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A Cost Analysis of Surgery for Ruptured Abdominal Aortic Aneurysm

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Objective: *this study compares our costs of salvaging patients with ruptured abdominal aortic aneurysms (AAA) with the costs for unruptured AAAs.*
Methods: *details of all AAAs presenting over 18 months were obtained. Costs of repair were carefully calculated for each case and were based upon ITU and ward stay and the use of theatre, radiology and pathology services. We compared the costs in unruptured AAAs with both uncomplicated ruptures and ruptures with one or more system failure.*
Results: *the mortality rate for ruptures undergoing repair was 18% and for elective repairs was 1.6%. The median cost for uncomplicated ruptures was £6427 (range £2012–13 756). For 12 complicated ruptures, it was £20 075 (range £13 864–166 446), and for 63 unruptured AAAs, was £4762 (range £2925–47 499).*
Conclusion: *relatively low operative mortality rates for ruptured AAA repair can be achieved but this comes at substantial cost. On average, a ruptured AAA requiring system support costs four times as much as an elective repair.*

Key Words: Abdominal aortic aneurysm; Rupture; Costs.

Introduction

Cost analyses of open elective abdominal aortic aneurysm (AAA) repair suggest an average cost of £4500 per procedure.[1,2] When these data are combined with a low 30-day mortality rate of 3.5–5.6%,[3–5] this appears to be a cost-effective procedure. In contrast, emergency repair of a ruptured AAA is associated with high mortality and consumes more resources. The actual mortality rate associated with this is difficult to define precisely since case selection varies and this markedly influences outcomes.[6] Mortality rates for ruptures of between 20 and 70% have been reported.[5,7,8] Although the costs of surgery for rupture are undoubtedly higher than for electives, robust data on exactly how much resources these challenging aneurysms consume are relatively lacking, although published estimates have ranged from £12 000 to 20 000.[5,9–13]

The aim of this study was to calculate the costs associated with ruptured AAA repair in a single vascular unit, which has a sub-regional emergency vascular rota and to compare these with our planned elective and "symptomatic" AAA repairs.

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Methods

Details of open AAA repairs between January 2000 and July 2001 were obtained retrospectively from the local computerised vascular database and the medical records for all these patients analysed. We are confident no AAAs were missed because all such referrals go to the Vascular Unit. The few elective endovascular stent repairs were not considered in this study. Details of resource use were obtained for preoperative assessment visits, the preoperative, perioperative and postoperative periods of the surgical admission, together with any related admission within one month of discharge. No other data were collected on resource use before or after the main hospital admission.

For each patient, demographic data, aneurysm size and resource use were entered on a pre-designed structured form. Costs were determined based on the following variables:

(1) Lengths of stay on the Intensive Care Unit (ITU), High Dependency Unit (HDU) or equivalent and the general surgical ward;
(2) Theatre usage;
(3) Radiological investigations;
(4) Physiotherapy input;
(5) Pathology costs.

Further, the above costs were varied, depending on whether the services were used during the regular working day or out-of-hours. For any patient

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transferred to another hospital, admission and discharge dates were obtained to calculate inpatient days spent there, but no itemised data on resource use elsewhere were collected. Data were also collected on whether the patient survived, together with concurrent illnesses and any complications of surgery. If the patient was readmitted within one month of the operation with a complication relating to the aneurysm repair, another similar data form was completed and the costs added to the previous admission tally.

Eight of the 47 rupture patients were not operated upon and cost analysis was not performed on these. A decision not to operate was taken by the consultant vascular surgeon on-call at the time of presentation. The principal factors used in this decision were a combination of the following: age over 80, cardiorespiratory or renal failure, known malignancy, hypotensive shock and impaired mental state.

Resource use and costing

Figures are valid for prices at year 2000 and are based on local hospital costs.

(1) Costs per bed day: ITU – £1200 (£1800 if haemofiltration needed); HDU – £700; general surgical ward – £171. All patients were cared for on inpatient surgical wards after intensive care stay. The cost for bed days is uniform for all patients.
(2) Theatre sessions: cost per 3.5 h session – £550.
(3) Radiology costs were determined by the type of investigation, the level of expertise present (consultant or specialist registrar) and whether it was an elective or emergency procedure.
(4) Physiotherapy – cost determined by the number of visits and whether in or out of hours.
(5) Pathology services: individual prices were calculated for each haematological or biochemical test done and the total cost per patient calculated.

We compared the costs of repair in three groups: *non-ruptures* (elective plus symptomatic repairs), *"uncomplicated" ruptures* and *"complicated" ruptures*. "Complicated" ruptures, by definition, developed one or more system failures needing system support, e.g., haemofiltration for acute renal failure.

Statistics

The costs were not found to be "normally" distributed and therefore medians and ranges were used to describe the data. Means and Student's *t*-test were used to describe and analyse the normally distributed data on patient age in each group.

Results

There were 110 aneurysms with a mean age of 72 years (range 55–85 years) admitted during the study period, of whom 91% were male. Sixty-three (57%) were non-ruptures and 47 (43%) ruptures. In retrospect, in the ruptured group, 27 (57%) turned out to be "uncomplicated" and twelve (26%) were "complicated". Eight ruptures (17%) were managed non-operatively, with a mean age of 79 years (range 69–85). These patients had either been previously turned down for elective aneurysm repair or had a combination of cardiorespiratory compromise, renal impairment and dementia. Of all the aneurysms, most (88%) were infra-renal and there were 5 supra-renal aneurysms, all in the ruptured group. Eight patients (7%) were transferred from neighbouring hospitals and no patient died in transit. There was no significant difference at the 5% level between the patients' age distribution in the different groups.

The average time spent by the different groups of patients on the intensive care unit and the general surgical ward is shown in Table 1. This illustrates that the complicated ruptured aneurysm repairs on average spend considerable more time not only on ITU but also on the general surgical ward. Furthermore, the complicated ruptures who ultimately died all spent a considerable time on the ward on their return from ITU before dying. Six patients (5%) were transferred to other hospitals for rehabilitation because either they were originally referred from there or wanted transfer nearer home. All went home without complications.

The mortality rates for each of the groups are shown in Figure 1. There were eight deaths in the post-operative 30-day period (one elective, four "uncomplicated" ruptures and three "complicated" ruptures). All patients managed non-operatively died within two weeks of admission. Our total rupture mortality rate, i.e., non-operated rupture and operated rupture deaths was 32%.

Figure 2 shows the median costs of salvaging the different groups of patients. The median cost of a non-rupture repair was £4762, an "uncomplicated" rupture

Table 1. Median length of in-hospital stay (days) in intensive care and the general surgical ward.

	Elective (range)	Uncomplicated ruptures (range)	Complicated ruptures (range)
ITU	2 (1–28)	3 (1–5)	9.5 (7–104)
Ward	9 (4–72)	10 (0–31)	19 (0–46)
Total	11 (5–85)	13 (1–36)	37.5 (15–123)

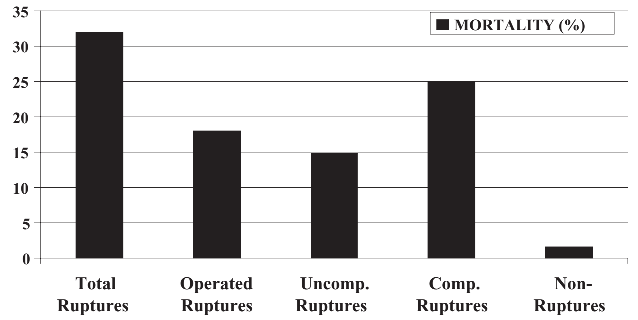

Fig. 1. Unit's mortality rates.

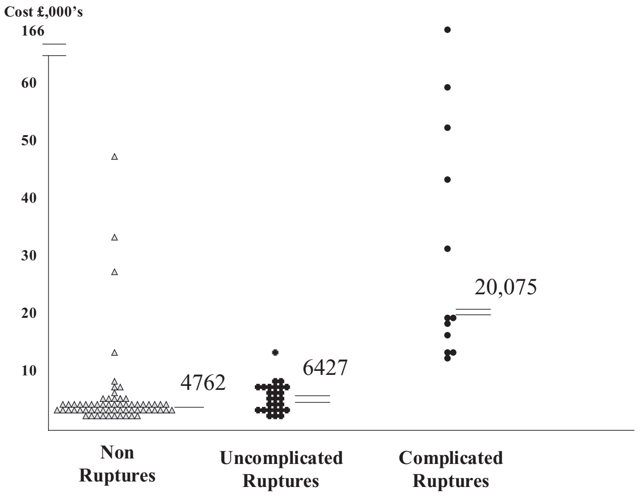

Fig. 2. AAA salvage costs.

was £6427, a "complicated" rupture was £20 075. The median cost of all ruptures was £8078. The cost analysis for those patients undergoing surgery for ruptured AAAs who subsequently died is interesting. The four "uncomplicated" ruptures died relatively early and consumed minimal resources – median cost of £2228 whereas the "complicated" ruptures utilised a large number of cost intensive resources – median cost £20 203.

Discussion

In this retrospective series, the estimated inpatient cost per case for a non-ruptured (i.e., elective plus "symptomatic") aneurysm repair at Addenbrooke's hospital was £4762, which is in keeping with recent published figures.[1,2] This demonstrates that our estimated costs are similar to those in other vascular units in the U.K. and this tends to validate our costing methodology.

If all ruptures are considered together, the median cost of £8078 is still nearly double that of an elective repair. This figure, however, is skewed by the complicated group. Most of the excess cost of ruptured AAA repair proves due to this group that often spent prolonged periods in ITU and for whom median costs were four times higher than for elective repair (£20 075 vs 4762). Whether the repair of a ruptured AAA is cost-effective is debatable and may depend on local wealth and health care systems, but a recent formal cost-effectiveness study from the U.S.A. suggests that it is.[12]

Given these high costs, preventing aneurysm rupture has potential benefits in terms of reducing mortality and cost. Screening programmes have been advocated as a mechanism for reducing aneurysm rupture rates,[14] particularly as the costs of running these programmes can be low. One estimate for the annual costs of actual screening at a Cambridgeshire district general hospital programme was £14 700 and this reduced mortality from ruptured AAA by more than 65%.[15] Based on these costs, a screening programme would only need to reduce the number of complicated ruptures by one or two a year to pay for itself.

The results in this study are notable in two other respects. Firstly the operative mortality rate for ruptured AAA repair is low. Secondly, a policy of non-operative management on high-risk cases resulted in 17% of ruptures being treated in this way. Clearly these two aspects of the study are interrelated to some degree. The patients not operated upon had a number of co-morbid conditions and were regarded as extremely unlikely to achieve recovery to a reasonable quality of life. Although the group of patients subjected to surgery was therefore selected to some degree, most ruptures presenting were operated upon (83%), including eight octogenarians (21%). Our data show that a low operative mortality rate for rupture was achieved at substantial financial cost. There is no doubt that an aggressive local ITU policy of extensive system support for ruptured aneurysms with multi-organ failure contributed to these costs, but may be justified by the low overall mortality rates achieved.

Conclusion

This study has shown a huge range of costs for repair of ruptured AAA. Overall the costs are nearly twice that of an elective repair, and if the group of patients requiring system support on ITU are analysed separately (complicated ruptures) the costs are increased four fold over elective cases. These costs need to be considered when planning the management of aortic aneurysms. In considering screening, a small reduction in the number of ruptures would make this a cost-effective exercise.

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