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Risk Prediction Models for Cardiac Morbidity and Mortality in Noncardiac Surgery: A Systematic Review of the Literature

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Background: Risk models for the prediction of cardiac morbidity and mortality are recommended as part of the stepwise preoperative assessment of patients undergoing noncardiac surgery in the American College of Cardiology/American Heart Association 2007 guidelines. However, no systematic comparison of the different risk prediction models has previously been published. We have conducted a systematic review of the discriminative precision of models used to predict cardiac morbidity and mortality in patients undergoing noncardiac surgery.

Methods: Inclusion criteria included all papers validating models for the prediction of perioperative cardiac adverse events, as well as those which validated known cardiac risk prediction models for other outcomes, such as long-term survival. A search of MEDLINE and EMBASE from 1980 until July 2009 led to 126,567 articles being screened; 34 papers describing 13 models were included in the final analysis. We assessed both the predictive precision of the models and the quality of the included studies.

Results and Discussion: The Lee Revised Cardiac Risk Index (Lee RCRI) performed best in direct comparison with other scores such as the Goldman and Detsky indexes. However, the area under the receiver operating characteristic curve (AUROC) for the Lee RCRI in most studies since its original validation was between 0.6 and 0.7, indicating only moderate predictive precision; yet when novel modifications of the Lee RCRI included more information relating to the type of surgery, discrimination improved. Newer models, such as that developed and validated from the National Surgical Quality Improvement Program (NSQIP) database, demonstrated superior discrimination but have not been validated in more than one study. Of note, the NSQIP model included variables which are not traditionally thought to be associated with cardiac outcomes, and did not include others, such as a history of ischemic heart disease, which are elements of most other cardiac risk prediction models. The quality of validation studies varied widely, with only half the studies being conducted in multiple centers, half using prospective data collection, and nine studies using small (< 100 patient) cohorts. There was also considerable variation in the outcome measures used, making direct comparison between different studies difficult.

Conclusions: It is likely that modifications of the Lee RCRI using more detailed information on the proposed surgical procedure would result in improved precision. We recommend that future work should focus on refining the Lee RCRI, and also use logistic regression analysis in multicenter cohorts to identify risk factors which may not be traditionally associated with adverse cardiac outcomes and which, if included in risk models, may improve their predictive precision.