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Scientific paper

A cumulative analysis of an individual surgeon's early experience with elective open abdominal aortic aneurysm repair

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Abstract

Background: Several studies have reviewed the role of hospital and surgeon case volumes in determining early mortality after elective open abdominal aortic aneurysm (AAA) repair. Few, however, have analyzed this relationship at the individual surgeon level. The purpose of this study was to display the usefulness of a unique statistical tool as a form of an ongoing practice audit.

Methods: All patients who underwent an elective open AAA repair by an individual surgeon at a university-affiliated medical center over a 5-year period were analyzed. The cumulative sum failure method was used to analyze the results over time. Failure was defined as the presence of early mortality, myocardial infarction, or a complication resulting in another surgical procedure or prolonged hospitalization. A target failure rate of 10% was chosen, and 80% alert and 95% alarm boundary lines were established.

Results: One hundred thirty-eight patients underwent elective AAA repair by this surgeon over a 5-year period (1998-2003). There were 5 early mortalities (3.6%), 15 myocardial infarctions (10.9%), and 3 major morbidities (2.2%). These results were plotted on a cumulative sum curve as an example of an ongoing practice audit.

Conclusions: The cumulative sum failure method provides a tool whereby a surgeon can prospectively audit his practice and recognize trends in performance before their recognition by standard statistical tools.

Keywords: Learning curve; Cumulative analysis; Aneurysm; Aorta

There are many factors that contribute to a successful outcome after a surgical intervention such as elective abdominal aortic aneurysm (AAA) repair. Until fairly recently, however, the majority of studies have considered patient- and disease-specific variables, and few have looked at surgeon and hospital related factors. Although it seems important intuitively, few studies have considered the individual surgeon's role in determining clinical success [1]. With respect to elective AAA repair, several articles have concentrated on surgeon training [2,3] and physician and hospital case volumes [3–7] as predictors of a successful outcome, most commonly defined as the avoidance of early or in-hospital mortality.

Although these volume-mortality–related studies are valuable, there are several difficulties in translating their conclusions to the level of the individual surgeon because many of these reports review data at the hospital or population levels in a retrospective fashion. Of more value to the individual practitioner would be the ability to analyze clinical data as they are being obtained in a prospective, ongoing fashion. This would allow for the review of outcomes before standard post hoc statistical tools are capable. Additionally, although the avoidance of early mortality is a commendable goal, outcome measures should be sufficiently flexible to take into account other determinants of clinical success.

The cumulative sum failure (CUSUM) method is a unique analytical tool that takes time and experience into account [8]. It allows for an individual practitioner to prospectively audit his/her clinical results and as such proves to be a valuable tool in learning curve analysis and continuing quality assurance. Our group has previously displayed the value of this form of analysis with ruptured [9] and endovascular AAA repair [10]. The purpose of the present study is to display the value of CUSUM analysis via the evaluation of a single surgeon's experience with open elective AAA repair at the beginning of his clinical career.

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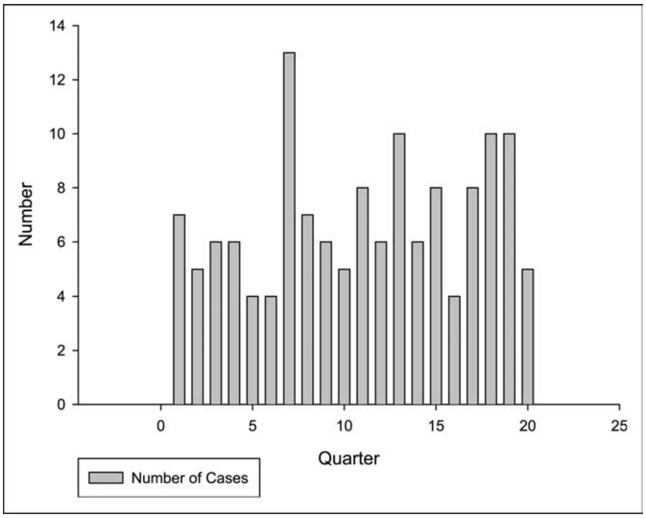

Fig. 1. Number of AAA repairs (1998–2003).

Methods

All patients who underwent an elective open abdominal aortic aneurysm repair during the initial 5 years (1998–2003) of the author's clinical practice at a university-affiliated medical center were reviewed. This study comprises a retrospective review of a prospectively obtained database of consecutive, unselected patients. Demographic and intraoperative data was obtained including medical comorbidities, positioning of aortic clamp, type of graft, additional procedures, and transfusion requirements. Outcome data consist of major morbidities including myocardial infarction, 30 day or in-hospital mortality, and length of hospital stay.

The CUSUM method was then used to document results over time. Each patient was deemed a success or failure as necessary for this form of statistical analysis. For the purpose of this series, a failure is defined as any patient who suffered from a postoperative myocardial infarction, 30 day or in-hospital mortality, and/or a major complication prolonging hospital admission or resulting in further surgical intervention. This type of analysis recognizes the importance of experience in clinical practice and can identify suboptimal or improved performance before its recognition by other statistical methods. CUSUM is defined as: $S_n = \Sigma(X_i - X_o)$, where $X_i = 0$ for success and $X_i = 1$ for failure [11–14]. For the purpose of this study X_o, or the "acceptable failure rate" was set at 10%. In addition, 80% "alert" and 95% "alarm" boundary lines were calculated using a "target failure rate" of 10%. These formulae are presented in Appendix 1.

Results

The study cohort consists of 138 patients who underwent elective open infrarenal abdominal aortic aneurysm repair during the first 5 years (1998–2003) of the author's career. These cases were evenly distributed temporally during this 5-year period (Fig. 1), and no cases were excluded from analysis. The vast majority of these patients were males with a mean age just over 71 years and aneurysm diameter of 6.4 cm (Table 1). The frequencies of various medical comorbidities are also listed in Table 1. Intraoperative details regarding type of graft, position of proximal clamp, use of adjunctive procedures, and blood transfusion requirements are displayed in Table 2. Close to 60% of patients received a bifurcated graft for diffuse aortoiliac aneurysmal disease with one third of patients requiring a straight graft for aneurysms isolated to the infrarenal aorta. Approximately one tenth of repairs required a proximal suprarenal clamp, whereas a slightly smaller number of aneurysm repairs were performed along with renal artery reconstruction or reimplantation of the inferior mesenteric artery. During the final 40 patients in this series, the routine use of the cell saver was instituted at our institution removing the need for red blood cell transfusion. Before this, a mean of 1.4 units (range, 0–7 units) were transfused intraoperatively per patient.

Significant outcome data are summarized in Table 3. Five patients died during hospitalization or the first 30 postoperative days for an early mortality rate of 3.6%. Major postoperative morbidity was defined as a myocardial infarction or any complication that resulted in another surgical procedure or prolonged hospitalization. Fifteen patients (10.9%) suffered from a MI, whereas 2 patients required hemodialysis during the postoperative phase. One patient underwent a tracheostomy because of prolonged ventilatory needs. Mean length of hospitalization was 10.8 days with a wide range (2–72 days).

The outcome data were converted to the "success" or "failure" format necessary for CUSUM analysis. For the purpose of this study, a failure was defined by 30-day or in-hospital mortality, myocardial infarction, or major morbidity resulting in another surgical procedure or prolonged hospitalization. Success was defined by the absence of these factors. In this series, 18 failures occurred in 138 consecutive patients (13%). Some patients suffered from more than

Table 1
Preoperative data

	Mean/number of patients	Range or %
Age (years)	71.4	53–87
Males	123	89
AAA diameter (cm)	6.4	5.0–10.2
Current smokers	75	54.3
Hypertension	101	79.7
Diabetes	19	13.8
Coronary disease (previous MI or angina)	64	46.4
Carotid artery disease	23	16.7
Pulmonary disease	40	29
Chronic renal failure (Cr >180 μmol/L/dialysis)	25	18.1