The Value of Routine Preoperative Electrocardiography in Predicting Myocardial Infarction After Noncardiac Surgery

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Objective: The added value of a preoperative electrocardiogram (ECG) in the prediction of postoperative myocardial infarction (POMI) and death was compared with clinical risk factors identified from the patient's history.

Summary of Background Data: An ECG is frequently performed before surgery to screen for asymptomatic coronary artery disease. However, the value of ECG abnormalities to predict POMI has been questioned.

Methods: The study included 2967 noncardiac surgery patients >50 years of age from 2 university hospitals, who were expected to stay in the hospital for >24 hours. All data were obtained from electronic record-keeping systems. Patient history and ECG abnormalities were considered as potential predictors. Multivariate logistic regression analysis was used to obtain the independent predictors of POMI and all-cause in-hospital mortality. The area under the receiver operating characteristic curve (ROC area) was estimated to evaluate the ability of different models to discriminate between patients with and without the outcome.

Results: A preoperative ECG was available in 2422 patients (80%) and 1087 (45%) of the ECGs showed at least one abnormality. The ROC area of the model that included the independent predictors of POMI obtained from patient history, ie, ischemic heart disease and high-risk surgery, was 0.80. ECG abnormalities that were associated with POMI were a right and a left bundle branch block. After adding these abnormalities in the regression model, the ROC area remained 0.80. Similar results were found for all-cause mortality.

Conclusions: Bundle branch blocks identified on the preoperative ECG were related to POMI and death but did not improve prediction beyond risk factors identified on patient history.

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All patients scheduled for surgery are evaluated by the surgeon and anesthesiologist to identify conditions that predispose the patient to adverse perioperative outcomes.[1–4] Postoperative cardiovascular morbidity and mortality are accurately predicted by variables determined from the patient history (eg, the Revised Cardiac Risk Index[5]), yet additional laboratory testing is frequently ordered as a means of identifying the asymptomatic patient at risk.[1–4]

Electrocardiograms (ECGs) are frequently performed in patients aged over 50 or 60 years to screen for asymptomatic coronary artery disease.[1–4] The predictive value of ECG abnormalities has been questioned, and ECG results appear to exert weak influence on clinician behavior.[3,4,6–8] Recent studies suggest that abnormalities detected on the preoperative ECG in patients undergoing higher risk surgery may predict postoperative or long-term cardiovascular death.[9,10] It is unclear if preoperative ECG abnormalities improve upon patient history in identifying the patient at risk for adverse postoperative outcomes, like myocardial infarction.

The purpose of this study was to estimate the value of a preoperative ECG in addition to patient history in the prediction of myocardial infarction and death from all causes during the postoperative hospital stay. Patients from 2 university hospitals from different countries were included to increase the generalizability of the results of this study.

METHODS

Patients

The study included noncardiac surgery patients aged over 50 years who were expected to stay in the hospital for more than 24 hours. Patients scheduled for lung and liver transplantations were excluded. Patients were operated on between February 2002 and August 2003 at the University Medical Center Utrecht (UMCU), The Netherlands, and between March 2003 and July 2004 at the University Health Network Toronto (UHNT), Canada.

UMCU Data

Data on patients from the UMCU were prospectively collected during a previous study including 4540 adult patients, which was approved by the hospital ethics board.[11] Data on preoperative history, physical examination, and additional testing (including preoperative ECG results) were collected in an electronic record-keeping system. An ECG was performed in all patients over 60 years of age or when

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clinically indicated. Postoperative outcome data on general surgery and vascular surgery patients were stored in an electronic record keeping system used by the general and vascular surgeons. All laboratory test results (coded with time of the test) were stored in a laboratory data warehouse. A postoperative Troponin I was ordered only when clinically indicated. Data on in-hospital death were stored in the hospital information system database. After linking these databases using unique hospital identification numbers, the data download included 766 patients admitted at the general and vascular surgery wards.

UHNT Data

Following approval by the institutional research ethics board, preoperative history data on all patients undergoing surgery at the UHNT were prospectively stored in a clinical registry system. An ECG was normally done in patients over 50 years of age. Preoperative ECG results were archived in a Cardiology database. All laboratory test results (coded with time of the test) were stored in a data warehouse along with ICD 9 and 10 codes. In all patients identified as high risk before surgery (Revised Cardiac Risk Index[5] >2), a Troponin I was drawn in the Post Anesthetic Care Unit. This was also done in patients noted to have intraoperative hypotension and/or ST changes. Thereafter, Troponin I was ordered when clinically indicated. Postoperative outcome data were collected in an Acute Pain Service database. Data on in-hospital death were stored in the hospital information system database. Linking all these diverse databases using the patient's unique hospital identification resulted in a comprehensive report of each patient's in-hospital visit. The download of the data comprised in total 2201 patients from different surgical specialties.

Thus, the final sample for the present study included 2967 patients, aged 50 years or older, who underwent noncardiac surgery in 2 different hospitals.

Predictors

Patient history data that were considered as potential predictors for postoperative myocardial infarction (POMI) included gender, age, the Revised Cardiac Risk Index (RCRI)[5] and the single predictors that are included in this risk index, ie, scheduled for high-risk surgery, a history of ischemic heart disease (IHD), a history of congestive heart failure (CHF), a history of chronic renal failure (CRF), a history of cerebrovascular accident (CVA) or a history of insulin dependent diabetes. Definitions of these conditions were similar to those used by Lee et al[5] The RCRI groups patients into 4 classes, according to the existence of 0, 1, 2, or 3 or more predictors.

The computerized interpretation of the ECG was reviewed and verified by a cardiologist before entry into the patient's electronic record. ECG abnormalities were categorized as: normal ECG, right bundle branch block (RBBB), left bundle branch block (LBBB), any ST-T changes, ischemia specific ST-T changes, old myocardial infarction (Q wave), atrial fibrillation, and left ventricular hypertrophy.

Outcome

The primary outcome was POMI, which was defined as a maximal Troponin I greater than 0.7 ng/mL and associated with at least one of the following: new Q waves at the ECG, persistent ST changes at the ECG, a new regional wall motion abnormality using echocardiography or clinical symptoms (chest pain or shortness of breath). The diagnosis of MI was confirmed independently. Death from all causes during hospital admission was considered as a secondary outcome.

Analysis

SPSS for Windows release 12.0.1 (SPSS Inc., Chicago, IL) was used for the analysis. Odds ratios (OR) were chosen to describe the relationship between predictors and outcomes. OR are equivalent to the more common relative risk ratio when the occurrence of outcome is less than 5%. A univariate OR with 95% confidence interval (95% CI) and a P value was calculated for each predictor using univariate logistic regression analysis. Any OR with a P value of <0.10 was considered as a potential independent predictor.[12] A similar approach was followed to estimate the incidences of outcomes for the different ECG abnormalities and to estimate the univariate associations with outcome.

The incidences of POMI and all-cause mortality were estimated for each of the 4 categories of the RCRI as well as for the single predictors included in the RCRI and for age and gender. Logistic regression models predicting POMI were fitted using RCRI as the only predictor (Model 1). Subsequently, backward stepwise multivariable logistic regression modeling was used to quantify the predictive ability of each of the 6 single predictors that are included in the RCRI (model 2). Gender and age (included as a continuous variable) were added to model 2 and their independent value in the prediction of POMI was quantified (model 3). Finally, to quantify the added value of the ECG, all ECG abnormalities that were found to be significantly associated with POMI in the univariable analysis were entered into model 3 and again backward stepwise regression was used to found the independent associations with POMI (model 4). As an ECG was not available in all patients, we did a complete case analysis in this final model.

A similar multistep modeling approach was used to identify predictors of all-cause mortality. Model 2 included CRF and CHF in addition to IHD and high-risk surgery. Male gender and age were added in model 3. ECG abnormalities were added in model 4.

The area under the receiver operating characteristic curve (ROC area) with 95% CI was estimated to evaluate the ability of the models to discriminate between patients with and without outcome.[12–15] The reliability (calibration or goodness of fit) of all models was quantified using the Hosmer & Lemeshow test.[15]

RESULTS

The baseline characteristics of the included patients from both hospitals differed with respect to gender, age, and type of surgery (Table 1). Patients from the UHNT were more frequently scheduled for high-risk surgery, but UMCU patients were more frequently scheduled for vascular surgery, resulting in significantly more patients with IHD and CVA from the UMCU (Table 1). As a result of the different age threshold for performing a routine ECG before surgery, an

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TABLE 1. Baseline Characteristics

	Toronto (n = 2201)	Utrecht (n = 766)	Total (n = 2967)	P*
Male gender	1260 (57.2)	401 (52.3)	1661 (56.0)	0.02
Age (yr) [mean (SD)]	65.2 (9.2)	64.2 (9.1)	64.9 (9.2)	0.02
Surgery				
General surgery	1132 (51.5)	515 (67.2)	1647 (55.5)	<0.01
Vascular surgery	301 (13.7)	190 (24.8)	491 (16.6)	<0.01
Other surgery	768 (34.9)	61 (8.0)	827 (27.9)	<0.01
Revised Cardiac Risk Index† variables				
High-risk surgery‡	1251 (56.8)	345 (45.0)	1596 (53.8)	<0.01
Ischemic heart disease	200 (9.1)	113 (14.8)	313 (10.5)	<0.01
Congestive heart failure	36 (1.6)	17 (2.2)	53 (1.8)	0.29
Cerebrovascular accident	21 (1.0)	101 (13.2)	122 (4.1)	<0.01
Chronic renal failure	60 (2.7)	21 (2.7)	81 (2.7)	0.98
Insulin-dependent diabetes	115 (5.2)	48 (6.3)	163 (5.5)	0.28
Revised Cardiac Risk Index†				<0.01
I	622 (28.3)	317 (41.4)	939 (31.6)	
II	973 (44.2)	391 (38.0)	1264 (42.6)	
III	461 (20.9)	126 (16.4)	587 (19.8)	
IV	145 (6.6)	32 (4.2)	177 (6.0)	
ECG available	1952 (88.7)	470 (61.4)	2422 (81.6)	<0.01
Normal ECG	1063 (54.5)	272 (57.9)	1335 (55.1)	0.18
Atrial fibrillation	78 (4.0)	14 (3.0)	92 (3.8)	0.29
Left ventricular hypertrophy	167 (8.6)	34 (7.2)	201 (8.3)	0.35
Right bundle branch block	119 (6.1)	27 (5.7)	146 (5.0)	0.77
Left bundle branch block	30 (1.5)	13 (2.8)	43 (1.8)	0.07
Any ST-T changes	275 (14.1)	74 (15.7)	349 (14.4)	0.36
Old myocardial infarction	162 (8.3)	39 (8.2)	201 (8.3)	0.90
Postoperative myocardial infarction	63 (2.9)	9 (1.2)	72 (2.3)	0.01
Death during admission	56 (2.5)	21 (2.7)	77 (2.5)	0.85

Values are no. (%) unless otherwise specified.
*Toronto data compared with Utrecht data.
†As published by Lee et al.[5]
‡Intrathoracic or intra-abdominal or suprainguinal vascular surgery, according to the Revised Cardiac Risk Index.[5]

ECG was available more frequently at the UHNT (89% vs. 61% at the UMCU). The proportion of ECGs with abnormalities did not differ between the 2 hospitals. POMI was significantly more common at UHNT (2.9%) when compared with UMCU (1.2%). This may reflect the use of routine postoperative troponin surveillance at UHNT in patients with an RCRI score >2.

Univariate Analysis

The likelihood of POMI increased with increasing RCRI, with incidences of 0.3%, 1.8%, 4.4%, and 11.4% for the RCRI class I, II, III, and IV, respectively. With RCRI group I as a reference, the OR for suffering a POMI for group II, III, and IV were 6 (95% CI, 2–19), 14 (5–48), and 40 (12–135), respectively. POMI was further associated with age, male gender, high-risk surgery, a history of IHD, and a history of CVA (Table 2). Postoperative death had the same associations except for a history of CVA but was further associated with a history of CHF and CRF (Table 2). Both POMI and postoperative death were significantly associated with any ECG abnormalities in univariate analysis (Table 3). POMI was associated with RBBB, LBBB, and Q waves; death was related to RBBB, LBBB, and atrial fibrillation.

Multivariate Analysis

Of the 6 predictors included in the RCRI, only IHD and high-risk surgery were significantly associated with POMI in the multivariate analysis (Table 4, models 1 and 2). The ROC area of the model that included these 2 predictors only was slightly higher than the model that included the RCRI as a whole (0.80 compared with 0.78). After entering age and gender into model 2, males appeared to be at higher risk of POMI (OR, 2.1; 95% CI, 1.1–3.7), but the ROC area remained 0.80 (Table 4, model 3). ECG abnormalities that were found to be associated with POMI in the univariable analysis were entered into model 3. Q waves were not associated with POMI. Thus, the final model (model 4) included high-risk surgery, history of IHD, male gender, LBBB, and RBBB (Table 4). The model's ROC area remained 0.80 (95% CI, 0.74–0.86). For all these models, the Hosmer & Lemeshow test had P values of >0.50, indicating that predicted and observed outcome rates were highly comparable.

A similar approach was followed to predict the occurrence of death during admission. The ROC area of the final model to predict death (Table 5) was 0.69 (95% CI, 0.62–0.75) and the P value of the Hosmer & Lemeshow test was 0.57. When LBBB was excluded the ROC area remained 0.69 (95% CI, 0.64–0.76).

DISCUSSION

Clinical risk factors identified on patient history accurately predicted postoperative myocardial infarction (ROC area of 0.80). Only 2 risk factors seem to be associated with POMI, ie, a history of ischemic heart disease and high-risk surgery (defined as intrathoracic, intra-abdominal or suprainguinal vascular procedures). Although male gender and the existence of bundle branch blocks at the preoperative ECG were also related to POMI, they did not provide added predictive value. Similarly, ECG abnormalities failed to provide added value in the prediction of all-cause in-hospital mortality.

Clinical Implications

The present results confirm the importance of clinical risk factors in the prediction of adverse postoperative events. Similar findings have been reported by others.[5,9] It should be noted, however, that of the 6 variables in the RCRI, only a history of IHD and a high-risk surgical procedure were required to accurately predict POMI, suggesting that the identification of patients at high risk for POMI can be simplified. Although Q

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TABLE 2. Univariate Associations of Patient Characteristics to Postoperative Myocardial Infarction (n = 2967) and Death During Admission (n = 2908, as survival data on 59 cases [2%] were missing)

	POMI (n = 72)	No POMI (n = 2895)	Odds Ratio (95% CI)	*P*	Death (n = 77)	Alive (n = 2831)	Odds Ratio (95% CI)	*P*
Age (yr) [mean (SD)]	68.4 (9.8)	64.8 (9.2)	3.6 (1.4–5.7)*	<0.01	68.8 (9.9)	64.8 (9.1)	4.0 (1.9–6.1)*	<0.01
Male gender	57 (79.2)	1604 (55.4)	3.1 (1.7–5.4)	<0.01	54 (70.1)	1581 (55.8)	1.9 (1.1–3.0)	0.01
High-risk surgery†	53 (73.6)	1543 (53.3)	2.4 (1.4–4.1)	<0.01	59 (76.6)	1500 (53.0)	2.9 (1.7–5.0)	<0.01
Ischemic heart disease	38 (52.8)	275 (9.5)	11 (6.6–17)	<0.01	18 (23.4)	294 (10.4)	2.6 (1.5–4.5)	<0.01
Congestive heart failure	3 (4.2)	50 (1.7)	2.5 (0.8–8.1)	0.12	10 (13.0)	42 (1.5)	9.9 (4.8–21)	<0.01
Cerebrovascular accident	7 (9.7)	115 (4.0)	2.6 (1.2–5.8)	0.02	4 (5.2)	118 (4.2)	1.3 (0.5–3.5)	0.66
Chronic renal failure	4 (5.6)	77 (2.7)	2.2 (0.8–6.1)	0.14	8 (10.4)	73 (2.6)	4.4 (2.0–9.4)	<0.01
Insulin-dependent diabetes	3 (4.2)	160 (5.5)	0.7 (0.2–2.4)	0.62	2 (2.6)	161 (5.7)	0.4 (0.1–1.8)	0.25

Values are numbers (column %) unless otherwise specified. POMI, postoperative myocardial infarction.
*Mean difference in years.
†Intrathoracic or intra-abdominal or suprainguinal vascular surgery, according to the Revised Cardiac Risk Index.[8]

TABLE 3. Univariate Associations of Electrocardiogram Characteristics to Postoperative Myocardial Infarction (n = 2422) and Death During Admission (n = 2416)

	POMI (n = 69)	No POMI (n = 2353)	Odds Ratio (95% CI)	*P*	Death (n = 71)	Alive (n = 2345)	Odds Ratio (95% CI)	*P*
Normal ECG	24 (34.8)	1311 (55.7)	0.4 (0.3–0.7)	<0.01	23 (32.4)	1308 (55.8)	0.4 (0.2–0.6)	<0.01
Right bundle branch block	9 (13.0)	137 (5.8)	2.4 (1.2–5.0)	0.01	8 (11.3)	138 (5.9)	2.0 (1.0–4.3)	0.06
Left bundle branch block	4 (5.8)	39 (1.7)	3.7 (1.3–11)	0.01	5 (7.0)	38 (1.6)	4.6 (1.8–12)	<0.01
Old myocardial infarction	14 (20.3)	187 (8.0)	2.9 (1.6–5.4)	<0.01	9 (13.0)	192 (8.2)	1.7 (0.8–3.4)	0.15
Atrial fibrillation	4 (5.8)	88 (3.8)	1.6 (0.6–4.4)	0.38	7 (10.3)	85 (3.6)	3.0 (1.4–6.8)	<0.01
Left ventricular hypertrophy	6 (8.7)	195 (8.3)	1.1 (0.5–2.5)	0.90	7 (9.9)	194 (8.3)	1.2 (0.5–2.7)	0.63
Ischemia specific STT changes	3 (4.3)	63 (2.7)	1.7 (0.5–5.4)	0.40	5 (7.0)	61 (2.6)	2.8 (1.1–7.3)	0.02
Any STT changes	11 (15.9)	338 (14.4)	1.1 (0.6–2.2)	0.71	14 (19.7)	333 (14.2)	1.5 (0.8–2.7)	0.19

Values are numbers (column %).
POMI indicates postoperative myocardial infarction.

TABLE 4. Multivariate Associations With Postoperative Myocardial Infarction

	Odds Ratio (95% CI)	*P*	ROC Area (95% CI)
Model 1 (n = 2967)			0.780 (0.730–0.829)
RCRI I	Reference		
RCRI II	5.8 (1.7–19)	<0.01	
RCRI III	14 (4.4–48)	<0.01	
RCRI IV	40 (12–135)	<0.01	
Model 2 (n = 2967)			0.796 (0.742–0.850)
High-risk surgery*	2.2 (1.2–3.7)	<0.01	
Ischemic heart disease	10 (6.2–16)	<0.01	
Model 3 (n = 2967)			0.798 (0.744–0.852)
High-risk surgery*	2.0 (1.2–3.4)	0.01	
Ischemic heart disease	9.1 (5.6–15)	<0.01	
Male gender	2.1 (1.1–3.7)	0.02	
Model 4 (n = 2422)			0.800 (0.742–0.857)
High-risk surgery*	1.8 (1.0–3.1)	0.04	
Ischemic heart disease	8.8 (5.3–15)	<0.01	
Male gender	1.9 (1.0–3.4)	0.04	
Right bundle branch block	2.1 (1.0–4.5)	0.06	
Left bundle branch block	3.1 (1.0–9.9)	0.05	

*Intrathoracic or intra-abdominal or suprainguinal vascular surgery, according to the Revised Cardiac Risk Index.[5]

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TABLE 5. Multivariate Associations With Death During Admission (n = 2416)

	Odds Ratio (95% CI)	*P*
High-risk surgery*	2.5 (1.4–4.4)	<0.01
Congestive heart failure	3 (2.7–15)	<0.01
Chronic renal failure	3.2 (1.4–7.5)	<0.01
Ischemic heart disease	1.7 (0.9–3.1)	0.08
Age (per year)	1.03 (0.99–1.06)	0.06
Left bundle branch block	3.5 (1.3–10)	0.02

*Intrathoracic or intra-abdominal or suprainguinal vascular surgery, according to the Revised Cardiac Risk Index.[5]

waves on the preoperative ECG and conduction defects like RBBB and LBBB were associated with POMI, they revealed no additional predictive value.

One might therefore reasonably question the utility of a preoperative ECG even among those patients at increased risk of cardiac complications. It can be argued that a preoperative ECG is still of value as a reference when ischemic events or dysrhythmias occur after surgery. Interval changes in the ECG are indeed still included among diagnostic criteria for myocardial infarction in the nonperioperative setting.[16] However, with a POMI incidence of 2.3% in the present study, 43 preoperative ECGs (100/2.3) have to be made to diagnose one case of POMI. Furthermore, the use of sensitive biochemical markers of myocardial injury, such as troponin T and I, have decreased reliance on ECG abnormalities in daily practice and clinical research, especially in the perioperative setting where myocardial infarctions are often limited in size.[16,17] For example, the ongoing POISE trial relies on troponin assay primarily and uses ECG abnormalities as secondary criteria.[18] ECG monitoring during anesthesia can be used as a reference for any new rhythm abnormalities that may occur after surgery.

Other Studies

The predictive value of a routine ECG before surgery has been questioned before.[3,6–9] Landesberg et al noted ST segment depression on the preoperative ECG in 98 of 405 (24%) patients awaiting vascular surgery.[19] Nineteen patients (4.7%) suffered postoperative cardiac complications. Patients with ST segment depression were at increased risk (OR, 4.7; 95% CI, 1.2–12.1) of cardiac events. Jeger et al also studied the prognostic value of a routine ECG in 172 noncardiac surgery patients with known or highly suspected coronary artery disease.[10] ST segment abnormalities were present in 38% of those studied. Thirty-one major adverse cardiac events (18%) and 40 (23%) deaths from all causes occurred in the 2 years following surgery. Multivariate analysis identified ST segment depression as an independent predictor of both cardiac events and all-cause mortality. The findings of the present study contrast these trials, probably because data in the present study were collected from clinical databases in a range of high- and lower-risk patients and procedures rather than from prospective research on high-risk vascular surgery patients only. Event rates in the present study (POMI, 2.3%; all-cause mortality, 2.5%), therefore, were substantially lower than that reported by Jeger and Landesberg.[10,19] Finally, these latter studies did not assess if ECG abnormalities offered any improvement in predicting events above clinical risk factors.

The present results are comparable to those of Liu et al who noted abnormalities on 75% of preoperative ECGs in a cohort of 513 geriatric patients undergoing a variety of surgical procedures.[8] Nineteen deaths (3.7%) and 9 (1.8%) nonfatal myocardial infarctions were reported prior to hospital discharge. ECG abnormalities including ST segment depression, bundle branch blocks, and Q waves were not found to be independent predictors of postoperative events. Instead, physical status and a history of congestive heart failure were the only factors associated with poor outcome. Noordzij et al recently evaluated the added value of preoperative ECG abnormalities in the prediction of postoperative cardiovascular death.[9] They used a hospital administrative database to include 28,457 (from a total cohort of 108,593 procedures) noncardiac surgery procedures for which ECG results were available. A variety of ECG abnormalities were present in 25% of patients and were independently associated with postoperative cardiac events. ECG abnormalities slightly improved the predictive value of the RCRI, increasing the C-index from 0.72 to 0.78. They reported that the preoperative ECG did not predict postoperative events in those patients undergoing low- to intermediate-risk surgery. The findings of these latter 2 studies support the present study in suggesting that preoperative ECGs add little benefit in patients with a broader spectrum of patient and surgical risk factors.

Limitations

First, patients from the 2 hospitals differed significantly with respect to baseline characteristics (Table 1). However, this study did not aim to compare any effect of a new treatment but aimed to evaluate the additional value of a certain test (ECG) upon information that should be available routinely (patient history). Therefore, it may be an advantage to include patients who differ in baseline characteristics to increase generalizability of the study results to different types of hospitals in different countries. Second, outcome assessments were driven by clinical care rather than by a prospective research protocol suggesting that events may have been underestimated. Lastly, as this was a retrospective study, we were unable to assess the impact of the ECG results on clinical patient management. Isolating the impact of an ECG from the remainder of the clinical assessment would present a formidable research design challenge. At a minimum, a large-sized prospective trial with a randomized assignment to "ECG" or "no ECG" arms would be required. The results of the current study suggest that ECG results were not an essential part of the preoperative evaluation as 11% of subjects in whom an ECG was indicated proceeded directly to surgery without an ECG on record. Failure to change management based on preoperative laboratory testing has been well described in a systematic review.[6]

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CONCLUSION

Postoperative myocardial infarction is related to a history of ischemic heart disease and to type of surgery. Although the existence of bundle branch blocks at the preoperative ECG was related to POMI and death during hospital admission, they did not provide added predictive value. It is therefore reasonable to question the utility of a preoperative ECG for screening asymptomatic individuals undergoing a variety of surgical procedures. Clinical risk factors should form the basis of risk assessment and prediction.

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