et al [32] examined the rates of angiography, PCI, or CABG in NY vs. the states of Michigan, New Jersey and CA before and after the policy

change. Once again, a significantly higher proportion of the patients underwent invasive management (cardiac catheterization, PCI, or CABG) or revascularization (PCI or CABG) after the exclusion of cardiogenic shock from public reporting in NY.

Another special group are those needing revascularization who were “turned down” for CABG [11–13,33]. There are multiple reasons for surgical turndown, including calcified aorta, severe co-morbidities, frailty, cachexia, and other clinical and anatomic variables. Surgical turndown status is associated with sixfold greater in-hospital mortality and threefold greater long-term mortality [31]. These high-risk patients are not properly accounted for by current risk-adjustment methods because the registries do not capture the necessary variables. As an unmeasured confounder, surgical turndown status may be so significant that it might partly explain the apparently higher mortality observed with PCI compared with CABG in comparative outcome studies [34,35].

Controversy remains whether removing high-risk cases enhances or diminishes the power of RAMR models to assess quality. Patient characteristics that are not adequately accounted for in risk models have the potential to create biased results that falsely raise or lower measured performance, especially if such characteristics are both prognostically important and unevenly distributed [36]. Removal of the highest-risk patients from RAMR would increase the likelihood that such patients receive needed care without fear on the part of providers that an adverse outcome would negatively affect their own report card. A major concern is whether this could constitute a “loophole,” whereby operators can “game the system” by classifying as many patients as possible as high-risk exclusions [37]. This might require independent adjudication and verification of correct categorization.

HOW ACCURATE IS INDIVIDUAL OPERATOR RAMR?

Public reporting at the operator level implies that poor outcomes are entirely related to operator technique or clinical judgment. However, most commonly, poor outcomes are due to acuteness of presentation, comorbidities, and organizational factors, rather than operator-related factors [17,18].

The limitations of RAMR for facilities are amplified when applied to individual physicians, partly because of the smaller numbers involved.

- Risk-adjustment models have their greatest validity in large populations. Models are statistical formulas that are approximations derived from reported outcomes, and hence can be influenced by errors in data collection (stochastic errors). The impact of such errors would be magnified when there are fewer cases.
- Subdividing data into subsets by individual operator, and then applying population-based models to calculate RAMR per operator, might not be valid due to stochastic error and multiplicity. The models are based upon assumptions about underlying distributions of clinical factors that might or might not be correct in a small selected subgroup of a single operator.
- The number of data points for any individual operator are too few, and the resulting CIs too wide, to draw firm conclusions. The median number of PCIs

performed annually by US operators ranges from 50–70 procedures, with a skew to the low end of distribution [38,39]. This very low sample size makes it doubtful that an accurate RAMR can be calculated on an annual basis.

An alternative approach to an annual calculation is to extend the collection interval. NY reports the individual operator risk-adjusted mortality calculated from the accumulated data over the three consecutive preceding years; however, the validity of this approach is controversial [37]. Aggregating individual physician data over several years to increase sample size is not necessarily valid. Changes that occur in medical therapies, technologies, and practice patterns over a long time frame (e.g., 3 years) make aggregated individual physician data unrepresentative and unreliable.

In an analysis of 3240 hospitals, Paddock et al [40] raised questions about the ability of statistical benchmarks to summarize provider performance distribution and highlighted the high variance of benchmarks for low-volume providers. Such data are unlikely to identify outliers (“superior” or “inferior” performers) in a valid way.

CONCLUSIONS

SCAI remains supportive of public reporting as a means to stimulate public interest in obtaining high-quality health care. Increasing the transparency and relevance of clinical data released to the public will encourage institutions and providers to strive for improvements in outcomes. A summary of SCAI’s recommendations to improve public reporting methods is found in Table III. In addition to the RAMR and its components (OMR, EMR, and their ratio), SCAI strongly recommends that public reporting programs feature a collection of non-mortality outcome metrics (Table IV). Optimally, a complete set of measures that assess case acuteness, appropriateness, resource allocation, and adverse events, such as bleeding and vascular complications, would be conveyed.

Although the public reporting of RAMR appears to be a necessary component of reporting outcomes, SCAI does not support its use as the sole or summary measure of quality. RAMR following PCI is a convenient but flawed and incomplete metric for the evaluation of operator and hospital quality. It is strongly recommended that RAMR be de-emphasized, because its value in discriminating performance quality is uncertain and directly leads to risk avoidance in case selection.

Fair comparisons among providers and hospitals require accurate risk adjustment to account for case selection and a clear presentation of its limitations. An imprecise or inadequate accounting of risk can misrepresent the quality of care being provided. Risk adjustment helps refine the appraisal of mortality, but cannot substitute for a complete assessment of all elements of care in complex situations. This assessment can only be accomplished by a careful and timely adjudication of procedural mortality at the level of the local facility.

The unintended consequence of reporting RAMR is the risk-averse behavior it produces. Risk avoidance behavior is counterproductive to public health, and it can no longer be ignored that public reporting leads inevitably to this result. Public reporting of outcomes in high-risk patients can lead to behaviors aimed at “gaming the system.” It might misidentify

risk-averse individuals who are marginal performers as being outstanding operators. For these reasons, SCAI provisionally supports reporting RAMR both inclusive and exclusive of high-risk cases.

SCAI advocates that patients with do not resuscitate orders and those who have out-of-hospital cardiac arrest or cardiogenic shock should be excluded from public reporting after internal review confirms the accuracy of this categorization. Surgical turndowns represent another high-risk group of patients. SCAI supports collection of surgical turndown data within registries. The reason for a surgeon's reluctance to operate might be highly predictive [33], and should be evaluated in depth. SCAI encourages further studies in this category to allow the various subsets of surgical turndown cases to be studied in detail and to identify subgroups that should be excluded in the future. It is strongly recommended that public reporting transition away from *procedure-related* risks to institutional risk-adjusted outcomes reporting for *disease* states.

Operator-specific mortality measures are imprecise and are subject to a multitude of inaccuracies. SCAI expresses profound concern about the validity of reporting the RAMR for individual operators. Public reporting of outcomes in high-risk patients, if done at all, should accurately reflect the performance of those operators and institutions. Perhaps in the future there will be ways to construct operator-specific mortality statistics that are valid for assessing individual operator quality. At the present time, however, such methods do not exist, especially for the highest risk patients.

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Fig. 1. Trends in treatment of AMI with PCI in MA and in neighboring non-reporting states. (From Ref. 6 with permission). [Color figure can be viewed at wileyonlinelibrary.com]

Fig. 2. Mortality in the SHOCK Trial registry for NY State versus the rest of U.S. (From Ref. 4 with permission). [Color figure can be viewed at wileyonlinelibrary.com]

Fig. 3.

In-hospital mortality for patients presenting with AMI stratified by Public Reporting and PCI status, 2005–2011. (From Ref. 8 with permission). [Color figure can be viewed at wileyonlinelibrary.com]

Fig. 4.

Adjusted risk of patients with cardiogenic shock and myocardial infarction receiving PCI per year compared to Non-New York states in 2002. NY (blue) and control states (red). Error bars represent 95% confidence intervals. Based on data from Ref. 31. [Color figure can be viewed at wileyonlinelibrary.com]

Fig. 5. Adjusted risk of in-hospital death compared for patients with cardiogenic shock and myocardial infarction per year compared to Non-New York states in 2002. NY (blue) and control states (red). Error bars represent 95% confidence intervals. Based on data from Ref. 31. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE I

Summary of state reporting

	New York (NY STATE)	Massachusetts (MASS-DEC)	Texas (THCIC)	Washington (COAP)
Basis for public reporting	Regulatory	Legislative	Legislative	Hospital Consortium Agreement
Year initiated	1991	2003	2009	2013
Public release level	Hospital and Individual MD	Hospital	Hospital	Hospital
Outcome of interest	In-hospital/30 day mortality rate (1 yr and 3 yr cumulative), 30 day readmissions	In-Hospital Mortality (30-day mortality to start w/ 2014 Report)	In-hospital mortality and mean charges per case	In-hospital adjusted mortality, Door-to-balloon time, Proportion of Appropriate Use PCI
Risk adjustment method	RAMR	Hierarchical SMIR	RAMR	RAMR
Data source	Case level clinical data	Case level clinical data	Hospital inpatient administrative data	Case level clinical data
Case stratification	Results reported for all cases and separately for Non-emergency cases	Stratified Reports: STEMI/Shock and No STEMI or Shock	No stratification	Reported for MI and non-urgent separately
Latest report released	October, 2015	October, 2015	2015	June, 2014
Data included in latest report	2010–2012	2013	2012	2013
Number of PCI hospitals (latest report)	60	24	198	34
Number of PCI operators	390	~160	Not Reported	Not Reported
Number of PCI	47,396 (2012) 152,579 (2010–2012)	12,132	32,660	~12,000
Observed overall mortality	1.00%	1.57%	1.70%	1.90%
Data quality audit method	Audits of all cases of shock and stent thrombosis	MD volunteers review all mortalities and high-risk covariates.	No case level audits	No case level audits
Exclusions (year)	Refractory Cardiogenic Shock (2006) Cardiac Arrest with Brain Injury (2010)	Exceptional Risk – Simultaneous Life-threatening condition (2009)	No public release of results for centers with <30 PCI cases Rural hospitals not required to report	None
Risk-adjustment refinement (year)	None	Compassionate Use Risk Adjustment (2006) - includes coma on presentation, STEMI with last remaining vessel.	None	None

TABLE II

Public reporting: example

Suppose a patient reviewed the operators in his area and had these 4 to choose from, and this data provided: Operator A: RAMR = 0.0, Operator B: RAMR = 0.5, Operator C: RAMR = 1.5 Operator D: RAMR = 1.1. Who should the patient choose to perform his procedure? Although many consumers would prefer operator A, and would likely eschew operator C given the median national RAMR = 1.3, the correct answer is that there isn't enough data presented to distinguish the good and bad operators: without OMR, EMR, or total volume, since few operators are doing >500 procedures/year, 1 or 2 deaths could be the difference among those RAMR values, and the deaths may have occurred in very high-risk patients. One can calculate case mix risk from EMR, by calculating OMR/RAMR, if OMR > 0, when OMR is known. However, that cannot be done with 0 OMR. Therefore, an operator with 0 OMR has an uncertain case selection and may be risk averse. The number of cases might provide some in-sight into this situation.
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TABLE III

Summary of SCAI recommendations to improve public reporting

In the future, PCI public reporting programs should:	
<ul style="list-style-type: none">• Transition from procedure based to disease based reporting<ul style="list-style-type: none">○ Include the risk adjusted survival statistics for those patients undergoing PCI and those patients not undergoing PCI for a given presenting diagnosis• De-emphasize the importance of RAMR as a summary metric• Avoid rank ordering of programs based on RAMR point estimates• Patients suffering out-of-hospital cardiac arrest and those patients with pre-existing DNR orders should be excluded from all public reports of PCI outcomes.<ul style="list-style-type: none">○ Adjudication of high-risk classification should be made at the local facility level• Hospital specific risk adjusted mortality should be reported in two ways: including and excluding specific high-risk patient cohorts.• Refrain from reporting physician-specific RAMR following PCI• Incorporate quality of care measures beyond RAMR (as shown in Table IV)	

TABLE IV

Additional metrics to include in public reports

Quality of care measures beyond RAMR should be incorporated into all public reporting efforts, including:	
<ul style="list-style-type: none">•	Proportion of patients with “rarely appropriate” indications by an improved and validated appropriate use criteria scheme
<ul style="list-style-type: none">•	Incidence of patients developing contrast induced nephropathy requiring subsequent therapy
<ul style="list-style-type: none">•	Incidence of patients with bleeding and vascular complications requiring subsequent therapy
<ul style="list-style-type: none">•	Proportion of patients free of repeat revascularization at one year following index PCI (not including first 30 days for planned staged PCI).
<ul style="list-style-type: none">•	Case volume included in the sample (both institutional and operator)
<ul style="list-style-type: none">•	Surveys of patient satisfaction, patient experience, and quality of life, especially anginal status post PCI

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