Development, validation, and comparative analysis of a simple clinical and laboratory-based risk score system for predicting and stratifying moderate-to-severe AKI after cardiac surgery

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Background: Cardiac Surgery-Associated Acute Kidney Injury (CSA-AKI) is prevalent and detrimental following cardiac surgery, without effective prevention. Early prediction and stratification are critical in informing appropriate care. Recent studies highlighted the predictive value of some routine laboratory markers in addition to traditional clinical variables. However, existing models suffer from complexity and practical difficulties in implementation.

Purpose: We aim to develop a high-performance preoperative risk score system for predicting moderate-to-severe CSA-AKI, while preserving its simplicity and utility through the integration of the most predictive and routinely accessible clinical and laboratory variables.

Methods: A total of 14,303 patients undergoing coronary artery bypass grafting surgery at a single institution, with comprehensive perioperative data, were included. Cohort 1 (N=9,416, 2013-2017) and cohort 2 (N=4,887, 2018-2019) were used to develop and validate a risk score system for predicting moderate-to-severe CSA-AKI, respectively, according to the Kidney Disease: Improving Global Outcomes (KDIGO) guidelines. Bootstrapped stepwise regression was employed to select the robust candidate variables for a logistic regression model (i.e., the full model), which was then simplified to a more parsimonious model. Model performance was evaluated and compared to several established models.

Results: The overall incidence of moderate-to-severe CSA-AKI was 3.5% in the entire cohort. Two preoperative risk scores were developed: the simple 6-variable ABC2-Surgery2 score (age, a biomarker of NT-proBNP, two clinical status variables of hypertension and preoperative critical state, and two surgery-related variables of combined surgery and on-pump surgery), and the complete 10-variable AB2C3-Surgery4 score (ABC2-Surgery2 plus an additional biomarker of blood urea nitrogen, a clinical status variable of Canadian Cardiovascular Society angina class, and two surgery-related variables of urgent surgery and previous surgery). In the validation cohort, the simple score (area under the curve, AUC 0.765) outperformed the previously established UK-AKI model (AUC 0.720), Mehta score (AUC 0.700), and Ng score (AUC 0.697), while statistically similar to the most complex 19-variable Cleveland Clinic Score (AUC 0.725). The complete score (AUC 0.777) was superior to all four models. The current score system also effectively stratified CSA-AKI with respect to requirements for vasoactive support (measured by cumulative vasoactive-inotropic score), intravenous diuretics, and renal replacement therapy, as well as in-hospital and long-term mortality.

Conclusion: A simple risk score system incorporating routine clinical and laboratory variables was developed to predict and stratify moderate-to-severe CSA-AKI and outperformed previous complex models. Further external validation is currently underway for generalizability.
Figure. Comparing AUCs of different models to predict moderate-to-severe CSA-AKI in the temporal validation set (2018-2019, n=4887). The simple model with only 6 variables performed significantly better than the UK-AKI score, the Mehta, and the Ng score, while similar to the Cleveland Clinic Score. Whereas, the full model with 10 variables are statistically better than all four models; AUC, area under the curve; Vars, variables.