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EDITORIAL

The Benefits and Pitfalls of the Use of Risk Stratification Tools in Cardiac Surgery

Akshat Saxena, MBBS, MS [a,b], Vikrant Dhurandhar, MBBS [a,b,c], Paul G. Bannon, MBBS, PhD [a,b,c], Andrew E. Newcomb, MBBS [d*]

[a]Department of Cardiothoracic Surgery, Royal Prince Alfred Hospital, Sydney, NSW, Australia
[b]Discipline of Surgery, Sydney Medical School, The University of Sydney, Sydney, NSW, Australia
[c]The Baird Institute, Sydney, NSW, Australia
[d]Department of Cardiothoracic Surgery, St Vincent's Hospital Melbourne, Melbourne, Vic, Australia

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Risk assessment tools are increasingly used in surgery. In cardiac surgery, risk models are used for patient counselling, surgical decision-making, performance benchmarking, clinical research, evaluation of new therapies and quality assurance, among others. However, they have numerous disadvantages which need to be considered. This article evaluates the utility of risk assessment tools in cardiac surgery including a discussion of their advantages and disadvantages.

Keywords Cardiac surgery • Risk stratification • Mortality • AusScore • EuroScore

Background

From its experimental background, cardiac surgery has become an indispensible tool in the armamentarium against congenital and acquired cardiovascular disease. In the last two decades, the continuous improvements in all aspects of healthcare have transformed cardiac surgery from a relatively morbid undertaking to a safe and effective treatment for cardiac disease. This has been reflected by the reduction in perioperative mortality and morbidity and improved long-term survival in patients despite an increased incidence of co-morbidities and advanced age (>65 years) in patient populations. A review of Australian data from 2001 through 2012 showed a 30-day mortality of 1.7% and 1.9% in patients undergoing isolated coronary artery bypass graft (CABG) surgery and aortic valve replacement (AVR), respectively [1,2]. In contrast, high-volume institutions in the 1980s and 1990s routinely reported 30-day mortality of between 3-6% [3,4]. A review of American data as collected by the Society of Thoracic Surgeons (STS) shows a continuous reduction in operative risk over time. Ferguson and colleagues [3] demonstrated that observed operative risk decreased by 23.1% (3.9% to 3.0%) from 1990 to 1999 ($p<0.001$) despite a 30.1% increase in predicted risk. A subsequent analysis of American patients undergoing isolated primary CABG showed that observed mortality decreased from 2.4% to 1.9% from 2000 to 2009 (relative risk reduction of 24.4%) despite no change in predicted risk.

Importance of Risk Assessment in Cardiac Surgery

Despite these improvements, cardiac surgery remains a major undertaking. It is imperative to preoperatively assess a patient's suitability for surgery by objectively evaluating their risk profile. Risk scoring algorithms are most commonly used for this purpose. They are usually generated from large, multi-institutional databases which have collected a variety of data points (patient demographics, intraoperative details, postoperative complications) on certain disease processes or surgical procedures. Statistical methods are then employed to determine which variables are associated with a good or bad outcome (e.g. 30-day mortality). The variables that are

*Corresponding author at: Department of Cardiothoracic Surgery, St Vincent's Hospital Melbourne, 59 Victoria Parade, Fitzroy, Victoria, Australia, 3065.
Tel.: +61 3 9411 7111., Email: andrew.newcomb@svha.org.au

relevant are then used to construct a risk scoring algorithm, again using specialised statistical tools. The algorithm can then be used to estimate the risk for future patients, assuming of course, that the prognostic factors identified in previous patients will be similar to those in future patients.

Standardised risk assessment for invasive procedures is important and useful for three main tasks in cardiac surgery (Table 1). The first is to inform patients and clinicians about risk. It is essential to provide a thorough explanation of potential risks to patients, particularly given that there may be non-surgical approaches available to them and to their clinicians that modify risks, especially in high-risk patients. This is particularly important in the contemporary era, when there is an expectation for clinicians to provide information to patients of potential risks and of alternative, non-surgical approaches. In fact, in current clinical practice, the allocation of patients to treatment is largely guided by risk-benefit assessment. For example, surgical aortic valve replacement (AVR) remains the gold-standard intervention for patients with severe aortic stenosis. In patients adjudged to be ''high risk'' as per risk assessment tools, however, surgical AVR may not be appropriate. In these ''high risk'' patients, studies have shown that transcutaneous aortic valve implantation (TAVI) may improve symptoms and survival [5,6]. Overall, risk assessment assists clinicians and patients in choosing the most suitable treatment option.

Secondly, collection of risk assessment data allows us to benchmark the performance of particular units against the general population. Arguably, the improved outcomes in cardiac surgery in recent decades have been influenced by the increased scrutiny on patient outcomes. Improvements in outcome can be correlated with changes in clinical practice through registries which are used to collect risk assessment data; for example, reductions in observed mortality versus predicted mortality have been traced to the increased use of the internal mammary artery for revascularisation [7,8]. Risk assessment data may identify underperforming units and thereby lead to internal or external audit of clinical practice with a view to improving patient outcomes. They also allow comparison between patient demographics and outcomes globally.

Table 1 Summary of potential uses of risk scoring systems.

Potential Uses of Risk Scoring Systems
1 Inform patients and clinicians about risk (i.e. patient counselling)
2 Benchmark performance of particular units against general population
3 Monitor impact of innovative new therapies
4 Evaluate the efficacy on investment of health promotion strategies
5 Improved data management

Thirdly, risk assessment is an important research tool. It allows us to monitor the impact of innovative new therapies on outcomes. In cardiac surgery, for example, the safety of novel operative techniques such as off-pump cardiac surgery has been established by comparing the safety and efficacy of this procedure in patients with a similar risk profile who underwent conventional on-pump surgery [9,10]. Risk assessment allows us to determine whether improvements in clinical practice have been made through standardised comparison of observed morbidity and predicted morbidity over time. Moreover, risk assessment allows identification of patient subgroups for whom it may be useful to evaluate alternative treatments, for example, ''high risk'' patients with valvular heart disease. Simply put, risk assessment facilitates innovation and scientific discovery.

Application of Risk Assessment tools in Cardiac Surgery

Given the considerable benefits of the collection and analysis of risk assessment data, several risk assessment scoring systems have been developed for cardiac surgery. The majority were developed to predict risk of operative mortality [11]. Non-fatal outcomes have been difficult to assess accurately because of the low incidence of some outcomes for patients undergoing cardiac surgery. The most common significant non-fatal outcomes after cardiac surgery include permanent stroke (0.5-2%), acute myocardial infarction (0.5-2%), new renal failure (4-6%) and return to theatre (6-10%) [1,2,12]. Early studies used single institution data to generate a risk prediction algorithm, while more recent studies have used multi-institutional data with larger patient samples [13–16]. This explains why there is significant variation in the clinical factors incorporated for the assessment of risk in the various scoring systems, because of variations in the patients being studied. Some factors, however, such as advanced age, non-elective procedures, acute renal failure and impaired left ventricular function have been ubiquitously associated with poorer outcomes [11,13–16].

The most commonly used scoring systems are the European System for Cardiac Operative Risk Evaluation (EuroSCORE) and the American Society of Thoracic Surgeons (STS) risk score [15–17]. Both of these can be easily accessed online and provide a near immediate assessment of a patient's risk of perioperative mortality provided their co-morbidities are accurately known. Studies have validated both scoring systems [18,19]. These scoring systems, however, must be used with caution (Table 2). Studies have also shown that they may overestimate the risk of operative mortality, especially in high-risk groups [20,21]. A study on the applicability of the EuroSCORE in an Australian patient cohort, for example, showed that it over-estimated the risk of operative mortality by a factor of 2 [20]. If the EuroSCORE alone was used to select patients for surgery, many patients who would have a reasonable outcome may be inappropriately excluded. Scoring systems have also been