
Editorials

Readmissions for coronary artery bypass graft surgery: an important supplementary outcome

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Introduction

Coronary artery bypass graft (CABG) surgery is possibly the most studied procedure in the medical literature, perhaps because of its high-tech nature, its cost, and the frequency with which it is performed (particularly in the United States). Numerous studies have identified significant risk factors for CABG surgery¹⁻⁸, explored the provider (hospital and/or surgeon)-volume-outcome relationship⁹⁻¹⁵, compared outcomes for different types of CABG surgery (e.g., on-pump vs off-pump)¹⁶⁻²¹, and have compared risk-adjusted provider outcomes^{1-3,8}. However, despite all of the attention that CABG surgery has received, the only adverse outcome that has been investigated in most studies is short-term mortality, usually in-hospital mortality. This is not surprising because short-term mortality is arguably the most important and most severe outcome and short-term, especially in-hospital, mortality is the most easily accessible and most objective of all possible adverse outcomes.

However, there are reasons why in-hospital mortality may not be sufficient and may be misleading when it is being used as a measure of provider quality. First, as a result of quality improvement initiatives and technical advances in surgery, anesthesia, and aftercare, in-hospital mortality has decreased substantially in recent years. For example, in 1989, the first year of the New York State Cardiac Surgery Reporting System Registry, the in-hospital mortality rate was 3.52%. By 2001, the in-hospital mortality rate in New York had fallen to 2.18% despite the fact that many patients with the lowest risk (patients with one-vessel and

two-vessel disease) who would have undergone CABG surgery in 1989 were undergoing percutaneous coronary interventions in 2000. Consequently, mortality has now become a relatively rare event, perhaps rare enough that it has become more difficult to distinguish among hospitals on the basis of mortality rates.

Another important adverse outcome of coronary artery bypass graft surgery

In a recent manuscript in the *Journal of the American Medical Association*, Hannan et al.²² examined another adverse outcome, readmission within 30 days after a live discharge following CABG surgery using data from all live discharges of New York State residents in 1999. The authors found that 12.9% of all live CABG surgery discharges were readmitted to an acute care hospital (not necessarily the one in which they underwent CABG surgery) within 30 days after discharge for complications related to CABG surgery.

Reasons for readmission

There were a variety of reasons why patients were readmitted, with the most frequent ones being infections (28.3% of all readmissions related to CABG surgery), heart failure (15.7%), myocardial ischemia/acute myocardial infarction (7.9%), arrhythmia (7.7%), pulmonary thromboembolism/deep vein thrombosis (6.3%), and respiratory and other chest symptoms (5.6%).

This information is important because knowledge about complications of care enable hospitals and surgeons to identify what process of care changes/initiatives can be undertaken to improve quality. This is because many of the most frequent reasons for readmission have well-proven prophylaxis measures that can be used to reduce their occurrence. For example, numerous studies provide evidence of the ability to prevent/reduce the occurrence of postoperative atrial fibrillation²³, deep vein thromboses and pulmonary embolism²⁴, and surgical site infections²⁵⁻²⁷ for cardiac surgery. Thus, hospitals with high risk-adjusted readmission rates can apply well-established strategies in order to reduce these rates. Furthermore, by reducing the occurrence of complications, mortality rates should decrease because mortality rates among patients with complications are considerably higher than mortality rates for patients without complications. If hospitals have access only to their risk-adjusted mortality rates and how they compare with the rates of other hospitals, they are not armed with enough information to effectively reduce adverse outcomes because there are many reasons why mortality rates can be high, and it is not clear what processes of care should be undertaken or improved.

Risk factors for readmission

The study by Hannan et al.²² also identified patient demographics and comorbidities, provider characteristics, and postoperative factors that were significant predictors of readmissions within 30 days of discharge following CABG surgery in a multivariable statistical model that controlled for other factors. Patient characteristics associated with higher readmission rates included older age, female sex, African-American race, greater body surface area, previous myocardial infarction within 1 week prior to CABG surgery, and six comorbidities (chronic obstructive pulmonary disease, diabetes, hepatic failure, dialysis, congestive heart failure, and femoral/popliteal disease). Two provider characteristics (annual surgeon CABG surgery volume < 100, and hospital risk-adjusted mortality rate in the highest tertile (the abstract reports highest decile but this is incorrect as reported in table III of the manuscript) were also associated with higher readmission rates. Also, two postoperative factors (discharge to a nursing home or rehabilitation/acute care facility and postoperative length of stay during the index admission of ≥ 5 days) were associated with higher readmission rates after controlling for other factors.

With respect to the patient characteristics, most (older age, female sex, recent myocardial infarction, and the comorbidities) were identified as significant predictors of in-hospital mortality in earlier New York studies and other studies^{1-3,8}. Although African-American race had not been identified in earlier New York

studies, it has been a variable that has been close to being a significant multivariable predictor in previous studies. The one variable that did prove to be a significant predictor of readmissions that had not emerged in any previous New York studies was higher body surface area. Although body surface area had been identified as a significant predictor of mortality, it was patients with lower body surface areas (presumably a proxy for smaller vessel sizes) who were found to have higher mortality risks in earlier studies. An interesting follow-up study would be to explore the reasons for readmission for patients with high body surface areas and to determine if there is some threshold body surface area at which the risk of readmission becomes particularly high.

The two postoperative factors related to significantly higher readmission rates are not altogether surprising. Clearly, patients who are discharged to nursing homes and rehabilitation facilities tend to be older and frailer than their counterparts who are discharged home after surgery. However, since older age is already contained in the statistical model, the emergence of discharge destination indicates that the need for extensive nursing care or rehabilitation is a significant factor above and beyond advanced age. Furthermore, to the extent that many of these patients can be identified well before discharge, this finding underscores the need to practice optimal processes of care for these patients prior to discharge.

The two provider characteristics that proved to be significant independent predictors of higher readmission rates were annual surgeon CABG surgery volume < 100 and hospital risk-adjusted mortality rate in the highest tertile. Since annual surgeon volume has been shown to be related to risk-adjusted mortality rate^{10,13}, both measures are indicative of a relationship between provider risk-adjusted mortality rates and risk-adjusted readmission rates for CABG surgery.

Relationship between in-hospital mortality and readmissions for coronary artery bypass graft surgery

It is important to explore the nature and strength of this relationship between a hospital's inpatient mortality and its readmissions within 30 days of discharge following CABG surgery when evaluating the advisability of using risk-adjusted complication rates as a supplement to risk-adjusted mortality rates when evaluating provider performance and quality. Arguably, a second quality measure should not be highly correlated on a provider level with risk-adjusted mortality because if it were it would be largely redundant and there would be no need to use it as measure of quality since mortality would suffice. On the other hand, if the measure were totally uncorrelated with risk-adjusted mortality, this would raise serious questions as to whether it was

actually a measure of quality. As mentioned above, the Hannan et al.²² study found that hospital risk-adjusted mortality rate was a significant predictor of readmissions within 30 days, controlling for patient risk factors and postoperative factors. However, the hospital-level correlation between risk-adjusted mortality and risk-adjusted readmissions within 30 days was a modest 0.09 ($p = 0.64$). These two facts suggest that risk-adjusted readmissions may be a quality measure that is capturing a different component of quality than mortality.

This hypothesis seems to make sense based on the findings of an earlier study of in-hospital complications of surgery by Silber et al.^{28,29}, although our interpretation of the findings may not be the same as the authors of that paper. Silber et al. found that mortality rate does not correlate well with complication rate, but does correlate well with failure rate (the tendency for patients with complications to die). Since readmissions related to the index CABG surgery are merely delayed complications, Silber's findings would appear to be relevant for readmissions as well. Thus, readmissions reflect complications that are frequently related to the quality of surgery and aftercare, and mortality represents the ability to rescue patients who suffer complications and (indirectly) the ability to avoid complications.

It should also be noted that if complications that require early readmission are worth identifying and using as a measure of quality of care, then surely complications that occur during surgery or during the index admission for surgery are worthy of being used as a quality measure also. Ideally, a risk-adjusted complication measure would include as adverse outcomes all complications that extend the length of stay (or extend it by some minimum number of days) as well as all complications that result in readmission within a short period of time.

This can easily be done by individual hospitals as a means of internally recording and improving outcomes. However, using complications that occur during the index admission in a system that compares outcomes for numerous hospitals in a state, region, or country is problematic because of the difficulty of guaranteeing the accuracy and completeness of the data. The accuracy of patients' preoperative risk factors can be audited relatively easily because hospitals with high rates of specific risk factors can be identified and the medical records of the relatively small percentage of patients who have the risk factor can be reviewed. However, if hospitals appear to be under-reporting complications because they report very low rates, all of the cases without complications would have to be reviewed to determine if they have occurred. Thus, in conclusion, it is certainly advisable for individual hospitals to monitor in-hospital complications as a means of improving their overall quality of care, but the use of these measures as part of public dissemination efforts like those in several US states is probably premature as a result of

the difficulty of ascertaining the accuracy and completeness of complications across hospitals.

Caveats

Although it would appear to be a very valuable exercise for individual hospitals to identify and track readmissions and their cause for purposes of internal quality improvement, there are caveats related to the use of risk-adjusted complication rates for public reporting of outcomes and for comparing readmission rates across hospitals or surgeons. The primary caveat is that it is possible that patients who require treatment for complications occurring after discharge from CABG surgery will be recommended for outpatient treatment by some physicians and inpatient treatment by others. This could lead to readmission rates that are affected by practice pattern variations and are therefore not an objective means of evaluating the quality of CABG surgery and inpatient care in the same admission. Furthermore, if it were known that hospitals/surgeons were being evaluated on the basis of their rates of readmission within 30 days, there would be a temptation for them to treat patients who are best off with inpatient care on an outpatient basis.

Obviously, another caveat is the arbitrary nature of choosing 30 days as the cut-off for readmissions that are included as adverse outcomes. It is possible that a longer or shorter period of time should be used, and this is a topic for further study. However, some cut-off has to be chosen, and this means that there will be instances in which two readmissions within a day of one another will be treated differently (one as a complication and one as no complication within the time interval chosen).

Conclusion

In conclusion, readmissions within a relatively short period of time following CABG surgery for reasons related to surgery provide valuable opportunities for hospitals and surgeons to improve their quality of care because complications relating to the need for readmission can be linked to appropriate processes of care. Future research should be aimed at using information on complications occurring during the index admission for CABG surgery or complications necessitating short-term readmissions to examine the advisability of new/proposed processes of care and to assure that processes that are already known to be effective (e.g., the use of beta-blockers, aspirin, and internal mammary artery grafts)³⁰⁻³² are being used.

Risk-adjusted readmission rates also offer promise as a complementary adverse outcome measure to be used along with risk-adjusted mortality rates as a means of assessing relative provider quality. Future re-

search in this area that would be beneficial would be further examination of the hospital- and surgeon-level relationship between risk-adjusted inpatient mortality and risk-adjusted readmission rate as well as examination of the variation in readmission practices for patients undergoing complications subsequent to discharge following CABG surgery.

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