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Predictive value of plasma brain natriuretic peptide for postoperative cardiac complications—A systemic review and meta-analysis ☆

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ABSTRACT

Background: We aimed to undertake a systematic review and meta-analysis of studies addressing perioperative natriuretic peptide (NP) levels to predict postoperative major adverse cardiac events (MACE) after major surgery.
Methods: We searched MEDLINE and Embase with no language restrictions up to May 2013. The end points were major cardiac complications. We summarized test performance characteristics with the use of forest plots, hierarchical summary receiver operating characteristic curves, and bivariate random effects models.
Results: Of the 662 retrieved articles, 24 studies satisfied the predefined eligibility criteria, including 5438 patients along with 712 (13.1%) events. After major surgery, the diagnostic odds ratio (DOR) of NP in predicting postoperative MACE was 14.3 (95% confidence interval [CI], 9.87-20.7) for overall population, 13.9 (8.43-22.8) for patients undergoing cardiac surgery, and 15.0 (8.84-25.5) for patients undergoing noncardiac surgery. The pooled sensitivity was 0.84 (95% CI, 0.79-0.88) and specificity was 0.76 (95% CI, 0.71-0.81). Postoperative measurement (DOR, 18.9; 7.68-46.3) was associated with higher predictive value than preoperative measurement (DOR, 13.6; 7.68-46.3). Results were similar for a subgroup with the composite outcome including mortality (DOR, 16.4; 10.6-25.5). B-type natriuretic peptide was associated with higher predictive accuracy (area under the summary receiver operating characteristic, 0.84; 0.81-0.87) than N-terminal pro–b-type natriuretic peptide (area under the summary receiver operating characteristic, 0.90; 0.87-0.92).
Conclusions: The existing literature suggests that perioperative NP testing have reasonable accuracy and can be useful in perioperative risk stratification. Natriuretic peptide testing has high rule-out value and low rule-in value for predicting postoperative MACE. Medical decisions should be made in the context of these characteristics.

1. Introduction

Patients with multiple risk factors undergoing major surgery carry high mortality and morbidity. Most patients did not die due to the operation itself but die due to the development of major cardiac complications associated in the perioperative period [1]. Early identification of patients at highest risk preoperatively allows early close monitoring and early preventive medical intervention such as perioperative β blockade or hemodynamic optimization, which may result in improved outcome and reduced cardiac complications.

Currently existing risk assessment instrument, such as the Revised Cardiac Risk Index, were developed in patients undergoing major elective noncardiac surgery and may not be generalized in many other high-risk surgeries [2]. American Heart Association and the American College of Cardiology recommend stress testing and/or echocardiography for preoperative risk assessment but may be impractical in emergency surgery [3]. A readily available "biomarker" that can assist with risk stratification would therefore be of particular value in this situation.

B-type natriuretic peptide (BNP) or its inactive cleavage product N-terminal pro–b-type natriuretic peptide (NT-proBNP) is secreted

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mainly from the left ventricle in response to pressure and volume overload. Systemic physiologic effects of natriuretic peptides (NPs) include natriuresis, diuresis, and vasodilation [4]. Several studies have shown its ability to predict perioperative major adverse cardiovascular events (MACE) including atrial or ventricular arrhythmia, myocardial infarction, or sudden cardiac death [5–31].

Several meta-analyses have demonstrated that increased NT-proBNP levels predict short- and longer term cardiac complications [4,32,33]. However, these meta-analyses reported odds ratio (OR) as the primary effect measure and did not report pooled estimates of sensitivity, specificity, or likelihood ratio [34]. For a diagnostic test, likelihood ratio can be used to calculate posttest probability of an event, which is critical for clinical decision or explanation of the risk of surgery to the patients. In addition, none of these analyses provided comprehensive comparison of the predictive performance between BNP and NT-proBNP tests. Recent individual patient's data analyses, though reporting sensitivity and specificity measures, could not include as many studies as done in an aggregate data meta-analysis [35]. The small number of studies available also did not allow subgroup analysis on multiple categories of clinical interest. We therefore carry out an updated systemic review and meta-analysis to summarize data on the association between NP values and cardiac complications in adult patients.

2. Methods

2.1. Data sources and searches

We performed this meta-analysis in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines. We searched MEDLINE and Embase for studies published through May 2013 with the following Medical Subject Headings terms and free text: "natriuretic peptide," "surgery," "cardiac complications," "myocardial infarction," "cardiac death," "ventricular tachycardia," "ventricular fibrillation," and "major adverse cardiac event." There were no restrictions on language, population, or publication year. We did not search abstracts from conferences, proceedings, or clinical trial registries. Instead, we manually reviewed the bibliographies of relevant studies, reviews, and meta-analyses to identify references we may have missed during our primary search. Selection was performed independently by 2 reviewers. The authors of the included trials were contacted for missing information if necessary. Discrepancies between the reviewers were resolved by a consensus meeting with a third reviewer.

The studies were screened for title and abstract in the first round, and potentially relevant articles were retrieved for full-text review in the second round. To be eligible for inclusion, the studies had to fulfill the following criteria: (1) have a study population of consecutive patients (age >18 years) undergoing cardiac or noncardiac surgery, (2) assess a BNP or NT-proBNP test in the perioperative period, (3) use perioperative cardiac death, acute coronary syndrome, heart failure, arrhythmia, or cardiogenic shock as one of the primary end point and (4) include calculation of sensitivity, specificity, or OR or have sufficient data to construct a 2×2 contingency table.

We excluded case reports, case series, review articles, editorials, and clinical guidelines. Full-text articles were retrieved if any of the reviewers considered the abstract suitable. The study inclusion and exclusion process is summarized in Fig. 1.

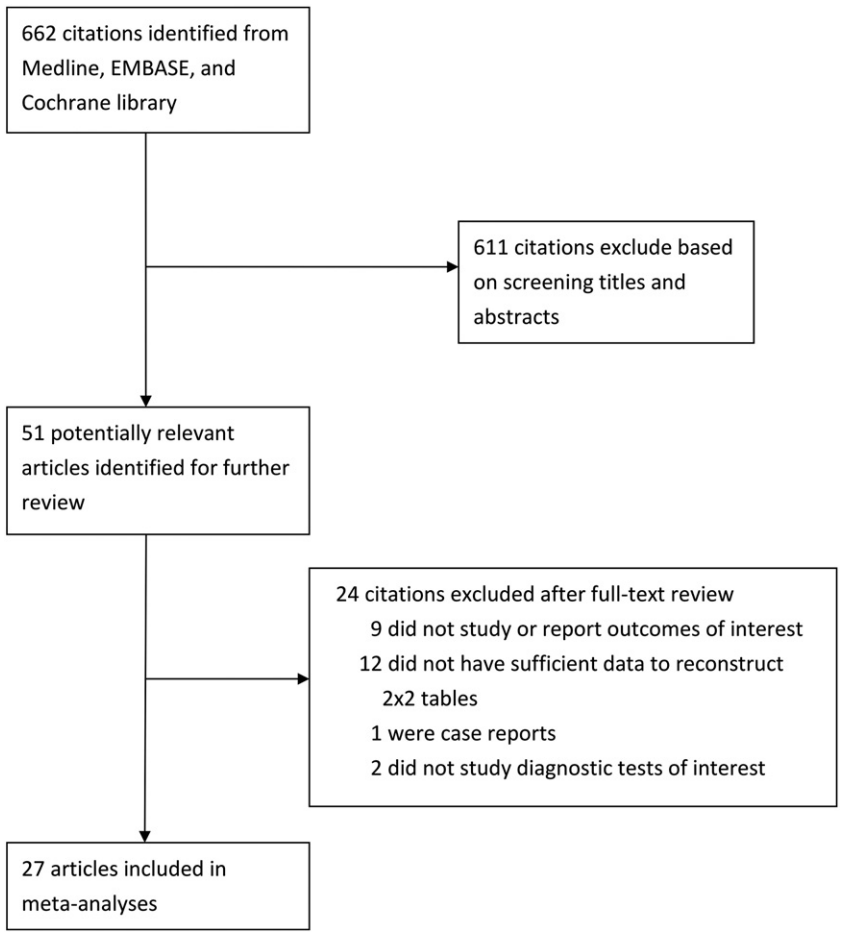

Fig. 1. Flow chart of study identification and inclusion.