PAPERS AND ORIGINALS

Head injuries in three Scottish neurosurgical units

Scottish Head Injury Management Study

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Summary and conclusions

The organisation of care for patients with head injuries in Scotland was investigated by studying retrospectively 785 patients admitted in 1974 and 1975 to neurosurgical units in Glasgow, Aberdeen, and Dundee. The reasons for the injuries and the patients' clinical conditions were similar in each unit. The referral practices at the hospitals containing the units were compared and found to be different from that of the unit in Edinburgh.

It is concluded that patients in the Glasgow, Aberdeen, and Dundee units, which operate a similar policy for head-injured patients, are in general similar. Transferring to a neurosurgical unit only selected patients rather than all patients with head injuries is safe practice only if policies are agreed with primary surgeons and patients can be transferred without delay.

Introduction

In Britain, as in most other countries where neurosurgical services are regionally organised, only a small proportion of head-injured patients are treated by neurosurgeons. To consider the consequences of this policy it is necessary to review the

patients who reach neurosurgical units in the context of all those with head injuries. The Scottish Head-Injury Management Study was set up to collect data from all parts of the hospital service in Scotland.¹ Detailed reports of surveys carried out on head-injured patients presenting to accident and emergency departments and on those admitted to primary surgical wards have already been published.^{2,3} The present paper considers patients with head injuries who were admitted to three neurosurgical units in Scotland.

Methods

Three of the four Scottish neurosurgical units (Glasgow, Dundee, and Aberdeen) serve 75% of the population of Scotland and operate a selective admission policy such as is common elsewhere in Great Britain. All patients admitted to these three neurosurgical units during 1974 were studied; Scottish accident and emergency departments and primary surgical wards were also surveyed during 1974. To increase the numbers available for analysis data were also collected for 1975 in Glasgow and Aberdeen, but this was not possible for Dundee.

Members of the team who had recently been junior staff in a neurosurgical unit developed a data form for retrieving information from existing case records. While a retrospective survey limits the amount of data that can be collected reliably, it avoids the possibility of bias arising from knowledge that a survey is being undertaken.

The Glasgow neurosurgical unit serves a population of 2.7 million. About 40% of the patients with head injuries in this region are admitted to primary surgical wards in the city, 4% to the hospital in which the neurosurgical unit is sited; 15% go to hospitals more than 30 miles away. Twenty-five neurosurgical beds per million population were available at the time of the survey (now increased to 33).

Aberdeen neurosurgical unit is within the campus of a teaching hospital, to which 31% of patients with head injuries are primarily admitted. Although about 60% of patients with head injuries are admitted to hospitals in the city, 26% are in hospitals more than 30 miles away. The population served is 660 000, and there are 35 neurosurgical beds per million.

Dundee neurosurgical unit is situated in one of two teaching hospitals in the city, but all cases of trauma come to this hospital, which admits (primarily) 63% of the cases of head injuries in the region. There are no hospitals more than 30 miles distant; the population served is 500 000, and there are 51 neurosurgical beds per million.

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Results

The patients reaching each of the three neurosurgical units were largely similar (tables I and II), and the differences were readily accounted for by geographical and organisational features of the three units. Glasgow admitted fewer patients with injuries from road accidents and more with injuries from assault; fewer Glasgow patients had associated extracranial injuries, which are more common in victims of road-traffic accidents. This feature of Glasgow reflects its predominantly urban population. Fewer patients reached the Glasgow neurosurgical unit within six hours of injury ($\chi^2=36$; $P<0.001$), probably because primary surgical wards are dispersed through so many hospitals in the west of Scotland and the number of neurosurgical beds is restricted. Aberdeen admitted fewer children, no doubt due to the proximity of the Sick Children's Hospital.

TABLE I—Details of head-injured patients in three neurosurgical units (NSUs). Figures are percentages of patients

	Unit			Total (n = 785)
	Glasgow (n = 545)	Aberdeen (n = 182)	Dundee (n = 58)	
Age:				
<15 years	29	7	38	25
≥65 years	8	15	5	10
Injury result of:				
Road traffic accident	34	43	41	37
Alcohol (age ≥15 years)	31	28	39	30
Assault (age ≥15 years)	18	9	11	15
Injury:				
Scalp laceration ..	34	29	40	33
Skull fracture ..	65	46	55	60
Major extracranial injury ..	15	25	31	18
Time between injury and admission to NSU:				
<6 hours	27	35	50	31
>24 hours	46	36	14	41

TABLE II—Clinical features of patients at time of admission to neurosurgical unit. Figures are percentages of patients

	Glasgow (n = 545)	Aberdeen (n = 182)	Dundee (n = 58)	Total (n = 785)
Glasgow coma scale*:				
3-5	15	8	9	13
6-9	22	15	28	21
10-11	9	13	12	11
≥12	54	64	52	56
Not talking	42	40	40	41
Not obeying	43	42	41	43
Deteriorating conscious level	45	46	36	44
Never lost consciousness	31	27	33	30
Non-reacting pupils ..	12	18	5	13

*Deepest coma scores 3; fully conscious scores 15.

Clinical state on admission to the neurosurgical ward—About 40% of the patients were not talking and not obeying when they arrived at the neurosurgical units. On the Glasgow coma scale, which is widely used in Europe and North America to assess conscious level after head injury,^{4,5} one-third of patients scored 9 or less. Of those who were fully conscious or only mildly confused (coma score more than 12), over one-third had been admitted because of a depressed fracture of the skull. Over 40% of patients had a history of deteriorating conscious state; one in five was suspected of having a change in pupil size, reaction, or equality; and one in 10 had had a fit before transfer.

PROCEDURE IN THE NEUROSURGICAL UNIT

One or more neuroradiological investigations were carried out in 57% of patients; other special tests—for example, isotope scanning, electroencephalography) were seldom used. At the time of the survey there was no scanner for computed tomography in Aberdeen or Dundee; that in Glasgow was installed in 1974, when 32% of Glasgow patients underwent the procedure, but angiography was performed in 51% of patients (45% of patients in Aberdeen and 36% in Dundee). In 1975, 52% of Glasgow patients underwent computed tomography

and only 15% angiography. When two scanners became available in Glasgow in 1978, 76% of patients with head injuries underwent computed tomography and only 3% angiography.

Non-surgical methods of managing the severely injured are currently much discussed. Not surprisingly, therefore, some differences existed between the three cities and between 1974 and 1975 in Glasgow and Aberdeen (table III). In these two centres steroids and osmotics were used less often in 1975 than 1974; in Aberdeen the tracheostomy rate also dropped, but tracheostomy was still used less often in Glasgow than Aberdeen or Dundee. The less frequent use of these measures, previously regarded as an essential component of the treatment of patients in coma after head injury, reflects a realisation that outcome is favourably influenced only in selected cases. This is discussed in detail in a report comparing treatment and outcome in large series of patients with severe head injuries from three countries.^{6,7}

Over half the patients admitted to these three neurosurgical units underwent an intracranial operation; over a quarter underwent craniotomy. One-third of the patients proved to have an intracranial haematoma, the distribution of sites being similar in the three centres (table IV).

TABLE IV—Final diagnosis. Figures are percentages of patients

	Unit			Total (n = 785)
	Glasgow (n = 545)	Aberdeen (n = 182)	Dundee (n = 58)	
Intracranial haematoma ..	37	30	33	35
Site of clot*:				
Extradural	10	6	10	9
Subdural	24	21	22	23
Intracerebral	11	8	7	10
Depressed skull fracture ..	23	11	14	19
Altered consciousness:				
No focal signs	6	21	21	11
With focal signs	8	9	17	9
Other cases	26	29	15	26

*Some patients had clots at more than one site.

OUTCOME

Mortality for the combined series from the three cities was 15%; there was little variation from place to place or from year to year (table V). The median duration of stay was between six and eight days in each centre but shortest in Glasgow. The mean stay, however, was much longer in Aberdeen and Dundee, since more patients in these centres stayed in the neurosurgical ward for over a month. The shorter stay in Glasgow was achieved by sending twice as many patients back to other hospitals rather than waiting until they were able to go home.

MINIPRINT TABLES

IIIIm

TABLE IIIIm—Management at the three units in 1974 and 1975. Figures are percentages of patients

	Unit			Total
	Glasgow 1974 n = 271	Aberdeen 1974 n = 95	Dundee 1975 n = 97	
Seroids given	22	25	13	22
Osmotics given	10	19	16	16
Tracheostomy	2	2	11	4
Ventilation	6	5	21	9
Operation (more than scalp suture) ..	66	57	56	47
Craniotomy	32	26	32	19

Vm

TABLE Vm—Duration of stay in neurosurgical units and proportion of patients discharged to another hospital and of death

	Unit			Total n = 785
	Glasgow n = 545	Aberdeen n = 182	Dundee n = 58	
Median duration, days	6	7	8	7
Mean duration, days	11	18	24	13
Proportion of patients staying:				
<2 days	21	27	19	22
3-7 days	36	23	29	31
8-28 days	35	36	28	34
>28 days	7	14	22	10
.. of patients discharged to other hospital	63	23	33	52
.. of patients who died	15	18	12	15

VIm

TABLE VIm—Proportions of patients admitted for head injuries to all wards and to neurosurgical units (NSUs) in Scotland, for catchment areas of units

	Glasgow	Aberdeen	Dundee	Edinburgh*
Population catchment as proportion of Scottish population ..	52	13	10	25
No. of neurosurgical beds ..	25	35	51	61
No. of patients with head injuries admitted to all wards, 100 000 population ..	306	130	404	332
Proportion of admissions for head injury that came to neurosurgical wards ..	4.5	3.8	2.6	3.5
No. of admissions to neurosurgical wards for head injury 100 000 population ..	14	13	10	116
Proportion of all neurosurgical admissions that are for head injuries ..	18	15	9	50
Proportion of primary surgical ward admissions that are admissions to hospital containing NSU ..	4	50	63	—

*Data from Scottish In-Patient Statistics.

HEAD-INJURY LOAD IN NEUROSURGICAL UNITS (TABLE VI)

How many head-injured patients reach a neurosurgical unit depends on the incidence of trauma in the catchment area, the referral practice of primary surgeons, and the policies and facilities of the neurosurgeons. When large proportions of patients with head injuries are admitted to primary surgical wards in the hospital containing the neurosurgical unit neurosurgeons can visit the patients, advise on their care, and even carry out special investigations without having to transfer them to the unit. This is probably why the proportions of admissions for head injury reaching the neurosurgical units at Aberdeen and Dundee were no greater than in Glasgow, although more neurosurgical beds were available in Aberdeen and Dundee at the time of the survey.

Edinburgh neurosurgical unit operates a policy for head injuries different from the other Scottish units. It has more beds available and a designated neurotrauma ward, to which many patients with mild head injuries are admitted briefly⁸ instead of to a primary surgical ward as happens elsewhere in Scotland. Although Edinburgh was not included in our survey the effect of its less selective policy on the work of the neurosurgical unit can be gauged from national hospital statistics.⁹ These show that the Edinburgh unit admits 35% of all patients with head injuries admitted to hospital in its entire catchment area and 50% of those admitted to hospitals in its own health board area. In the rest of Scotland less than 5% of head-injured patients admitted go to neurosurgical wards, where they account for less than one-fifth of neurosurgical admissions, compared with half in Edinburgh; the neurosurgical admission rate for head injury (on a population basis) is almost 10 times greater in Edinburgh than other Scottish centres. No evidence exists that head injuries are any more common in the Edinburgh catchment area, as judged by the people attending accident and emergency departments or hospital admissions as a whole.

Discussion

This survey has shown that patients in the Glasgow neurosurgical unit are similar in most respects to those in Aberdeen and Dundee, and a recent study from the Liverpool neurosurgical unit showed a close correspondence with Glasgow.¹⁰ This suggests that Glasgow is representative of most British units that operate a similar policy for patients with head injuries, and that the findings of various large-scale studies of head-injured patients in Glasgow will largely apply elsewhere. Routinely collected statistics show that in England and Wales about 5% of patients admitted to hospitals after recent head injury go to neurosurgical wards.¹¹ In the present study the proportion was similar for Scottish neurosurgical units that accept only those patients likely to require specialised investigation or treatment, as is common practice elsewhere in the UK.

What proportion of head-injured patients should be transferred to a neurosurgical unit to provide optimal care within reasonably cost-effective limits is controversial. This can be discussed usefully only in the light of detailed data about all head-injured patients, not just those who reach neurosurgical units. Reports of the Scottish Head-Injury Management Survey¹⁻³ have provided this information for the first time, and the role of the neurosurgical unit can now be reviewed in the light of those reports and the present study. Most primary surgeons and a few neurosurgeons⁸ advocate that more patients should be under neurosurgical care, at least in the acute stage. American neurosurgeons (who are seven times more numerous on a population ratio than in Britain) admit large numbers of mildly injured patients to their units and are openly critical of the British system of selective admission.¹² Our study showed, however, that an average of 230 beds in primary surgical wards of the hospitals served by Glasgow, Aberdeen, and Dundee neurosurgical units are occupied each day by head-injured patients; if all these patients were to be admitted under neurosurgeons then the number of neurosurgical beds would have to be increased by more than two and a half times.

Some British neurosurgeons maintain that primary surgeons should become more self-sufficient with regard to injured

patients, including those requiring intracranial surgery.¹³ They argue that the delays incurred in transfer to a neurosurgical unit are apt to be harmful. This argument is, however, difficult to sustain as long as scanners for computed tomography are largely confined to regional neurosurgical centres (and body scanners to only the largest general hospitals). The efficacy of computed tomography in showing post-traumatic intracranial lesions is beyond doubt—indeed, it can identify an intracranial haematoma before it is clinically obvious. This is the lesion that contributes so much to preventable mortality and morbidity when diagnosis is delayed.⁷ These neurosurgeons, however, suggest that if scanners were available in many more general hospitals then many more head-injured patients could be safely managed there by primary surgeons.^{13 14} The question is whether such hospitals would admit sufficient cases of head injury severe enough to justify a scanner or to enable radiological or surgical skill to be gained and maintained.

With increasing specialisation in surgery fewer surgeons are now prepared to undertake emergency cranial surgery even in hospitals at a distance from a neurosurgical unit. For the surgeon who only occasionally opens the skull an acute intracranial haematoma can present formidable problems; only one haematoma in four is an uncomplicated extradural, and in most of the remainder a large flap must be turned and damaged brain removed. The neurosurgical unit also offers facilities for neuroradiological investigation and other monitoring techniques such as measurement of intracranial pressure and electrophysiological tests of brain function. Although intensive non-surgical treatment (such as controlled ventilation, high-dose steroids, osmotic agents, and induced barbiturate coma) is now widely available in general intensive care units, it is doubtful whether it is wise to embark on such management without the possibility of conducting repeated computed tomography and intracranial-pressure monitoring and without immediate access to neurosurgical operating facilities. A patient in coma, whether or not he should prove to need intracranial surgery, probably stands a better chance of survival and of recovering without disability if he is treated by a neurosurgeon and managed by a team of nurses and doctors used to caring for brain-damaged patients.

The question is whether the policy of selectively transferring a relatively small proportion of head-injured patients to regional neurosurgical units can be made to work effectively and safely without having to provide neurosurgical beds for all head-injured patients or install scanners for computed tomography in many general hospitals. Unless there are sufficient neurosurgical beds to ensure that requests for the transfer of patients are seldom deferred or refused, then the selective admission policy may result in delays in management associated with preventable mortality and morbidity, as was evident when neurosurgical beds were restricted recently in Glasgow.^{15 16} When more neurosurgical beds became available then more head-injured patients were transferred to the neurosurgical unit, without evidence of any change in the incidence of head injury in the community served (from attendances at accident and emergency departments and admissions to primary surgical wards). The proportion of severely injured patients who reached the neurosurgical unit within six hours of injury doubled, and more patients with intracranial haematoma were admitted than in previous years. Moreover, the mortality from intracranial haematomas that were operated on fell appreciably for both extradural (from 36% to 15%) and intradural haematoma (from 54% to 26%). These figures approach the lowest attainable or "ideal" mortality for these complications proposed by Hooper¹⁷ 20 years ago.

The safe application of selective admission calls for a clearly defined policy that declares which patients should be transferred and when; and it requires adequate exchange of information between primary surgical wards and neurosurgical units about individual patients. Furthermore, if neurosurgeons are to be able to admit more patients with head injuries in the acute stage (without a large increase in the number of beds) they

need to be able to send patients back to primary surgical wards once they no longer need the special facilities of a neurosurgical unit. When more beds were available in Glasgow the number of head-injured patients in the neurosurgical unit did not greatly increase and they accounted for less than 20% of admissions; moreover, the mean duration of stay was shorter than before.

These Scottish studies suggest that a limited increase in neurosurgical facilities would probably be sufficient to enable optimal care by modern standards to be offered to most head-injured patients, provided that there was also a rethinking of the respective roles of primary surgeons and neurosurgeons in the light of local needs and facilities.

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Development of a cushion to prevent ischial pressure sores

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Summary and conclusions

A study was carried out jointly by nursing staff and technologists in an attempt to develop a cushion based on scientific principles and measurement that might prevent pressure sores. At each stage in the development clinical trials were carried out, and using the results of these together with the opinions of medical staff and patients who used the cushion the design was suitably modified. Over four years a seat was evolved that was simple to construct and fulfilled the clinical requirements for a wide range of patients while providing maximum relief of high-pressure points. The design was subsequently taken up commercially.

Introduction

The prevention and treatment of pressure sores have received considerable attention recently.¹⁻² Most research, however, has been concerned with bedfast²⁻⁵ rather than chairbound people.⁶⁻⁷ Some special cushions are available but have found only limited favour among users.⁸ Since 28% of all pressure sores occur in the ischial region⁹ and sores are consistently more

common in chairbound than bedfast patients with the same degree of helplessness,¹⁰ a cushion is needed that is effective in relieving high-pressure points by distributing body weight uniformly over a large area of the buttocks and thighs. We therefore set up this project jointly between technologists and nursing staff to develop a cushion based on both scientific analysis and the needs of the users that would have a wide potential field of application and be effective in eliminating areas of high pressure.

Theory

Pressure sores occur when the blood flow through the skin and underlying fat is interrupted by continuous pressure in excess of capillary blood pressure (30-40 mm Hg), so that the tissues are deprived of nutriment and become necrotic. These lesions may be prevented, therefore, either by reducing the applied pressure to less than 30 mm Hg or by limiting the time for which greater pressures act. In recumbent patients the area available for support is large, and by spreading the load the pressures can be reduced below capillary blood pressures.¹¹ Furthermore, these patients can be repositioned frequently, so that dangerously high pressures do not act for long. The scope for repositioning seated patients, however, is limited, while the minimum attainable pressure on a conventional padded seat (36-40 mm Hg) is still dangerously high. Thus the maximum practicable area of buttocks and thighs must be used for supporting the weight. Uniform distribution of body weight in the recumbent patient may be achieved by flotation using a water bed,¹² but this approach is impractical for the sitting patient, as a true flotation seat offers no stability and any slight movement of the patient causes flow of the fluid.

The problem is thus to design a support surface that is effectively both fluid (for uniform distribution of weight) and solid (for stability and acceptability in the wheelchair). These two apparently irreconcilable characteristics can, however, be combined by using a thixotropic substance. These materials are gels that in the unstressed state behave as solids. When pressure is applied the gel remains solid

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