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Ruptured Abdominal Aortic Aneurysm – Can Treatment Costs and Outcomes be Predicted by Using Clinical or Physiological Parameters?

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Mortality rates for patients undergoing surgery for ruptured abdominal aortic aneurysm (RAAA) remain high. The high cost of providing care for these patients mandates that proposed treatment protocols be evaluated for their cost-effectiveness. This study assessed costs related to outcome in different groups of patients with RAAA. From July 1987 to December 1993, 140 patients underwent emergency surgery for RAAA. Complete data on preoperative haemodynamic status, blood transfusion requirements, intensive care unit (ICU) stay and other hospital costs was available for 94 patients. Seventy-seven males (mean age 71.6(6)) and 17 females (mean age 77.2(6)) underwent surgery. Known risk factors including age (< or >70 years), shock on admission (systolic blood pressure (BP) < or >90 mm Hg), sex, and acute renal failure were analysed. For the purpose of comparison, costs (£) were assessed by the ESRI (Economic and Social Research Institute of Ireland) based on 1992 prices. The overall survival rate was 48%; 53% among males and 24% among females ($p<0.05$, Chi-squared test). In addition to having a significantly worse outcome than males, female patients with RAAA also had longer hospital and ICU stays and this was reflected in significantly greater expenditure. Similarly, male patients >70 years old presenting with haemodynamic instability had significantly longer hospital and ICU stays than younger male patients. The average cost per RAAA survival (£12 945) in this series is not prohibitive, and the greater cost in high risk groups should not discourage intervention.

Introduction

The incidence of abdominal aortic aneurysm (AAA) is increasing worldwide.[1–3] Despite an increased awareness and detection of the condition, the number of patients presenting to hospital for the first time as emergencies remains high.[2–4] While mortality rates for elective AAA resection have improved to 3–5%, mortality rates from ruptured abdominal aortic aneurysms (RAAA) have remained at 50%.[5–8]

Aside from the cost in lives, management of RAAAs imposes an ever increasing financial burden on hospitals. Most of the costs incurred arise from post-operative intensive care unit management. The financial implications of RAAA management have been advanced by some as an argument in support of a selective policy of surgical intervention, particularly in the elderly patient.[9] The high cost of providing care for these patients mandates that proposed treatment protocols be evaluated for their cost-effectiveness. The aim of this study was to examine the influence of age, sex, systolic blood pressure and acute renal failure on treatment costs and outcomes.

Patients and Methods

From July 1987 to December 1993, 140 patients underwent emergency surgery for RAAA. This was an unselected group, as it is policy in the unit to operate on all patients with RAAA. Demographic data and information on preoperative haemodynamic status, blood transfusion requirements, intensive care unit (ICU) stay and other hospital costs were analysed in 94 of these patients. Clinical indicators of outcome including systolic blood pressure on presentation (BP< or >90 mmHg), and incidence of acute renal failure were analysed. For the purpose of comparison, costs (£) were assessed by the ESRI (Economic and Social Research Institute of Ireland) based on 1992 prices. Results are expressed as mean with standard error in parentheses. Statistical comparison was by means of unpaired Student's *t*-test and Chi-squared analysis.

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Table 1. Demographic data and perioperative details of the 94 patients included in this study. Data are expressed as mean (S.E.M.).

	Total	Survivors	Deaths
Age (years)	72.5(7.1)	71.1(7.5)	73.8(6.5)**
Sex	77M:17F	41M:4F	36M:13F‡
Hospital stay (days)	15.1(17.9)	23.9(18.6)	7.0(12.9)*
ICU stay (days)	8.6(12.9)	10.7(12.8)	6.8(12.8)
Theatre time (min)	159(61)	159(60)	148(62)
Blood transfusion (units)	12.6(7.3)	10.3(5.4)	15.3(8.2)†

**$p<0.06$ vs. survivors; *$p<0.001$ vs. survivors; †$p<0.01$ vs. survivors (Student's t-test); ‡$p<0.05$ vs. survivors (Chi-squared test).

Results

Complete data on preoperative haemodynamic status, blood transfusion requirements, ICU stay and other hospital costs, was available for 94 patients – 77 males (mean age 71.6(6)) and 17 females (mean age 77.2(6)). The overall survival rate was 48% (24% in females; 53% in males; $p<0.05$). Demographic details are outlined in Table 1. The hospital cost per patient presenting with RAAA and the cost per survival were calculated from hospital cost variables based on 1992 prices as follows: operating theatre time £90/h; blood transfusion £52/unit; ICU stay £475/day; ward stay £105/day.

Patients who died were older than those who survived, but this difference was not statistically significant. As expected, most of the postoperative deaths occurred relatively early. However, total ICU stay was not statistically different between survivors and nonsuvivors. Operating theatre time was similar in both groups. Patients who subsequently died required significantly larger intraoperative blood transfusions ($p<0.01$) (Table 1).

The overall mean cost per survivor (£7872) was significantly greater than per non-survivor (£4659), reflecting the longer hospital stay (Fig. 1). Age had no effect on either mean cost per patient or overall survival (Fig. 2). Although female patients had a significantly worse outcome than males in terms of survival, this was not reflected in greater cost per patient (Fig. 3). Similarly, patients presenting with hypotension tended to have a worse outcome, but this did not impact on overall expenditure per patient (Fig. 4).

Table 2 summarises the combined contribution of age, sex and shock on admission to overall cost per survivor.

The onset of acute renal failure in the postoperative period resulted in a worse outcome, and this was reflected in greater expenditure during the ICU stay (dialysis: £7840 (2405); no dialysis: £2950 (1427)).

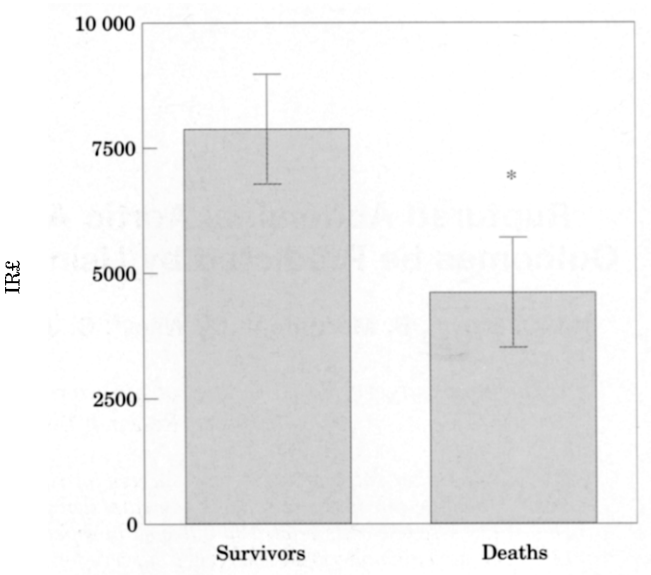

Fig. 1. Comparison of overall costs for patients who survived and patients who died after emergency AAA surgery. Costs are indicated as IR£ on the y-axis. *$p<0.04$ vs. survivors (Student's t-test).

Discussion

Surgical intervention provides the only hope of survival in the patient with RAAA. Given the high mortality rate and significant financial expenditure associated with emergency AAA surgery, the wisdom of operating on all such patients has recently been questioned.[9] The cost of RAAA surgery in the present study is somewhat cheaper than figures from previous studies. Breckwoldt *et al.* estimated that emergency AAA treatment carried a mean total hospital expenditure of US $25 000 per patient mainly due to prolonged postoperative stay and complications.[3] A similar study by Sweiert *et al.* placed the estimated total cost at $40 000.[10] Johansen *et al.* demonstrated that certain clinical features on presentation helped to predict extremely high early mortality and concluded that such patients should not undergo surgery.[11] The current and other studies have shown that no combination of clinical variables recorded before operation can be used to predict mortality with confidence, and that an attempt at operative repair is warranted in all patients.[6,7,12]

This study confirms the high mortality rate (52%), the high cost of care and the inability to predict mortality before operation in patients with RAAA. It also confirms the findings of others that women with RAAA have a worse outcome than males of the same age group.[6,11,12] The number of women in this study group is small, particularly the number of women under 70, illustrating the relative rarity of this condition among females. A previous study from this

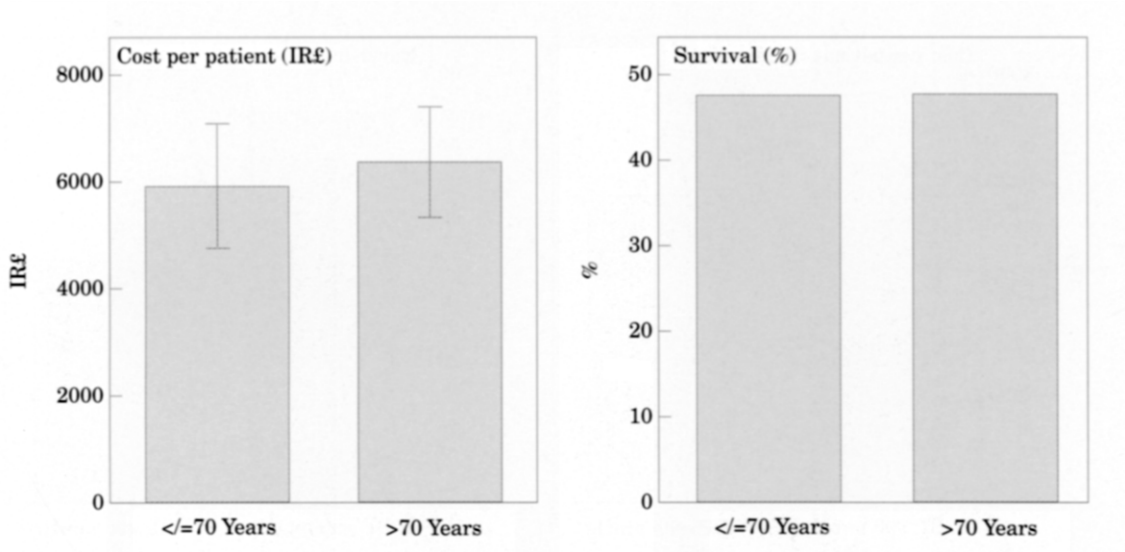

Fig. 2. Effect of age (< or >70 years) on cost and survival following emergency surgery for AAA. Cost is indicated on the y-axis as IR£ and survival as %.

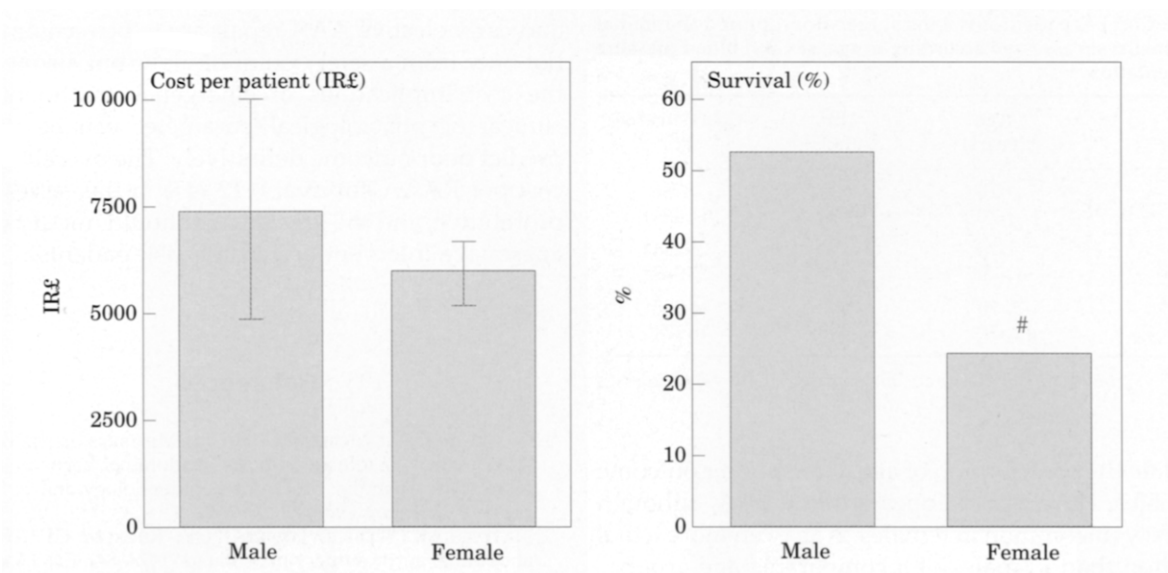

Fig. 3. Comparison of cost and survival between male and female patients undergoing surgery for ruptured AAA. $p<0.03$ vs. female (Chi-squared test).

department showed that advancing age, female sex, renal failure and intra-operative complications are associated with greater mortality in patients with RAAA.[13] In keeping with the findings of others, this study failed to identify a single preoperative clinical parameter which significantly influenced in-hospital mortality.[3,11]

The main costs incurred in the treatment of RAAA are those associated with postoperative ICU treatment. The development of organ system failure following emergency AAA repair is the most important factor in determining ICU requirements.[14]

Prediction of organ failure based on preoperative clinical parameters remains imprecise. The combination of advanced age and preoperative haemodynamic instability were associated with longer ICU and total hospital stay. However, when either variable was analysed alone there was no significant difference in cost. When age, sex and degree of hypotension on presentation are analysed together, it becomes clear that a combination of these factors, rather than any single one alone, determines overall cost per survivor. The greatest financial outlay was associated with elderly females (>70) presenting with or without hypotension. Unfortunately, a subgroup of younger female patients was not available for comparison to further

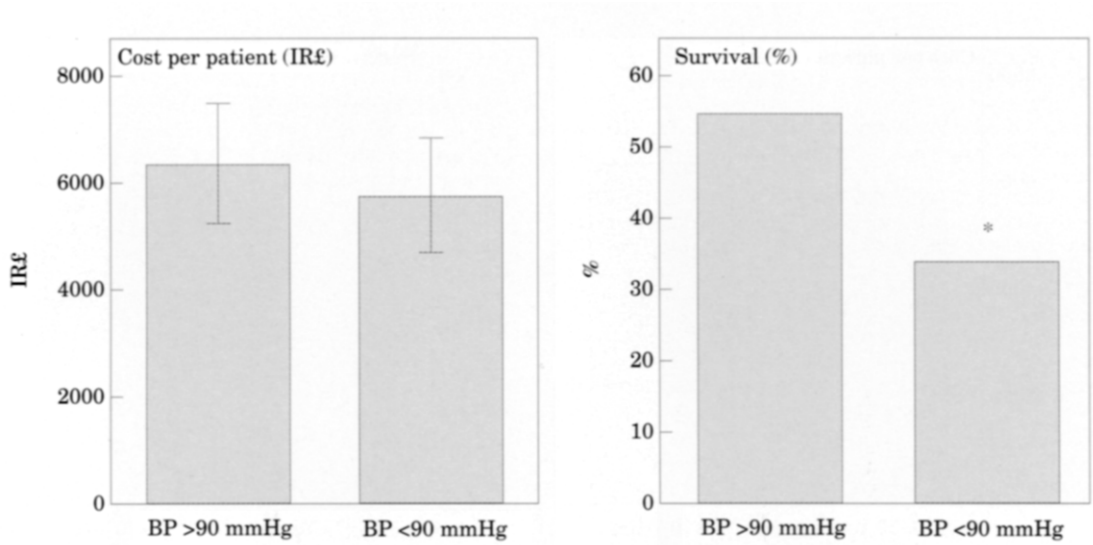

Fig. 4. Effect of systolic blood pressure at presentation on cost and survival from surgery for ruptured AAA. *$p<0.06$ vs. systolic BP>90 mmHg (Chi-squared test).

Table 2. Cost per patient surviving surgery for ruptured abdominal aortic aneurysm assessed according to age, sex and blood pressure at presentation.

Sex	Age (years)	BP (mm Hg)	Cost/survivor (£)
Male	<70	>90	8786
Male	<70	<90	15 494
Female	>70	>90	25 284*
Female	>70	<90	23 342†
Male	>70	>90	11 958
Male	>70	<90	10 174

* $p<0.05$ vs. male>70; BP>90; † $p<0.05$ vs. male>70; BP<90 (Student's *t*-test).

elucidate the contribution of age to the poorer outcome in females. However, it appears that RAAA, although relatively uncommon in females, is an even more lethal condition than in males of a comparable age group.

The results of this study support the use of a non-selective policy in dealing with patients with RAAA. No single preoperative clinical parameter can be used to determine outcome, and each patient must be assessed on an individaul basis. Decisions regarding appropriateness of prolonged aggressive treatment can usually be more readily made in the postoperative period with the development of multiple organ failure. The limited data in the current study regarding the onset of acute renal failure suggests that it is a major determinant of outcome from RAAA and is associated with significantly greater expenditure.

Treatment of RAAA imposes a significant financial burden on hospitals. However, it is important to remember that the 5-year survival and quality of life for patients surviving emergency AAA surgery is identical to that of elective AAA repair.[15,16] Diagnostic screening and early elective AAA repair are to be recommended not only from a safety point of view, but also to avoid the cost implications of emergency treatment.[17] No clinical or physiological parameter can be used to predict poor outcome definitively. The overall average cost per RAAA survival (£12 945) in this series is not prohibitive, and the greater cost should not discourage aggressive intervention in high risk patients.

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