MEDICAL PRACTICE

Process and Outcome

Avoidable factors contributing to death after head injury

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Summary

We reviewed 116 patients, known to have talked before dying after head injury, to discover factors which had contributed to death but which might have been avoided. All the patients were admitted to a neurosurgical unit and had a neuropathological post-mortem examination. One or more avoidable factors were identified in 86 patients (74%); an avoidable factor was judged certainly to have contributed to death in 63 patients (54%). The most common avoidable factor was delay in the treatment of an intracranial haematoma; others included poorly controlled epilepsy, meningitis, hypoxia, and hypotension. Changes in the management of patients with head injuries which reduce the incidence of avoidable factors should decrease mortality from this condition.

Introduction

When a patient talks soon after a head injury he clearly has not sustained overwhelming impact damage to the brain. If he then dies it is reasonable to assume that it is because of one or more secondary events, which raises the possibility that death might have been avoided—either by preventing or by treating complications more effectively. A preliminary study of the clinical and pathological features of 66 patients with head injuries who talked and subsequently died in this institute supported this view.[1] Many patients had lesions which were potentially treatable, such as intracranial haematoma, raised intracranial pressure, or hypoxic and ischaemic brain damage.

We report here on 116 patients who talked after sustaining head injuries, but later died (including the previous 66 cases), with the specific intention of identifying factors in management which might have contributed to death, and which could have been avoided.

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Patients and methods

All patients were admitted to the regional neurosurgical unit, having been previously admitted to a primary surgical ward in a general hospital. This neurosurgical unit serves a population of 2·7 million, about half of whom are in the Glasgow conurbation and the rest in towns or rural areas up to 100 miles from the unit.

TALKING AND LUCID INTERVAL

If a patient uttered any recognisable words either immediately after injury or after an initial period of unconsciousness he was regarded as having talked. About a third of all patients who died after admission to the neurosurgical unit during this period had talked. Of the patients who talked a third were reported as having been completely lucid for a time, either by their relatives or by others who saw them earlier.

OCCURRENCE OF AVOIDABLE FACTORS

This was a study based on scrutiny of the case records made during the patient's stay in the institute, often supplemented by the notes from the referring hospital, and by details supplied by the police at the time of the necropsy. The adoption in the early 1970s of the Glasgow Coma Scale[2 3] made it relatively easy to document the degree of deterioration and the time course of changes in the patient's condition. Coma was defined on this scale as "not obeying commands,

not uttering any recognisable words, and not opening the eyes." We paid particular attention to the time intervals between injury and subsequent events such as deterioration, development of coma, transfer to neurosurgical unit, operation for intracranial haematoma, and to death.

We looked for avoidable factors such as delay in diagnosing complications, or in initiating action once deterioration was recognised; inappropriate or inadequate management (for example—of meningitis, epilepsy, or intracranial haematoma); failing to prevent, or to correct sufficiently rapidly, extracranial factors such as hypoxia, hypotension, or airway obstruction. Whenever there was evidence that an incident of this kind had occurred it was recorded—whether or not it was judged to have been avoidable in practice, and whether or not it was considered to have contributed to death.

SIGNIFICANCE OF AVOIDABLE FACTORS

It is seldom easy to decide what combination of factors has contributed to death, and how to apportion their relative importance. For each avoidable factor in individual patients we assigned significance on a two-point scale, according to whether the contribution to death was certain or only possible. Due weight was always given to neuropathological findings, without which we often would not have known what significance to assign to an incident—for example, hypotension or airway obstruction. Evidence of the severity of the impact damage from necropsy findings was also important in helping us to decide whether survival would have been likely but for the occurrence of an avoidable factor. We also considered the chronological order in which events had occurred. When avoidable factors such as hypoxia occurred in a patient already in deep coma from delayed diagnosis of intracranial haematoma this was not considered to have certainly contributed to death.

NECROPSY FINDINGS

Only patients on whom a necropsy (including full neuropathological examination) had been carried out were included. As the necropsy rate for head injuries in this institute is over 90%, few cases were excluded. Occasionally complications such as meningitis, intracranial haematoma, severe hypoxic brain damage, or some major extracranial injury were disclosed only at necropsy. We often needed neuropathological evidence to assess the degree of impact damage, so that we could judge whether or not survival would have been likely but for the occurrence of avoidable factors.[4] Details of the neuropathological findings will be the subject of another article.

Results

Age distribution of patients who talked before death—Because mortality is related to age there are more older patients in a fatal series than in a complete population of patients admitted with head injuries. Nevertheless, among fatal cases, those that talked included fewer younger than 20 years and more who were over 60 years of age (table I).

TABLE I—*Distribution of fatal head injuries among 166 patients according to age*

Age (years)	After talking (n = 116)	Never talked (n = 50)	P value
<20	25 (22%)	17 (34%)	NS
20-60	49 (42%)	23 (46%)	NS
>60	42 (36%)	10 (20%)	<0·05

INCIDENCE OF AVOIDABLE FACTORS

One or more avoidable factors were found in 86 (74%) of patients, and were judged certainly to have contributed to death in 63 (54%) of the whole series of patients. There were 188 factors in 86 patients, multiple factors being more common when no single factor was considered to have had a certain effect on the patient's death (table II).

TABLE II—*Incidence of avoidable factors in 116 patients*

Factor	Contribution to death		Total
	Certain	Possible	
Intracranial:			
Delay in treatment of haematoma	50	22	72
Poorly controlled epilepsy	7	13	20
Meningitis	7	0	7
Other	4	9	13
Extracranial:			
Airway obstruction	8	22	30
Hypotension	6	19	25
Other	8	13	21
Total	90	98	188
Total No (%) of patients with avoidable factors	63 (54)	33* (28)	86 (74)

*Including 10 who also had a certain factor; hence total No of patients only 86.

INTRACRANIAL FACTORS

Delay in the treatment of an intracranial haematoma was the most common factor. A delay was recorded when we considered that an unreasonable time had elapsed between the onset of clinical deterioration and subsequent positive diagnostic or therapeutic action. Deterioration was considered to have occurred if there was a significant alteration in consciousness or if focal neurological abnormalities in the limbs or in the pupils developed. By this subjective evaluation 39 patients with intracranial haematoma were recorded as having had a definite delay.

TABLE III—*Where delay occurred in treatment of intracranial haematomas and effect of delay on subsequent death*

	Certain effect (% of 50 incidents in 39 patients)	Possible effect (% of 22 incidents in 15 patients)	Total (% of 72 incidents in 54 patients)
Before hospital	10 (20)	4 (18)	14 (20)
At accident and emergency department	6 (12)	2 (9)	8 (11)
Primary surgical ward	22 (44)	12 (55)	34 (47)
Neurosurgical ward	12 (24)	4 (18)	16 (22)

These delays occurred at various stages after injury (table III), and in 18 patients (33%) delay happened at more than one stage. One delay in five was due to the patient not having reported to a doctor at all until already deteriorating—often because he was under the influence of alcohol at the time of injury. Delays seldom occurred in accident and emergency departments, whereas almost half of all delays were caused by slowness of transfer from the primary surgical ward to the neurosurgical unit. During this survey the neurosurgical unit in Glasgow had many beds continuously closed, so that transfer from another surgical ward was often postponed until there was unequivocal evidence of a haematoma, or was refused; the responsibility for some of these delays was therefore shared by neurosurgeons and primary surgeons. More often there was failure to recognise deterioration for some time, or to act promptly once it was recognised. Sometimes delay occurred because the patient's coma was attributed to alcoholic intoxication or to a cerebrovascular accident, as reported by Galbraith.[5]

The distance of the primary hospital from the neurosurgical unit did not significantly influence the interval between injury and operation for haematoma, and it alone could not be blamed for delays. No fewer than nine patients had been sent home from the accident and emergency department, or after admission to a primary surgical ward, before returning with a haematoma which proved fatal. Once in the neurosurgical unit delays sometimes still occurred, usually when the degree and rate of deterioration that had already occurred was underestimated.

Poorly controlled epilepsy was the next most common intracranial factor; status epilepticus was regarded as the sole cause of death in two children who were mildly injured and who had extensive hypoxic and ischaemic damage at necropsy. The rule that sedative drugs should be avoided if possible after head injury sometimes leads to reluctance to give anticonvulsants after the first fit, and the problem then gets out of hand. Epilepsy occasionally contributed to delay, when deterioration was attributed to a postictal state, but was in fact caused by cerebral compression.

Meningitis caused seven deaths; it was clinically wholly unsuspected in four of these patients. These deaths resulted from compound

depressed fractures of the vault, or basal fractures with dural tears. We have reported in detail the problem of intracranial infection after compound depressed fractures[6]; none of the cases from that report are included here.

EXTRACRANIAL FACTORS

Airway obstruction and systemic hypotension were commonly recorded, but were seldom considered to have been a certain cause of death. This is because these complications tend to occur in patients already in deep coma due to some other factor, usually delay. Hypotension was defined as a systolic blood pressure of < 80 mm Hg for more than 15 minutes. Hypotension was most often associated with operative procedures and general anaesthesia, frequently for associated extracranial injuries. Other extracranial complications included metabolic disorder, peritonitis from unsuspected viscus perforation, and pulmonary embolism. Avoidable factors occurring in the neurosurgical unit were usually extracranial, often a direct complication of investigative or operative procedures.

PATIENTS WITHOUT AVOIDABLE FACTORS

Most (21; 70%) of these 30 patients died after rapid deterioration due to an intracranial haematoma. A higher proportion of patients without avoidable factors developed coma within six hours of injury (25; 83%) than did those who had avoidable factors (36; 42%). Avoidable factors which certainly contributed to death were significantly more common in patients with haematomas who underwent operation more than 12 hours after injury (table IV). Patients without avoidable factors had less often been completely lucid, and more often had had major extracranial injuries than those with avoidable factors.

TABLE IV—*Incidence of avoidable factors in patients who underwent operation for haematoma, according to interval between injury and operation*

Interval (hours)	No	Avoidable factors with certain effect
<12	40	12 (30%)
>12	40	34 (85%)
P		<0·001

Discussion

HOW FREQUENT ARE AVOIDABLE FACTORS?

A survey of this kind inevitably underestimates the incidence of the factors which we have called "avoidable." Not all incidents known to have occurred are recorded in the case notes, while others are not known at all (for example, an unwitnessed fit with respiratory obstruction, or an episode of hypotension before blood-pressure recordings were begun). Established ischaemic brain damage found in patients dying within 6-12 hours of injury emphasises how quickly secondary events can cause additional brain damage.[7] Without careful clinical and pathological observations such patients might be assumed to have died from overwhelming impact damage. Perhaps we sometimes wrongly attributed secondary brain damage to the factors which we had identified, when it had actually been caused by other factors unknown to us.

It might be suspected that because this unit is a secondary referral centre it would receive an undue proportion of patients who had deteriorated after a lucid interval. Nevertheless, the incidence of talking and of a lucid interval before prolonged coma was exactly the same in the neurosurgical units from the two other countries (Netherlands and USA) that contributed to the Glasgow collaborative head injury study.[8] These other centres accepted 90% of their patients as primary admissions within six hours of injury; in them and in Glasgow the proportion who talked before going into coma was similar for fatal cases and for survivors.

Avoidable factors are not confined to patients who talk. In a sample of 50 patients who died in this unit without any record of having talked we found similar avoidable factors in 20 (40%)—less than in those who talked but still an appreciable proportion. We are currently investigating the possibility that some of the brain damage in survivors, especially after the removal of haematoma in patients who have been in deep coma, might be partly due to avoidable factors.

WOULD THE PATIENTS HAVE SURVIVED OTHERWISE?

Although we judged that to have uttered even a few words showed that the impact brain damage had not been overwhelming, pathological examination sometimes showed quite extensive lacerations and contusions associated with local and generalised swelling, and in some cases, with intradural haematoma. Such patients usually deteriorated very rapidly, and accounted for most of the cases in which we concluded that no avoidable factors had occurred. We considered that survival would have been likely when the impact damage, judged from pathological findings, was limited to a few contusions; extensive white-matter lesions on microscopy are not found in patients who have talked.[4] When an intracranial haematoma was associated with minor impact damage, we assumed that earlier removal might have allowed the patient to survive. It is generally believed that once clinical deterioration is occurring, delay in evacuating blood clot reduces the chances of recovery substantially. McKissock[9] has written (about extradural haematoma): "The earliest possible diagnosis and the most urgent possible surgical treatment are the only measures which will effectively reduce what is still an excessively high mortality." Regarding traumatic intracerebral haematoma, Jamieson[10] called attention to the "high mortality rate (40·9%) amongst those who, having been lucid, had lost consciousness before operation, since many of these deaths may have been preventable"

HOW CAN AVOIDABLE FACTORS BE MINIMISED?

The incidents that we have described are well recognised as occurring occasionally after head injury, but their incidence and importance have not been recorded. Even when it is known that avoidable incidents have occurred it is only too easy to regard the patient as having sustained irrecoverable damage, unless careful pathological examination is carried out. Patients with head injuries who initially appear relatively mildly affected, or at least not to have sustained a life-threatening injury, may develop serious complications that require rapid neurosurgical intervention. It is in the hope of recognising such complications in good time that so many mildly injured patients are admitted to primary surgical wards for 24-48 hours. Our investigation shows that good intentions are not enough: there is need for keener awareness of the danger signs, and of what should be done once they are recognised. One purpose of devising the Glasgow Coma Scale[2,3] was to simplify the assessment of patients after head injury and to facilitate communication between neurosurgical units and junior medical staff in primary surgical wards. This represents only a small step towards finding a solution to the problem.

Everyone knows the importance of maintaining a clear airway in patients who are unconscious. For this reason, ambulance crews are commonly instructed in the proper care of unconscious patients at the scene of accidents, and during their initial journey to hospital. About half of deaths attributed to head injury occur before the patient reaches hospital,[11] but preliminary results of a review we are conducting of post-mortem examinations on such cases shows most to have suffered overwhelming brain damage or multiple injuries; airway obstruction associated with a recoverable degree of brain damage was rare. Once the patient reaches hospital it is the doctor's responsibility to ensure that adequate precautions are taken at

all times to avoid compromise of the airway—particularly when a patient in coma is transferred from one hospital to another. Yet two-thirds of the patients in this study who were in coma when transferred to the neurosurgical unit arrived without an endotracheal tube in place; some of these patients were not even appropriately positioned to minimise the risk of airway obstruction.

Some might regard this investigation as evidence that the organisation for care for patients with head injuries should be reviewed, so as to ensure that more of these patients receive direct neurosurgical supervision soon after injury. In the West of Scotland only 4% of patients admitted to hospital after head injury eventually come to the regional neurosurgical unit, a similar proportion as in the regions served by the Aberdeen and Dundee neurosurgical units.[12] Because head injuries are so common, considerable redeployment of beds and of medical manpower would be needed if neurosurgeons were to take primary responsibility for an appreciably greater proportion of acute head injuries. Before recommending such a radical reorganisation we must consider the scale of the problem, and whether there are better ways of identifying the relatively small number of patients who are at risk from complications, and who may require neurosurgical investigation or treatment. This is one purpose of the epidemiological study of head injuries in Scotland currently being conducted from this department.

Whatever the findings of that study there is obviously need for closer collaboration between neurosurgeons, primary surgeons, and specialists in accident and emergency, so that appropriate guidelines for different local conditions may be established. How this might best be achieved is beyond our scope here, which is to show the need for a critical review of the care of patients with head injuries in the acute stage. One possibility would be to establish a system of confidential reporting of patients who "talk and die" after head injury, similar to that which has proved useful in identifying preventable factors contributing to maternal mortality.

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References

1 Reilly, P J, *et al*, *Lancet*, 1975, **2**, 375.
2 Teasdale, G, and Jennett, B, *Lancet*, 1974, **2**, 81.
3 Jennett, B, and Teasdale, G, *Lancet*, 1977, **1**, 878.
4 Adams, J H, *et al*, *Brain*, 1977, **100**, 489.
5 Galbraith, S, *British Medical Journal*, 1976, **1**, 1438.
6 Jennett, B, *Journal of Neurosurgery*, 1972, **36**, 333.
7 Graham, D I, PhD thesis, University of Glasgow, 1972.
8 Jennett, B, *et al*, *Journal of Neurology, Neurosurgery and Psychiatry*, 1977, **40**, 291.
9 McKissock, W, *et al*, *Lancet*, 1960, **2**, 167.
10 Jamieson, K, and Yelland, J, *Journal of Neurosurgery*, 1972, **37**, 528.
11 Field, J H, *Epidemiology of Head Injuries in England and Wales*. London, HMSO, 1976.
12 Jennett, B, *British Medical Journal*, 1975, **3**, 267.

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Contemporary Themes

Improving drug compliance after hospital discharge

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Summary

The effect of counselling on medication errors was assessed in 165 elderly patients after leaving hospital. Counselling was effective, with counselled patients making under one-third of the errors made by uncounselled patients. Three types of memory aid were tried to supplement counselling. The pill wheel increased errors, a tablet identification card was unhelpful, and only a tear-off daily calendar seemed to improve results modestly. Counselling was virtually as effective in improving compliance in poorly orientated patients.

A designated member of staff should spend about 15 minutes with each elderly patient before discharge to ensure that the discharge drug regimen is fully understood and remembered, that old tablets are destroyed and that other people's tablets are not taken.

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Introduction

Drug-induced disease in the elderly is commoner than is often realised. Poor drug compliance plays a substantial part in this problem. Studies of elderly patients have shown that half do not take the drugs prescribed[1] and that from 25% to 59% of patients make errors in their medication.[2] Many patients do not understand their regimens[3] and in more than one-third of patients the resulting errors actively endanger their health.[2] The problems of tablet schedules are aggravated in the elderly because many elderly are mentally frail yet have no relative or friend to supervise their drug taking. In a general practice survey 87% of patients over 75 years old taking tablets were responsible for their own medicines.[4] One-third of this group were taking more than four types of tablet a day.

Methods of improving drug compliance centre on drug counselling and memory aids. Wandless and Davie[5] improved drug compliance in a group of well-orientated hospital inpatients by using calendars and tablet identification cards. We have assessed the value of drug counselling and memory aids in