PAPER

Timing of surgery for supratentorial aneurysmal subarachnoid haemorrhage: report of a prospective study

N Ross, P J Hutchinson, H Seeley, P J Kirkpatrick

J Neurol Neurosurg Psychiatry 2002;**72**:480–484

Objectives: The debate on the timing of aneurysm surgery after subarachnoid haemorrhage (SAH) pivots on the balance of the temporal risk for fatal rebleeding versus the risk of surgical morbidity when operating early on an acutely injured brain. By following a strict management protocol for SAH, the hypothesis has been tested that in the modern arena of treatment for aneurysmal SAH the timing of surgery to secure supratentorial aneurysms does not affect surgical outcome.

Methods: Over a 6 year period, patients admitted with a diagnosis of SAH to a regional neurosurgical unit have been prospectively studied. All have been on a management protocol in which early transfer and resuscitation has been followed regardless of age and clinical condition. Angiographic investigation and surgery have been pursued in those who have been able to at least flex to pain. A total of 1168 patients (60.7% female, mean age 54.3) with proved SAH were received on median day 1 (86.4% arrived within 3 days) of the ictus. Of these, 784 (67.1%) showed aneurysms on angiography and were prepared for surgery. Those who received surgery for a supratentorial aneurysm within 21 days of the ictus were included in the final analysis (n=550). Patients with an initial negative angiogram, with posterior circulation aneurysms, or aneurysms treated by endovascular means, with aneurysms requiring emergency surgery for space occupying haematomas, with aneurysms which re-bled before surgery, and those who received very late surgery (after 21 days from ictus) were excluded. Surgical outcomes at hospital discharge and after 6 months were assessed using the Glasgow outcome score (GOS). Discharge destination and duration of stay in a neurosurgical ward were also documented. The influence of the timing of surgery (early group day 1–3 postictus, intermediate group day 4–10, or late group day 11–21) was analysed prospectively.

Results: 60.2% of cases fell into the early surgery group, 32.4% into the intermediate group, and 7.5% into the late operated group. Late surgery was due to delays in diagnosis, transfer, and logistic factors, but not clinical decision. The demographic characteristics, site of aneurysm, and clinical condition of the patients at the time of initial medical assessment were balanced in the three surgical timing groups. There was no significant difference in GOS between the surgical timing groups at 6 months (favourable GOS score 4 and 5: 83.2%, 80.5%, and 83.8% respectively; p=0.47, Kruskal-Wallis test). Outcome was favourable in 84% of patients under 65 years, and 70% in those over 65. The discharge destinations (home, referring hospital, nursing home, rehabilitation centre) showed no significant difference between surgical timing groups. There was no significant difference in mean time to discharge after admission to this hospital from the referring hospital (16.2, 16.2, and 14.6 days for early, intermediate, and late groups respectively; p=0.789, Analysis of variance (ANOVA)). As a result, there was reduction in the mean duration of total hospital inpatient stay in favour of the earliest operated patients (mean time 18.1, 22.0, and 28.3 days respectively; p=0.001. ANOVA showed that besides age, the only determinant of surgical outcome and duration of stay was presenting clinical grade (p<0.0005).

Conclusion: The current management of patients presenting with SAH from anterior circulation aneurysms allows early surgery to be followed safely regardless of age. The only independent variables affecting outcome are age and clinical grade at presentation. The timing of surgery did not significantly affect surgical outcome, promoting a policy for early surgery that avoids the known risks of rebleeding and reduces inpatient stay.

See end of article for authors' affiliations

Correspondence to:
Dr P J Kirkpatrick,
University Department of Neurosurgery, Box 167, Block A, Level 4, Addenbrookes Hospital, Cambridge CB2 2QQ, UK;
pjk21@medschl.cam.ac.uk

Received 6 June 2001
In revised form 23 November 2001
Accepted 5 December 2001

The controversy over the optimum timing after aneurysmal subarachnoid haemorrhage (SAH) continues.[1–8] Recent recommendations towards earlier surgery to reduce the devastating effects of aneurysmal rebleeding (15%-20% incidence within the first 2 weeks with an associated 70%-80% mortality)[9] have not generally been followed due to the perceived risk for higher surgical morbidity and mortality when operating on the acutely injured brain. Large studies during the 1980s indicated that the intermediate period (days 4–10) after the primary SAH was a particularly precarious time for surgery when cerebral vasospasm and cerebral ischaemia may be the most active.[10] Even in units which do advocate early surgery, late surgery still occurs due to referral and service delays.[11 12]

Medical advances in the management of patients with SAH have provided an effective prophylaxis and treatment for cerebral ischaemia after SAH. Attention to fluid resuscitation,

Abbreviations: SAH, subarachnoid haemorrhage; GOS, Glasgow outcome score; WFNS, World Federation of Neurosurgical Societies; DSA, digital subtraction angiography electrolyte correction, and the administration of calcium antagonists have reduced the incidence of ischaemic complications significantly.[13–22] Early surgery to allow irrigation of the subarachnoid spaces is also thought to play a part in reducing cerebral ischaemia.[5 11 13 23 24] The opportunities for early surgery have therefore broadened, and recent reports indicate that it is the severity of the initial bleed and rebleeding, which are now the main causes of mortality for this condition, not cerebral ischaemia.[25 26] Encouraged by our own pilot study into the effects of the timing of surgery on outcome[11 16] we have now completed a prospective assessment for supratentorial aneurysmal SAH within the modern arena of aggressive resuscitation before surgery. We have tested the hypothesis that the timing of surgery no longer influences the surgical outcome. The data support the hypothesis, and also show that early surgery reduces overall inpatient stay. In addition, age no longer seems a contraindication for the surgical management for this condition as a favourable outcome can be achieved in most.

METHODS

Patients

All patients admitted to the regional neurosurgical unit over a 6 year period from January 1993 to March 2000 with SAH (confirmed on preadmission CT) were entered into the study. Throughout this period a policy was followed in which all patients, regardless of age and clinical grade, were admitted on the day of referral for resuscitation, correction of hydrocephalus, and further investigation. After resuscitation (see below) patients were graded according to the World Federation of Neurosurgical Societies (WFNS) scale. Patients who presented to the neurosurgical unit late (after 7 days) were graded according to the earlier assessment provided by the referring hospital.

Medical protocol

All patients were treated according to a standard preoperative protocol for resuscitation. Fluids (500 ml normal saline alternating with 500 ml haemacel) were administered to provide a central venous pressure of between 8 and 12 cm H_2O, and a systolic blood pressure of about 160 mm Hg. Oral nimodipine was started (60 mg every 4 hours). Patients in poor clinical grade were managed on a neurointensive care unit and had an external ventricular drain inserted in the presence of hydrocephalus. If necessary, inotropes were used to support the blood pressure after adequate fluid replacement, and were monitored with the assistance of a pulmonary arterial flotation catheter. Nimodipine was administered intravenously centrally (1–2 mg/hour infusion) but reduced if any difficulty was encountered in maintaining an adequate blood pressure.

After surgery the medical protocol continued for a minimum of 48 hours and was discontinued thereafter in good grade patients. In poor grade patients, and those who deteriorated postoperatively due to possible cerebral ischaemia, blood pressure support was increased to achieve a systolic pressure of up to 180 mm Hg and maintained until 48 hours after clinical improvement.

Patient selection for further investigation and surgery

Surgery was conducted according to a preagreed protocol, and pursued the practice of an early operation. After resuscitation, all patients obeying commands were investigated further with cerebral digital subtraction angiography (DSA). Poor grade patients who were intubated were assessed after reversal of paralysing agents: those showing flexion to pain or better were selected for DSA. All patients who had a supratentorial aneurysm on DSA were scheduled for surgery within 48 hours.

Patients with the following factors were excluded from the final data analysis;

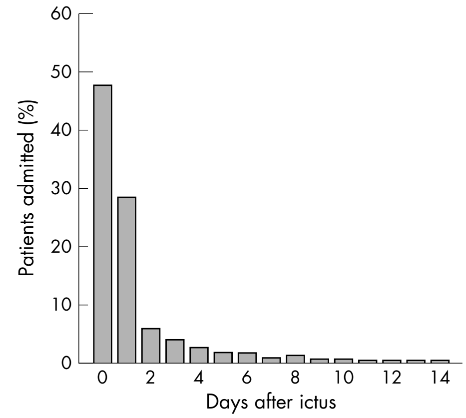

Figure 1 Distribution of admission days to neurosurgical unit for all patients diagnosed as having had a subarachnoid haemorrhage (SAH). Those admitted after day 21 have been omitted (n=1168; day of SAH=day 0).

- Space occupying haematoma requiring emergency treatment
- Could not at least flex to pain after resuscitation
- Initial negative angiogram
- Clinical deterioration before surgery resulting in an inability to flex to pain
- Non-aneurysmal SAH
- Bleed from an infratentorial aneurysm
- Endovascular treatment for aneurysm
- Rebleed before surgery
- Multiple aneurysms in which the source of bleed was unclear
- Surgery occurring after 21 days

By adopting these exclusion criteria, the study addresses the influence on the timing of surgery for the most common aneurysms encountered which do not require emergency surgery, and encompasses those often managed by general neurosurgeons.

Patient follow up

Patients were assessed at discharge and at 6 months by an independent assessor (HS) who was blind to the details and timing of surgery. Outcome was gauged according to the Glasgow outcome score (GOS).[27] Neuropsychological assessment for good outcome patients was also undertaken between 6 to 18 months after surgery, and is the subject of separate reports.[28 29] Inpatient duration of stay was documented, as was the discharge destination (home, referring hospital, rehabilitation centre, nursing home/care centre).

Statistical analysis

Patients fulfilling the above criteria were grouped according to the time to surgery after the day of the initial SAH (taken as day 0):

- Early group (day 1–3)
- Intermediate group (day 4–10)
- Late group (day 11–21)

Patients were classed as having achieved either a favourable outcome (GOS: good recovery (five); moderate disability (four)) or unfavourable outcome (GOS: severe disability (three); vegetative state (two); death (one)). Comparisons between these outcome measures were made using the χ^2 test. The surgical timing groups were also assessed with respect to inpatient stay using analysis of variance (ANOVA). Finally, the effect of age on surgical outcome was examined using the Kruskal-Wallis test.

Table 1 Demographic details, clinical grade of patients and site of aneurysm in the different timing to surgery groups

	Time to surgery (day after ictus) (day of SAH=day 0)		
	1–3	4–10	11–21
No of patients (% age of total n=550)	331 (60.2)	178 (32.4)	41 (7.5)
Mean age (range)	51.6 (15–80)	55.1 (24–84)	56.2 (32–77)
Sex (% female)	63.7	72.8	60
% poor grade (WFNS 4/5)	10.2	10.2	10
Site of aneurysm (% total in group)			
Anterior cerebral artery	42.6	38.4	32
Post communicating artery	24.7	22.7	40
Middle cerebral artery	23.1	29.1	15
Internal carotid artery	6.5	8.1	10
Pericallosal artery	3.1	1.7	2
Favourable outcome at 6 months (%)	83.2	80.5	84.0

RESULTS

Study patients

A total of 1168 (60.7% female, mean age 54.3; range 14–89 years) with CT established SAH were entered into the study over a 76 month period (1993–2000). They were received on median day 1 (86.4% within the first 3 days) after the ictus (fig 1). Of these, 784 (67.1%) fulfilled the criteria for further investigation and were found to have aneurysms on cerebral DSA. Those with supratentorial aneurysms whose clinical condition remained stable and underwent surgery within 21 days of the ictus were entered for final analysis (n=550). Most of the study population who did not fulfil the criteria were angiogram negative (n=295, 25.3%).

For distribution of patients among the surgical timing groups: 60.2% of cases fell into the early surgery group, 32.4% into the intermediate group, and 7.5% into the late operated group (table 1). The demographic characteristics (table 1) and site of aneurysm were well balanced between the three surgical timing groups. There were small differences in mean age between the three groups. The early group had a mean age of 3.5 and was 4.6 years younger than the intermediate and late surgical groups respectively (ANOVA, p=0.008; post hoc LSD p=0.006 and 0.043). There were no significant differences in WFNS grade at initial assessment (Kruskal-Wallis test p=0.767) between the early, intermediate, and late surgery groups with 66%, 63%, and 65% respectively presenting in WFNS grades 1 or 2.

Outcomes

There was no significant difference in GOS at discharge or 6 months (fig 2) between early, intermediate, or late surgery groups (Kruskal-Wallis test p=0.274; p=0.477). Favourable outcomes (GOS score 4 and 5) at 6 months were seen in 83.2%, 80.5%, and 83.8% of patients for the early, intermediate, and late groups respectively. The destination of patients at discharge was similar in each study group.

The WFNS grade at presentation was the major determinant of surgical outcome with poor grades (WFNS 4 and 5) fairing worse than better grades (p<0.0005).

Effect of age on outcome

Outcome was favourable in 84% of patients under 65 years of age, and in 70% of those over 65 (fig 3). Further examination of the effect of age by dividing the study group into seven age Ntiles showed that the mean GOS at 6 months ascended with age only in the last two age Ntiles representing patients between 62 and 68 years, and 69 and 84 years (Kruskal-Wallis test p<0.0005). In all age Ntiles the outcome was independent of the timing of surgery.

Time to discharge

There was no significant difference in mean time between admission to this neurosurgical centre to discharge (16.2, 16.2, and 14.6 days for early, intermediate, and late surgery groups respectively, p=0.79, ANOVA). As a result, there was a

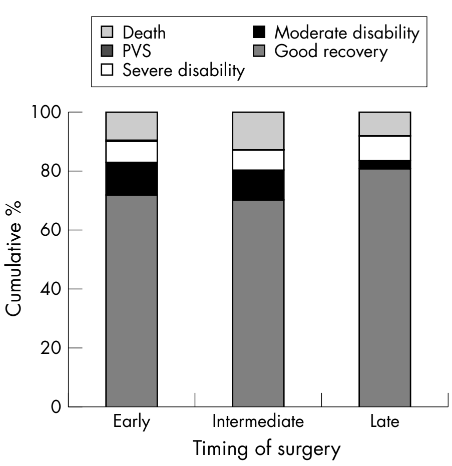

Figure 2 Stacked bar graph to showing Glasgow outcome score at 6 months in each surgical timing group.

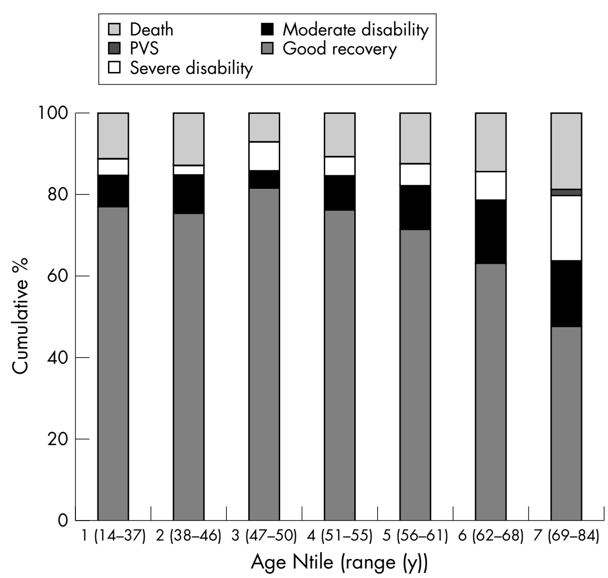

Figure 3 Stacked bar graph showing Glasgow outcome score in of seven age Ntiles. The age range encompassed by each Ntile is shown in parentheses. The surgical outcome is independent of age except for the last age Ntile.

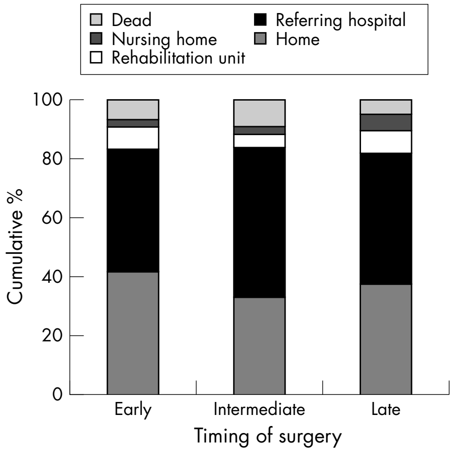

Figure 4 Stacked bar graph showing the destination after discharge from hospital for patients in each surgical timing group.

significant reduction in the mean duration of total hospital stay in favour of the earliest operated patients (mean duration of stay 18.1, 22.0, and 28.3 days respectively; p=0.001, ANOVA). Further examination of the duration of stay showed that the major determinant was presenting WFNS grade, with a significantly longer hospital admission for grades 3 and 4 ($p<0.0005$). Age was not a major factor in duration of stay ($p<0.65$). The discharge destiny was no different between timing of surgery groups (fig 4).

Rebleed rate during study

Forty four patients (4.1% of the all patients with SAH) sustained a CT established rebleed. Five bleeds occurred in patients who had not yet had angiography. There were 34 rebleeds in the patients with proved anterior circulation aneurysms (4.9%) with a mortality rate of 41%. The incidence of rebleeding was evenly distributed across the first 21 days.

DISCUSSION

This prospective study confirms earlier findings showing that, within the confines of a specific medical and surgical protocol addressing common supratentorial circulation aneurysms, the timing of surgery is no longer an important factor influencing surgical outcome.[30 31] Bearing in mind the well characterised incidence of aneurysmal rebleed (15%-20% within the first 2 weeks of the initial ictus) and associated high mortality,[9 26] the data give strong support to the notion that surgery for such aneurysms should not be delayed after adequate preparation and investigation.[32] Cerebral ischaemia due to non-surgical causes (such as "vasospasm") no longer seems to be the important issue governing the timing of surgery.[33 34] This is true regardless of the age and presenting grade.

Selection bias may be operating within this study. However, by far the most prognostic indicator after aneurysmal SAH is the presenting grade of the patient, which was well matched between the early, intermediate, and late operated groups. In addition, the influence of technical difficulty has been reduced by excluding infratentorial aneurysms and those requiring endovascular intervention. The data therefore reflect outcome in a relatively pure subgroup of patients with SAH that represent the most commonly encountered intracranial aneurysms requiring standard neurosurgical approaches within the realm of the general neurosurgeon.

The present data support conclusions drawn from recent retrospective series demonstrating the importance of aneurysm rebleeding despite attempts at early surgery, and also those studies showing that operative complications are independent of the timing of surgery.[35] The fall in the incidence of cerebral ischaemic complications after surgery may be an effect of multiple factors including improved general neurointensive care, optimal cerebral haemodynamics due to fluid resuscitation, and neuroprotection with nimodipine. Improved microsurgical attention and neuroanaesthesia may also be key factors. This study did not consider these specific influences individually, but indicates that in combination they have reduced the surgical contribution to cerebral ischaemia to an extent that allows earlier surgery on an injured, non-autoregulating cerebrovascular field without increasing morbidity.

A concern exists that cognitive deficits after SAH may not be within the resolution of the Glasgow outcome scale, which measures physical outcome. Recent subgroup analysis of patients with anterior communicating aneurysms taken from the present study population has shown that general neuropsychological performance is also independent of timing of surgery.[28] Indeed, improvements in tasks which assess rational performance have been detected in the early operated group.[29]

Previous reluctance for operating on aged people with aneurysmal SAH is no longer founded.[36] Even though the surgical outcomes are not as good in the over 65 year group compared with the younger patients, they are still very respectable, with three quarters achieving a favourable outcome. Again this was independent of the timing of surgery. Because many elderly patients with SAH present with confusion and are generalised as having had a "stroke", resulting in delayed investigation, a more active policy for early CT in these patients is now indicated.

Earlier surgery resulted in more rapid discharge from the neurosurgical unit. The discharge destiny was comparable between groups with a similar proportion of patients being discharged for home. Although the time spent in the various rehabilitation and convalescence facilities was not documented, the even distribution within the different types of facility and the near identical clinical outcomes at both discharge and at 6 months does not suggest that earlier operated groups required more rehabilitation after their surgery. Thus, despite early operations being conducted in patients who had more recently had an SAH, the postoperative course seemed near identical to that of the later operated group. A cost saving is realised by receiving and treating such patients expeditiously without an associated risk to their care and outcome. Time at the referring hospital seems to be time wasted and attracts an increased risk of rebleeding.

In summary, with suitable perioperative resuscitation the timing of surgery for common supratentorial aneurysms no longer affects surgical outcome. In this series early surgery would have resulted in an improved management outcome for patients of all ages by reducing the high risks of rebleeding. Expeditious treatment also results in a more rapid discharge from hospital resulting in calculable savings. The data support a more expeditious approach to SAH irrespective of patient age and clinical condition.

....

Authors' affiliations
N Ross, P J Hutchinson, H Seeley, P J Kirkpatrick, University Department of Neurosurgery, Box 167, Block A, Level 4, Addenbrookes Hospital, Cambridge CB2 2QQ, UK

REFERENCES

1 **Kassell NF**, Torner JC, Haley EC, *et al.* The international cooperative study on the timing of aneurysm surgery. Part 1: overall management results. *J Neurosurg* 1990;**73**:18–36.
2 **Yoshimoto T**, Uchida K, Kaneko U, *et al.* An analysis of follow-up results of 1000 intracranial saccular aneurysms with definitive surgical treatment. *J Neurosurg* 1979;**50**:152–7.
3 **Suzuki J**, Onuma T, Yoshimoto T. Results of early operations on cerebral aneurysms. *Surg Neurol* 1979;**11**:407–12.
4 **Kassell NF**, Boarini DJ, Adams HP, *et al.* Overall management of ruptured aneurysm: comparison of early and late operation. *Neurosurgery* 1981;**9**:120–8.

5 **Ljunggren B**, Saveland H, Brandt L, *et al*. Early operation and overall outcome in aneurysmal subarachnoid hemorrhage. *J Neurosurg* 1985;**62**:547–51.
6 **Ohman J**, Heiskanen O. Timing of operation for ruptured supratentorial aneurysms: a prospective randomized study. *J Neurosurg* 1989;**70**:55–60.
7 **Solomon RA**, Fink ME, Lennihan L. Early aneurysm surgery and prophylactic hypervolemic hypertensive therapy for the treatment of aneurysmal subarachnoid hemorrhage. *Neurosurgery* 1988;**23**:699–704.
8 **Maurice-Williams RS**, Wadley JP. Delayed surgery for ruptured intracranial aneurysms: a reappraisal. *Br J Neurosurg* 1997;**11**:104–9.
9 **Jane JA**, Winn HR, Richardson AE. The natural history of intracranial aneurysms: rebleeding rates during the acute and long term period and implication for surgical management. *Clin Neurosurg* 1977;**24**:176–84.
10 **Kassell NF**, Torner JC, Jane JA, *et al*. The international cooperative study on the timing of aneurysm surgery. Part 2: surgical results. *J Neurosurg* 1990;**73**:37–47.
11 **Whitfield PC**, Moss H, O'Hare D, *et al*. An audit of aneurysmal subarachnoid haemorrhage: earlier resuscitation and surgery reduces inpatient stay and deaths from rebleeding. *J Neurol Neurosurg Psychiatry* 1996;**60**:301–6.
12 **Roos YB**, Beenen LF, Groen RJ, *et al*. Timing of surgery in patients with aneurysmal subarachnoid haemorrhage: rebleeding is still the major cause of poor outcome in neurosurgical units that aim at early surgery. *J Neurol Neurosurg Psychiatry* 1997;**63**:490–3.
13 **Pickard JD**, Murray GD, Illingworth R, *et al*. Effect of oral nimodipine on cerebral infarction and outcome after subarachnoid haemorrhage: British aneurysm nimodipine trial. *BMJ* 1989;**298**:636–42.
14 **Hasan D**, Vermeulen M, Wijdicks EF, *et al*. Effect of fluid intake and antihypertensive treatment on cerebral ischemia after subarachnoid hemorrhage. *Stroke* 1989;**20**:1511–5.
15 **Nelson RJ**, Roberts J, Ackery DM, *et al*. Measurement of total circulating blood volume following subarachnoid haemorrhage: methodological aspects. *J Neurol Neurosurg Psychiatry* 1987;**50**:1130–5.
16 **Kudo T**, Suzuki S, Iwabuchi T. Importance of monitoring the circulating blood volume in patients with cerebral vasospasm after subarachnoid hemorrhage. *Neurosurgery* 1981;**9**:514–20.
17 **Solomon RA**, Post KD, McMurtry JG. Depression of circulating blood volume in patients after subarachnoid hemorrhage: implications for the management of symptomatic vasospasm. *Neurosurgery* 1984;**15**:354–61.
18 **Wijdicks EF**, Vermeulen M, ten Haaf JA, *et al*. Volume depletion and natriuresis in patients with a ruptured intracranial aneurysm. *Ann Neurol* 1985;**18**:211–6.
19 **Lolin Y**, Jackowski A. Hyponatraemia in neurosurgical patients: diagnosis using derived parameters of sodium and water homeostasis. *Br J Neurosurg* 1992;**6**:457–66.
20 **Maroon JC**, Nelson PB. Hypovolemia in patients with subarachnoid hemorrhage: therapeutic implications. *Neurosurgery* 1979;**4**:223–6.
21 **Kassell NF**, Peerless SJ, Durward QJ, *et al*. Treatment of ischemic deficits from vasospasm with intravascular volume expansion and induced arterial hypertension. *Neurosurgery* 1982;**11**:337–43.
22 **Awad IA**, Carter LP, Spetzler RF, *et al*. Clinical vasospasm after subarachnoid hemorrhage: response to hypervolemic hemodilution and arterial hypertension. *Stroke* 1987;**18**:365–72.
23 **Mizukami M**, Kawase T, Usami T, *et al*. Prevention of vasospasm by early operation with removal of subarachnoid blood. *Neurosurgery* 1982;**10**:301–7.
24 **Bailes JE**, Spetzler RF, Hadley MN, *et al*. Management morbidity and mortality of poor-grade aneurysm patients. *J Neurosurg* 1990;**72**:559–66.
25 **Broderick JP**, Brott TG, Duldner JE, *et al*. Initial and recurrent bleeding are the major causes of death following subarachnoid hemorrhage. *Stroke* 1994;**25**:1342–7.
26 **Hutchinson PJ**, Seeley HM, Kirkpatrick PJ. Factors implicated in deaths from subarachnoid haemorrhage: are they avoidable? *Br J Neurosurg* 1998;**12**:37–40.
27 **Jennett B**, Bond M. Assessment of outcome after severe brain damage. *Lancet* 1975;i:480–4.
28 **Mavaddat N**, Sahakian BJ, Hutchinson PJ, *et al*. Cognition following subarachnoid hemorrhage from anterior communicating artery aneurysm: relation to timing of surgery. *J Neurosurg* 1999;**91**:402–7.
29 **Mavaddat N**, Kirkpatrick PJ, Rogers RD, *et al*. Deficits in decision-making in patients with aneurysms of the anterior communicating artery. *Brain* 2000;**123**:2109–17.
30 **Dorsch NW**. Surgery for cerebral aneurysms. An eight-year experience. *Med J Aust* 1984;**141**:18–21.
31 **Miyaoka M**, Sato K, Ishii S. A clinical study of the relationship of timing to outcome of surgery for ruptured cerebral aneurysms. A retrospective analysis of 1622 cases. *J Neurosurg* 1993;**79**:373–8.
32 **Dorsch NW**, Besser M, Brazenor GA, *et al*. Timing of surgery for cerebral aneurysms: a plea for early referral. *Med J Aust* 1989;**150**:183, 183–7, 188.
33 **Sano K**, Saito I. Timing and indication of surgery for ruptured intracranial aneurysms with regard to cerebral vasospasm. *Acta Neurochir (Wien)* 1978;**41**:49–60.
34 **Macdonald RL**, Wallace MC, Coyne TJ. The effect of surgery on the severity of vasospasm. *J Neurosurg* 1994;**80**:433–9.
35 **Tucker WS**. The relationship between timing of surgery and operative complications in aneurysmal subarachnoid hemorrhage. *Can J Neurol Sci* 1987;**14**:84–7.
36 **Lanzino G**, Kassell NF, Germanson TP, *et al*. Age and outcome after aneurysmal subarachnoid hemorrhage: why do older patients fare worse? *J Neurosurg* 1996;**85**:410–8.