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A Prospective Evaluation of Cardiac Risk Index

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The prediction of cardiac risk from surgery and anesthesia is important in allocating medical resources and evaluating the risk-benefit ratio for operations, anesthetic management, and monitoring techniques. Goldman *et al.*[1] followed a large group of patients who underwent a wide variety of anesthetic and surgical procedures and determined their cardiac risk index (CRI) by comparing the patient's preoperative state with the incidence of life-threatening or fatal postoperative cardiovascular complications. Unfortunately, the CRI has been put into general use without properly testing its accuracy in predicting risk for individual patients.[2] Waters *et al.*[3] applied the CRI to a diverse surgical population and found the incidence of cardiac complications and cardiac death similar to that of Goldman. However, they found the CRI no better at prediction than the A.S.A. physical status. They also found that abdominal aortic surgery was related to the incidence of cardiac complications and cardiac death. The CRI attempts to control for the type of operation but only assigns an increased risk for broad classes of surgery giving abdominal aortic surgery the same number of risk points as any intraperitoneal or intrathoracic noncardiac surgery. If the CRI is to be used to determine the risk of cardiac complications and cardiac death, it should be accurate for each class of operation and thereby aid in risk prediction for individual patients. Therefore, we prospectively evaluated it in a group of patients undergoing one type of operation, elective abdominal aortic surgery, and examined their cardiac outcome.

METHODS

Ninety-nine consecutive patients over the age of 40 years undergoing their first elective abdominal aortic procedure were studied. No patient had a documented myocardial infarction within the past six months. The operations were either for occlusive or aneurysmal disease or both. Each patient's preoperative data were collected by interview, physical examination, and laboratory testing. A CRI was assigned following the scheme of Goldman *et al.*[1] (table 1). Intraoperative anesthetic and surgical course was evaluated using the hospital record and interviewing the anesthesiologists. Anesthetic management was independently chosen by the staff, resident, or nurse assigned to the case. In one-third of the patients a pulmonary artery catheter was deemed necessary and was inserted preoperatively. ECG changes and arrhythmias were treated promptly with appropriate therapy and exaggerated sympathetic responses were treated with narcotics, vasodilators, or propranolol. Hypotension and/or bradycardia were managed in standard clinical fashion with fluid administration, vasopressors, and anticholinergic drugs as indicated. This level of care was fully continued into the postoperative period until patients were considered stable. Each postoperative day the patients were seen by a member of the study group who reviewed their charts and/

TABLE 1. Computation of the CRI

Criteria	Points
1. Age > 70 years	5
2. Myocardial infarction in previous 6 months	10
3. S_3 gallop or JVD	11
4. Important valvular aortic stenosis	3
5. Rhythm other than sinus or PACs on last preoperative ECG	7
6. >5 PVCs/min documented at any time before operation	7
7. $P_{O_2} < 60$ or $P_{CO_2} > 50$ mm Hg, K < 3.0 or $HCO_3 < 20$ mEq/L, BUN > 50 or Cr > 3.0 mg/dl, abnormal SGOT, signs of chronic liver disease, or patients bedridden from noncardiac causes	3
8. Intraperitoneal, intrathoracic, or aortic operation	3
9. Emergency operation	4
TOTAL POSSIBLE	53

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TABLE 2. Risk Factors in 99 Patients Having Elective Aortic Surgery

	Number of Patients
History of smoking	97
Hypertension	55
Coronary artery disease	44
Previous myocardial infection (by history or ECG)	32
Angina	27
Previous CHF	10
Chronic respiratory disease	46
Diabetes	9
Renal impairment	3

or interviewed their physician. Life-threatening cardiac complications were defined as documented myocardial infarction (MI), ventricular tachycardia, or pulmonary edema. Cardiac death was defined as death arising from an arrhythmia or low cardiac output refractory to therapy which was not part of an inexorable downhill course caused by a non-cardiac condition, *e.g.*, septic shock. The critiria for these definitions were the same as those used by Goldman *et al.*[1]

RESULTS

Seventy-eight men and 21 women with an average age of 65 years were studied. Ninety-seven patients had a smoking history and 51 smoked at the time of study. Fifty-five had a history of hypertension, 44 had a history of coronary artery disease by history or ECG, 27 had a history of angina, 32 had a myocardial infarction by history or ECG, and 10 had a history of congestive heart failure. Forty-six patients had respiratory disease either by history or chest x-ray. Three patients suffered minor renal impairment (table 2).

The CRI was 5 points or less in 56 patients (Class 1), between 6 and 12 points in 35 patients (Class 2), and between 13 and 25 points in eight patients (Class 3). No patients had more than 25 points. Eleven patients had either life-threatening or lethal cardiac complications postoperatively, seven of which occurred within the first two postoperative days. Five of these 11 patients developed a new myocardial infarction, one of which resulted in death on the eleventh postoperative day; five patients developed pulmonary edema and one patient had one episode of ventricular tachycardia (table 3). There were two additional deaths, one on the third postoperative day secondary to a probable pulmonary embolism, and the other on the forty-ninth postoperative day secondary to intraoperative renal failure. The risk of serious cardiovascular complications in our study was significantly underestimated in Class 1 using Goldman's CRI ($P < 0.01$). Classes 2 and 3 showed no statistically significant difference (table 4).

TABLE 3. Serious Postoperative Cardiac Complications

	Number of Patients
Pulmonary edema	5
Myocardial infarction	5
Ventricular tachycardia	1
Cardiac death	1*

* Resulted from myocardial infarction.

DISCUSSION

Those patients prospectively identified as being at high cardiac risk did in fact suffer a high incidence of serious cardiovascular events. In this sense the CRI criteria were useful, and Goldman's recommendation that a preoperative medical evaluation be obtained persists unchallenged.

However, there was also a significant incidence of serious cardiovascular events in patients who, by CRI criteria, were not in a high cardiac risk group. This group of patients experienced no obvious difference in patient care from Goldman's population, as the study was done in the same hospital using the same routines for patient management. The incidence of myocardial infarction, cardiac death, and overall mortality in this study is similar to recently published series.[4,5] In addition to aggressive treatment of perioperative hemody-

TABLE 4. Comparison of Cardiac Complications in Two Groups

	Abdominal Aortic Patients			Goldman *et al.* Group			
Class	Number of Patients	Cardiac Complications		Number of Patients	Cardiac Complications		P*
1	56	4	(7%)	537	5	(1%)	0.01
2	35	4	(11%)	316	21	(7%)	NS
3	8	3	(38%)	130	18	(14%)	NS
TOTAL	99	11	(12%)	983	44	(4%)	0.01

* Pearson's chi-square and likelihood ratio chi-square of abdominal aortic patients *vs.* Goldman's group.

namic and ECG changes, one-third of the patients had a pulmonary artery catheter in place. Rao *et al.*[6] showed that this intensity of perioperative management was associated with a lower than expected reinfarction rate in patients with recent myocardial infarctions. We believe that the CRI in its present form is not helpful in estimating cardiac risk in patients undergoing elective aortic surgery. This type of surgery seems to impose a higher cardiac risk to the patient than predicted by criteria developed from a broad base of surgical patients. Prospective evaluation of the CRI as a predictor of postoperative cardiac complications is warranted for other surgical procedures before it is used.

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The Advantage of the Prone Position Approach to the Lumbar Epidural Space

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The prone position has been used for many years for the administration of hypobaric spinal anesthesia. The merits of using this position for entering the spinal canal (epidural or subarachnoid spaces) have not been documented previously. One of the authors (K.M.) has experienced many years of success using the prone "jack-knife" position for lumbar epidural block. Our experience, comprising 260 patients, was reviewed to determine the success of lumbar epidural analgesia using the prone jack-knife position. Additionally, a computerized axial tomographic study of the lumbar spine was performed to assist in explaining the merit of this approach.

Materials and Methods

This study was approved by our local Committee for Protection of Human Subjects. Epidural anesthesia was administered to 260 patients in the prone position. Before each patient was positioned for epidural block, an inflatable plastic bag, approximately 45 cm long × 30 cm wide, was placed crosswise on the operating table. The patient laid in a prone position with the bag under the lower half of the abdomen.§ The table then was angulated into a slight "jack-knife" tilt. The bag was connected to the common gas outlet of the anesthesia machine and inflated by using the oxygen flush. A pressure manometer was inserted in the circuit as a safety device. The pressure in the bag was permitted to rise to 60 mmHg at which point the patient's lower abdomen was elevated approximately six inches above the table. The "jack-knife" angulation combined with the elevation of the lumbar spine rendered the spinous processes more conspicuous and the interspinous spaces more palpable. Any voluntary curvature or splinting of the spine tends to be straightened by the effects of gravity. After prone jack-knife positioning, the interspinous space was palpated and infiltrated with local anesthetic agent. The epidural needle was advanced into the epidural space which was identified by either the hanging drop technique or the air/liquid column device.[1]

Anesthetic agents were injected, and the catheter was introduced and secured. The bag was deflated, and the patient positioned appropriately for the surgical procedure.

In order to confirm the advantage of the prone po-

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§ The "E-Z-M Carotid Pillow" obtained from the E-Z-M Co. Portland Avenue, Westbury, New York 11590.