

# Prognostic Significance and Clinical Utility of Intraventricular Conduction Delays on the Preoperative Electrocardiogram

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**The prognostic significance of the preoperative electrocardiogram (ECG), particularly intraventricular conduction delays (IVCDs), on postoperative outcomes among patients undergoing noncardiac surgery is uncertain. In a retrospective cohort, we evaluated the risk associated with preoperative IVCDs on in-hospital death and postoperative myocardial infarction (POMI). The 152,479 patients who underwent noncardiac surgery were categorized by preoperative electrocardiographic findings: normal (36.1%), left bundle branch block (LBBB, 1.2%), right bundle branch block (2.9%), nonspecific IVCD (3.3%), and any other ECG abnormality (56.5%). The primary and secondary outcomes were postoperative in-hospital mortality and POMI, respectively. In multivariable-adjusted models, compared with normal ECGs, each electrocardiographic abnormality category was associated with increased risk of postoperative death: LBBB odds ratio (OR) 1.89 (95% confidence interval [CI] 1.35 to 2.65), right bundle branch block OR 1.73 (95% CI 1.33 to 2.24), nonspecific IVCD OR 1.95 (95% CI 1.53 to 2.48), and other abnormal ECG OR 1.94 (95% CI 1.68 to 2.25). ECGs with conduction delays did not confer increased risk of postoperative death compared with other ECG abnormalities. Moreover, receiver operating characteristic analysis of models incorporating demographic and co-morbidity data demonstrated marginal additive benefit of any electrocardiographic data. Risk of POMI was not significantly increased among ECGs with conduction delays compared with both normal and other abnormal ECGs. In conclusion, patients with intraventricular conduction disease, including LBBB, on preoperative ECG are not at greater risk of postoperative in-hospital death or POMI compared with patients with other ECG abnormalities. Furthermore, any preoperative electrocardiographic abnormalities, including intraventricular delays, provide marginal clinical utility beyond demographic and clinical history for predicting postoperative in-hospital death or POMI. © 2018 Elsevier Inc. All rights reserved. (Am J Cardiol 2018;■■■:■■■–■■■)**

An electrocardiogram (ECG) is often obtained to aid assessment of perioperative cardiovascular risk and guide perioperative management. Although some studies have demonstrated increased postoperative risk associated with abnormal ECGs,<sup>1,2</sup> more recent data have questioned the added utility of this test.<sup>3–5</sup> Accordingly, some guidelines recommend against preoperative ECGs for asymptomatic patients undergoing low-risk surgery.<sup>6,7</sup> Conduction abnormalities, in particular left bundle branch block (LBBB), have a known association with coronary artery disease (CAD) and have been associated with an increased risk of death.<sup>8–13</sup> Consequently, in preoperative evaluation, conduction abnormalities may lead to further

cardiac testing. With increasing awareness of cardiovascular co-morbidities, however, such preoperative electrocardiographic findings as markers of prognosis may be of lesser value. A few small studies suggest that intraventricular conduction delays (IVCDs) may be of limited value in predicting postoperative myocardial infarction (POMI).<sup>5,14,15</sup> Nevertheless, more definitive data are lacking. Using a large single-center cohort, we sought to quantify the association between preoperative ECG abnormalities, specifically intraventricular conduction delays, and the postoperative risk of in-hospital death or POMI.

## Methods

The Vanderbilt University Institutional Review Board approved this retrospective, single-center cohort study. Since 2000, a Perioperative Data Warehouse has been maintained by the Department of Anesthesiology at Vanderbilt University Medical Center. Using this resource, we retrospectively identified patients with an available preoperative ECG who underwent anesthesia for any operative procedure from February 2000 to September 2015. The most recent ECG preceding the procedure was used, and all were clinically read by institutional cardiologists.

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See page xx for disclosure information.

These data were previously presented in a moderated poster session at the American College of Cardiology 2016 National Conference.

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An overview of the study population is shown in [Figure 1](#). Of 383,725 surgical cases with an available preoperative ECG, we identified 152,479 unique adult patients who underwent noncardiac surgery for inclusion in the postoperative death analysis. A total of 7,179 patients with available troponin data within 30 days of the index surgery were included in the POMI analysis. Patients younger than 18 years, deceased organ donors, patients who underwent cardiac or obstetric procedures, and patients with an uninterpretable ECG were excluded. For patients with multiple anesthesia encounters, only the first was included to reduce the effect that previous postoperative complications, or lack thereof, might have on the likelihood of undergoing future surgeries.

Patients were categorized into 5 groups according to clinically reported ECG findings: normal, LBBB, right bundle branch block (RBBB), nonspecific IVCD, and all other ECG abnormalities. Only those ECGs without any abnormalities cited in the clinically reported read were classified as normal. All ECGs with any abnormality (including arrhythmias) that did not include findings on LBBB, RBBB, or IVCD were included in the abnormal ECG group. A subset of 100 ECGs was abstracted and reinterpreted by a cardiologist to adjudicate appropriate assignment to the 5 categories. None required reassignment. Of the 11,278 with any conduction disease, 28 included 2 types of IVCD patterns in the final read (e.g., “IVCD consistent with LBBB”); these were individually reassigned.

Our perioperative database and electronic medical record were queried for covariates including age, gender, urgency of surgery, American Society of Anesthesiologists (ASA) physical status classification, and Revised Cardiac Risk Index (RCRI). The ASA classification is a 1 to 6 scale assigned to each patient: 1 for healthy, 2 for mild systemic disease, 3 for severe systemic disease, 4 for severe systemic disease that is a constant threat to life, 5 for a moribund patient not expected to survive without the surgery, and 6 for a declared brain dead organ donor. The RCRI is a 1 to 6 scale used to estimate perioperative cardiac risk and assigns 1 point each for heart failure (HF), CAD, cerebrovascular accident or transient ischemic attack, insulin-dependent diabetes mellitus, renal failure, and a planned high-risk surgical procedure.<sup>2</sup> To

assessment, the RCRI score was calculated using database information, and it was used as a covariate in adjusted models.<sup>2</sup> HF, CAD, cerebrovascular accident, or transient ischemic attack were considered present if noted in the preoperative evaluation or coded in previous discharge documentation. *International Classification of Disease* (ICD)-9 codes listed in [Supplementary Table S1](#) were used, and the most recent case occurred before the ICD-10 transition. Insulin-dependent diabetes mellitus was considered present if home medications included insulin. Renal failure was considered present if any creatinine in the 6 months preceding the procedure was  $\geq 2.0$  mg/dl or if laboratory data were absent but the preoperative evaluation documented renal failure. RCRI data that were missing were considered absent when calculating the RCRI score. A subset of 50 charts was abstracted to confirm accurate data extraction, and none required adjustment of clinical history assignments.

High-risk surgical procedures were defined using the RCRI definition as well.<sup>2</sup> Primary current procedural terminology codes were reclassified into 1 of 244 clinically meaningful categories using the Clinical Classification Software for Services and Procedures developed by the Agency for Healthcare Research and Quality.<sup>16</sup> These 244 categories were classified as high risk or non-high risk according to the definition used by Lee et al.<sup>2</sup> If no procedure code was available, the procedure was considered non-high risk.

The primary outcome was the occurrence of postoperative in-hospital death from any cause. Vital status at hospital discharge was available on every patient and was ascertained through linkage with our institution’s electronic health record. The secondary outcome was POMI, defined as a circulating troponin level greater than the upper limit of normal within 30 days of the initial procedure. Thresholds utilized to define POMI based on the troponin assays at Vanderbilt University Medical Center varied over time: February 2000 to November 1, 2007, troponin T  $> 0.05$  ng/ml; November 2, 2007, to September 30, 2013, troponin I  $> 0.05$  ng/ml, and October 1, 2013, to the most recent case included, troponin I  $> 0.03$  ng/ml.

Recognizing that a positive troponin does not necessarily represent a clinically significant event and that baseline

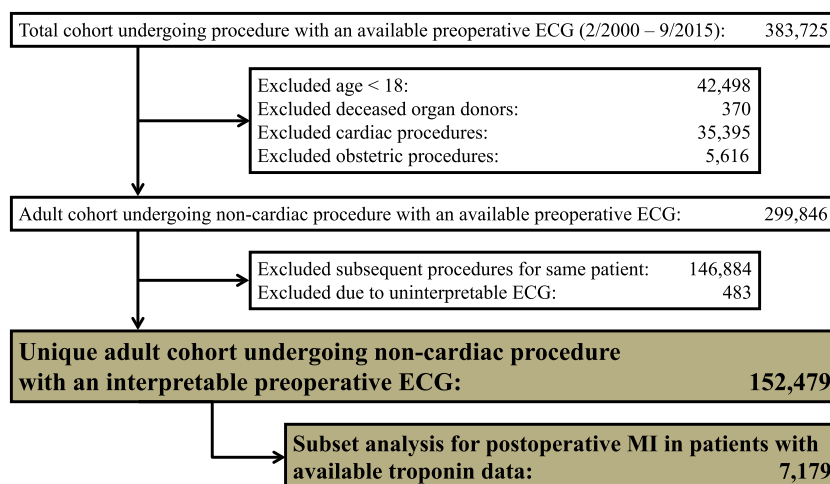


Figure 1. Patient selection and exclusion criteria.

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