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ORIGINAL ARTICLE

When is 'Urgent' Really Urgent and Does it Matter? Misclassification of Procedural Status and Implications for Risk Assessment in Cardiac Surgery

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Background Many patients classified as ''urgent'' in Australia New Zealand Society of Cardiac and Thoracic Surgeons (ANZSCTS) registry contradict the prescribed definition (surgery within 72 hours of angiogram or unplanned admission). The aim was to examine the impacts of this misclassification on the prediction of 30-day mortality following cardiac surgery.

Methods The 'reported clinical status' was compared with a 'corrected clinical status' following reclassification based on the standard definition calculated from raw data. Observed-to-predicted risk ratios (OPRs) of 30-day mortality were calculated for the model using reported status and corrected status and compared. A Bland-Altman plot was generated to examine the level of agreement between the two OPRs.

Results Of 18496 cases reported as urgent, 49.9% were operated after 72 hours, leading to misclassification of 14.6% in the registry. Misclassified patients had significantly higher mortality (3.5%) than true urgent patients (2.9%). Underweight (OR:1.6,CI:1.2-2.1), dialysis (OR:1.4,CI:1.1-1.7), endocarditis (OR:2.1,CI:1.7-2.5), shock (OR:1.6,CI:1.3-2.0) and poor ejection fraction (OR:1.2,CI:1.1-1.4) were significant predictors of misclassification. Bland- Altman plot demonstrates significant disagreement between two risk estimates (P<0.001). Misclassification results in overestimation of risk by 9.1%. Observed-to-predicted risk increased with corrected definition (0.8975 vs 0.9875), suggesting poorer calibration with reported status.

Conclusions In the ANZSCTS database, misclassification prevalence is 14.6%. Misclassification compromises the discrimination capacity and calibration of the model and results in overestimation of mortality risk.

Keywords Clinical status • Misclassification • Global model • Risk prediction • Cardiac surgery • 30-day-mortality

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Introduction

The Australian and New Zealand Society of Cardiothoracic Surgery (ANZSCTS) Database Program was established in 2001 with the aim of reporting risk adjusted clinical outcomes for patients undergoing surgery. The registry has developed a number of risk prediction equations that have been shown to provide the best available estimates of pre-operative risk which enables confidence in benchmarking performance at a national and international level [1–4]. Fundamental to the process of establishing the registry was the development and agreement of a standard data set and definitions to be used by all centres participating in the program [5,6]. The variable 'Clinical status' captures data relating to the clinical urgency of a patient (whether Elective, Urgent, Emergency, or Salvage).

It has been observed by the ANZSCTS registry that some cases in the database did not meet the criteria of ''urgent'' because surgery was undertaken more than 72 hours after an angiogram. This misclassification of clinical urgency first surfaced in the report, Victorian Cardiac Surgery Database Program Public Report 2009–2010 [7]. As clinical status classification is one of the major outcome predictor variables in the risk prediction models developed from the database, the misclassification of urgent cases has the potential to affect the prediction of mortality.

We hypothesised that patients classified as ''Urgent'' but where surgery was undertaken more than 72 hours after an angiogram or after unplanned admission, would represent a stable, lower risk group, and that these patients were better classified as elective cases. The aim of the current research is to a) determine the extent of misclassification of ''Urgency''; b) to identify the predictors of urgent status misclassification; and c) to assess its impact on estimates of 30-day mortality risk.

Material and Methodology

The ANZSCTS database is a large, multicentre registry which has been collecting data for 14 years. Currently, 28 cardiac hospitals across Australia are contributing data on surgical procedures into the registry. The database consists of 287 pre-operative, intra-operative and post-operative variables. Data elements were defined and adapted from internationally standardised data definitions [5,6]. The index outcome of 30-day-mortality is defined as death within 30 days post-procedure. The database contains all information of patients, who had cardiac surgery during 1 July 2001 to 2013, from the participating centres over their period of involvement. The institutional review board of each participating hospital had approved the use of these databases for research; hence, the need for individual patient consent was waived for this study. The study received ethical approval from Monash University, Standing Committee on Ethics in Research Involving Humans (SCERH).

Definition of 'Clinical Status'

In the ANZSCTS Data definition manual [5] 'clinical status' has been categorised into Elective, Urgent, Emergency and Salvage. *Elective* refers to the status where the procedure could be deferred without increased risk of compromised cardiac outcome. *Urgent* refers to the status where the procedure is not routine, there is a medical reason for operating this admission, a) within 72 hours from angiography if on the same admission that angiography was performed OR b) within 72 hours after an unplanned admission. *Emergency* refers to unscheduled surgery required in next available theatre on the same day due to refractory angina or cardiac compromise. *Salvage* refers to the status where the patient is undergoing CPR en-route to the operating room, that is, prior to surgical incision. Clinical status is recorded as a check-box entry on a web-based entry system or data record form at the time of the procedure. Misclassification of urgent clinical status was calculated by determining the difference between the time of admission and the time of the procedure recorded in the database. Those procedures which were check box recorded as urgent but had a calculated surgery time greater than 72 hours following catheterisation or unplanned admission were identified as misclassified. The data is presented as 'Reported' versus 'Corrected' clinical status.

Statistical Methods

a) Extent of misclassification. Descriptive statistics were generated to determine the extent of the misclassification.
b) Predictors of misclassification. The association of relevant pre-operative characteristics to misclassification was investigated through cross-tabulation and chi-square analysis. Predictors of misclassification among reported urgent cases were investigated using multiple logistic regression analysis.
c) Impact on estimates of 30-day mortality. The 30-day-mortality risk was re-estimated with all procedure 30-day mortality risk prediction model for cardiac surgery (global model) 4 using both reported and corrected definitions of urgency. Predicted mortality estimates were calculated separately with reported and corrected definitions of 'clinical status'. Observed-to-predicted risk ratios (OPRs) of mortality were calculated for the models with reported and corrected definitions of clinical status. Percentage change of OPR following reclassification of cases was assessed. A Bland-Altman plot [8] was generated to evaluate the agreement between the two OPRs. The 95% limits of agreement for each comparison (average difference $\pm$ 1.96 x standard deviation of the difference) were computed. The difference between the OPR was then regressed on the average of the two risk ratios. Both the risk ratios were then stratified into categories of each variable in the existing all procedures model.
d) Statistical software packages Stata (version 12) [9] and Medcalc 6.1 [10], where appropriate, were used for all analyses.