Head injuries are badly managed in accident and emergency departments and neurosurgeons are partly to blame

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The indictment that is implicit in the title raises three questions. Are head injuries indeed badly managed? Does this happen in accident and emergency departments? How much are neurosurgeons responsible? The writer, having accepted the editor’s invitation to respond to these charges, has to decide if he should prosecute, defend, or attempt to arbitrate. Perhaps a little of each is necessary, but so is an analysis of the background of the problem and of the prospects for future improvements, before judgement is passed.

Management may be bad because it is inefficient or ineffective; it will be shown that injury management has failed on both counts. Despite the expenditure of considerable resources, a large part of the death and disability caused by head injuries could have been avoided with better management. Fortunately, as a result of the increasing interest in head injuries in the last decade, many of the problems they present are now being clarified. Solutions are being identified but to put these to best effect, aspects of the care of head injuries will need to be revised.

Traumatic brain damage, the key to understanding management

In defining the aims of the management, an important concept is the distinction between damage sustained at the time of the injury (primary damage), and that which develops subsequently and is caused by complications (secondary damage). It is only secondary damage that can be influenced by management.

Primary damage

Detailed neuropathological studies in fatal cases (Adams et al., 1980; Adams et al., 1982) and observations in experimental models (Generelli et al., 1982) have demonstrated that the most important component of primary damage is an injury to the nerve fibres in the white matter of the cerebral hemisphere and brainstem. The hallmark of this so-called ‘primary diffuse axonal injury’ is an impairment of consciousness. A head injury that did not cause immediate loss of consciousness cannot have caused diffuse axonal injury. Mild degrees of axonal injury are recoverable but their sequelae probably underlie the
features of the so-called post-concussional syndrome. At the other extreme, severe primary axonal injury results in death, either immediately following the injury or after varying durations of persisting coma.

Little, if any, active treatment is available for primary damage, but fortunately the brain possesses considerable potential for recovery. The initial aim in head injury management can therefore be stated to be to provide the optimum conditions to encourage the processes of recovery. In practice, this is best achieved by avoiding the additional insults to the brain which result from the complications that cause secondary damage.

Secondary (avoidable) brain damage

Secondary brain damage is the consequence of a range of intracranial and extracranial complications (Table 1). What these have in common is that they threaten the oxygenation of the brain and lead to hypoxic/ischaemic brain damage. When this is found in the brain of a fatal case, it is a clear indication that at least part of the brain damage might have been avoided with better management.

Table 1 Causes of Secondary Brain Damage

<table>
<thead>
<tr>
<th>Intracranial</th>
<th>Extracranial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haematoma</td>
<td>Respiratory obstruction/dysfunction (Hypoxia/Hypercarbia)</td>
</tr>
<tr>
<td>Infection</td>
<td>Shock (Hypotension/Anaemia)</td>
</tr>
<tr>
<td>Swelling (oedema/vasocongestion)/raised ICP</td>
<td>Fluid/Electrolyte imbalance</td>
</tr>
<tr>
<td>Obstruction to CSF flow</td>
<td>Infection/Hyperthermia</td>
</tr>
<tr>
<td>Vasospasm</td>
<td>Epilepsy</td>
</tr>
<tr>
<td>Epilepsy</td>
<td></td>
</tr>
</tbody>
</table>

The evidence of the problem

Although the need to avoid the so-called ‘second accident’ after head injury has long been recognized, the frequency of potentially avoidable brain damage has received increasing attention. This followed reports in the early 70s of the results of detailed neuropathological studies of patients who died after transfer to a neurosurgical unit (Graham & Adams, 1971; Graham et al., 1978). When examined after death 91% of these patients’ brains showed evidence of hypoxic/ischaemic damage; half of the remainder had evidence that their intracranial pressure had been elevated in life. Only in 5% of these fatalities was there no evidence of either of these features of secondary damage. These studies suggested that both intracranial and extracranial complications were important and that these often exerted their effects in combination. What was
difficult to say from pathological data alone was the stage at which these insults had arisen. Evidence about this, and also about their importance in the outcome of survivors, came from subsequent clinical studies (Table 2).

The term 'talk and die' was coined to highlight the patient whose life could have been saved, on the premise that to have talked after the injury meant that irrecoverable primary damage had not occurred. Analysis of the findings in a series of such patients showed that 75% had an intracranial haematoma (Reilly et al., 1975). These cases were treated before the use of CT scanning but a very similar finding was noted in a more recent study reported from the USA (Marshall et al., 1983). The importance of ineffective management of intracranial haematomas was highlighted in a review of a consecutive series of patients who had undergone operation in the Glasgow Neurosurgical Unit (Galbraith, 1976). This showed that very often there had been a considerable delay after the patient started clinically deteriorating before the diagnosis was established and action was taken. Delay in diagnosis of a haematoma was shown to lead to a worse outcome, a finding corroborated by several subsequent studies (Table 2).

Rarely was the delay in diagnosis of a haematoma the responsibility of the staff of the accident and emergency department (Rose et al., 1977; Jennett & Carlin, 1978). Indeed, delay was commonest after admission to hospital, while the patient was undergoing a period of observation. The causes for delay at this stage included the erroneous attribution of the patient's condition to either a stroke or to the effects of alcohol and also reflected poorly conducted observations (Galbraith, 1976). In a fifth of the cases the delay was the result of the patient not having come to hospital immediately after the injury but only after deterioration had commenced. In only a small proportion of cases was the delay in diagnosis caused by management in the accident and emergency outpatient department.

These observations from neurosurgical departments have now been extended by a study in Merseyside (Jeffreys & Jones, 1981). This showed that avoidable factors were present in many patients whose death occurred in general hospital, most of whom had not even been referred to a neurosurgical unit. Again, the commonest factor was an intracranial haematoma, which caused up to 33% of deaths in patients dying in general hospitals.

Of the other causes of potentially avoidable death or disability, extracranial factors are the most important (Kohi et al., 1984). Studies in the USA (Miller et al., 1978; Miller & Becker, 1982) and in Glasgow have emphasized that in head injured patients in coma, airway obstruction, respiratory dysfunction and hypotension (Table 3) are

<table>
<thead>
<tr>
<th>Table 2 Evidence of ineffective management of traumatic intracranial haematoma</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intracranial Haematoma</strong></td>
</tr>
<tr>
<td>• was found in 75% of patients who talked and died (Reilly et al., 1975, Marshall et al., 1983)</td>
</tr>
<tr>
<td>• 36% of patients deteriorated &gt;12 h before diagnosis (Galbraith, 1976)</td>
</tr>
<tr>
<td>• 52% of talking patients deteriorated into coma before operation (Teasdale et al., 1982)</td>
</tr>
<tr>
<td>• delay and deterioration worsened outcome (Galbraith, 1976; Mendelow et al., 1979; Seelig &amp; Becker, 1981; Teasdale et al., 1982)</td>
</tr>
<tr>
<td>• found in 33% of deaths outside a neurosurgical unit (Jeffreys &amp; Jones, 1981)</td>
</tr>
</tbody>
</table>


common. Surprisingly, airway obstruction is rarely a factor causing death before a patient reaches hospital (Hoffman, 1976). Respiratory problems arise most often during transfer between one department and another (Yates, 1977), or from one hospital to another (Gentleman & Jennett, 1981). Hypotension is rarely due to a head injury and should always raise suspicion that an extracranial injury has been overlooked or inadequately treated. The usual reason for this is that too much attention is focussed on the fact that the patient has had a head injury and the possibility of injuries elsewhere is not given due consideration. A recent study from Edinburgh has shown that there are errors in the diagnosis of fractures in almost a half of recently injured unconscious patients (McLaren et al., 1983).

Many factors contribute to the delays and difficulties in diagnosis. The most important is the disparity between the large number of patients at risk of secondary damage, and the limited facilities available for investigation and treatment.

<table>
<thead>
<tr>
<th>Insult</th>
<th>Prevalence</th>
<th>% Good/moderate recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoxia</td>
<td>35%</td>
<td>41%</td>
</tr>
<tr>
<td>Hypotension</td>
<td>15%</td>
<td>35%</td>
</tr>
<tr>
<td>Anaemia</td>
<td>9%</td>
<td>38%</td>
</tr>
<tr>
<td>Hypercarbia</td>
<td>8%</td>
<td>22%</td>
</tr>
<tr>
<td>No insult</td>
<td>53%</td>
<td>64%</td>
</tr>
</tbody>
</table>

The Question of Numbers

One of the foremost aspects of the head injury problem, from the viewpoint of accident and emergency departments, is the great number of patients who attend with a head injury, compared with the relatively small number who develop a serious complication (Strang et al., 1978; Swann et al., 1980). It is estimated, on the basis of surveys conducted in Scotland, that about 1 000 000 recently head-injured patients attend hospital each year in Britain—1:50 of the population (Jennett & MacMillan, 1981).

One of the greatest worries for staff in accident and emergency departments is that they might discharge a head-injured patient who later develops an intracranial haematoma. In the event, a haematoma develops in only one in approximately 500 hospital attenders. The risk varies in different kinds of patients, an important point that I will return to later. An open fracture that needs a neurosurgical operation is even less frequent and occurs in about 1:2000 attenders. Of the 7000 deaths that occur each year in Britain, about half occur before the patient reaches hospital; the evidence is that almost all of these patients have sustained an overwhelming injury, incompatible with survival. On the other hand, secondary factors are probably important in at least a third of those who die after admission to hospital. Head injury is the major avoidable cause of death and disability in young adults.
Decisions in Management

In the management of a head-injured patient, the decisions taken by accident and emergency staff depend upon the answers to several questions (Table 4) (Jennett & Teasdale, 1981). Perhaps the most difficult but also the most crucial is if, and when, a patient should be transferred to a neurosurgical unit. In Britain only 5% of admitted patients are subsequently transferred to a neurosurgical unit, although this percentage varies widely from region to region (Jennett et al., 1979).

There are several reasons why it is necessary to send a patient suspected of an intracranial complication to a neurosurgical centre. The most important factor has been that the facilities needed to exclude or to diagnose an intracranial complication are commonly found only within regional neurosurgical centres. In the past, the appropriate investigation was cerebral angiography. This was difficult to perform and to interpret and also was potentially hazardous. For this reason it was considered good practice to restrict its use to those patients most obviously suffering from a complication. There was also a fear amongst neurosurgeons that their resources would be overloaded if they accepted head injuries too liberally. Nevertheless a very important reason for transfer is that if a haematoma is diagnosed, the operation usually demands the skills and facilities of a neurosurgical unit. Although the best known intracranial complication is a simple extradural haematoma, this is much less common than an intradural lesion, a considerably more complex problem. Subdural haematomas, intracerebral haematomas, burst lobes, and even many extradural clots cannot be dealt with adequately by the burrholes and subsequent craniectomy that are employed by surgeons without access to neurosurgical expertise and facilities (Teasdale & Galbraith, 1981).

The effect of these constraints was that the transfer of a patient to a neurosurgical unit almost always depended upon the patient developing clear clinical signs of deterioration due to progressive brain compression. This policy was a major factor in delaying diagnosis and evacuation of the clot until irreversible damage had developed. There was little attempt to pre-empt deterioration and so avoid secondary damage.

The change in the attitude towards head injury management that has taken place in the last decade is the result of the introduction of CT scanning (Teasdale & Galbraith, 1981; Jennett & Teasdale, 1981; Teasdale et al., 1982). It was soon clear that CT scanning enabled a very accurate diagnosis, so that surgery could be planned and conducted more effectively; nevertheless, several studies showed that the introduction

<table>
<thead>
<tr>
<th>Decision</th>
<th>Where taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>? X-ray skull</td>
<td>Accident and emergency department</td>
</tr>
<tr>
<td>? Admit for Observation and for how long</td>
<td>Accident and emergency department</td>
</tr>
<tr>
<td>? Transfer (CT scan)</td>
<td>Observation Ward (accident and emergency/surgical)</td>
</tr>
<tr>
<td>? Investigate, Monitor or Operate</td>
<td>Neurosurgery</td>
</tr>
</tbody>
</table>
of scanning by itself did not lead to improved results (Ambrose et al., 1976; Jeffreys & Lozada, 1982). This was because the limited number of scanners available meant that all head-injured patients could not and still cannot have a scan.

The failure to improve results was because patients were still being selected by the traditional criteria. In order to improve results it was essential to break away from the practice that an intracranial clot was suspected only after a patient had become unconscious with a dilated pupil. An improvement in results depended on scanning patients at risk of later deterioration, that is before the haematoma caused secondary damage. Now that this has been appreciated, increasing numbers of head injuries are being transferred to neurosurgical units and this leads to an improvement in results (Teasdale et al., 1982). Scanning has also become more widely available. Nevertheless, it is still not possible to scan every head injury, either in a neurosurgical unit or on a scanner in a general hospital.

The optimum use of the available resources demands the adoption of policies to select which patients need CT scanning—which usually means transfer for investigation. What were lacking until recently were effective and reliable methods for communicating about patients and also firm factual foundations for such policies. The Glasgow Coma Scale (Teasdale & Jennett, 1974; Gentleman & Teasdale, 1981) has facilitated communication and studies carried out in Glasgow over the last decade have now yielded the data about the risks of intracranial complications in different types of patients, on which to base policies.

The risks of a Haematoma

Galbraith pointed out that patients who developed an intracranial haematoma commonly had either a skull fracture or a depression of consciousness at the time they first presented to hospital; also he emphasized that in the absence of a fracture a haematoma seldom develops except in a child (Galbraith & Smith, 1976). Our recent studies have quantified the level of risk associated with these two features in adult patients. We have also estimated the number of patients in different risk categories, so that the resource implications of different policies can be debated (Mendelow et al., 1983).

Four categories of patients were considered: with and without a fracture; and with and without altered consciousness (Table 5). The results showed that at the time the patient attended an accident and emergency department, most of those who subsequently developed a haematoma had a skull fracture and were also either disorientated or had impairment of consciousness. A patient in coma even in the absence of a skull fracture has been shown by other studies also to have a high risk of having an intracranial haematoma (Table 6). By contrast, a patient with neither a fracture nor impaired consciousness at the time of attending hospital has a risk of only 1:6000. Even among the patients in this group admitted to hospital for observation (presumably because of a history of amnesia) the risk was only 1:1000.

On the basis of these findings, a group of neurosurgeons have evolved a series of guidelines for management that aim to maximize the efficient use of facilities in order to achieve early diagnosis and treatment of intracranial complications (British Medical
Head injuries 129

Table 5 Risks of an Intracranial Haematoma in Adult (>15 yrs) Head-Injured Patients (data derived from Mendelow et al., 1983)

<table>
<thead>
<tr>
<th>Numbers of patients in West of Scotland per million population per year</th>
<th>Haematomas per year (rounded to nearest whole number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All A/E attenders</td>
<td>Risk</td>
</tr>
<tr>
<td>No skull fracture</td>
<td></td>
</tr>
<tr>
<td>Fully orientated</td>
<td>10000</td>
</tr>
<tr>
<td>Not orientated</td>
<td>740</td>
</tr>
<tr>
<td>Skull fracture</td>
<td></td>
</tr>
<tr>
<td>Fully orientated</td>
<td>110</td>
</tr>
<tr>
<td>Not orientated</td>
<td>93</td>
</tr>
</tbody>
</table>

Table 6 Intracranial haematomas in head injuries in coma for 6 h (data from series described by Jennett et al., 1979)

<table>
<thead>
<tr>
<th>No. of Patients</th>
<th>Haematoma</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never talked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No skull fracture</td>
<td>291</td>
<td>61 (21%)</td>
</tr>
<tr>
<td>Fracture present</td>
<td>505</td>
<td>237 (47%)</td>
</tr>
<tr>
<td>Talked → Coma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No skull fracture</td>
<td>102</td>
<td>72 (71%)</td>
</tr>
<tr>
<td>Fracture present</td>
<td>221</td>
<td>172 (78%)</td>
</tr>
</tbody>
</table>

Journal, 1984). The versions of these used in the West of Scotland are shown in Tables 7–10.

Guidelines for initial Management of Head Injuries

Skull Radiography

Clearly, it can be crucial to know whether or not a head-injured patient has a skull fracture, but there is pressure from radiologists to reduce the number of skull X-rays requested (Royal College of Radiologists, 1981). At present only about half of accident and emergency department attenders have a skull X-ray, so that it is clear that clinicians already exercise discretion and judgement. Neurosurgeons agree with radiologists that it is not necessary for all head-injured patients to be X-rayed, but emphasize the need not to miss a skull fracture (Jennett, 1980). The recommended guidelines should reduce the number of negative X-rays taken while ensuring that almost all patients with a skull fracture are X-rayed.

The difficulty in obtaining good films and in having these reliably reported have been used by radiologists as additional reasons for belittling the value of skull radiology. The
Clinical judgement is necessary but the following criteria are helpful:

1. Loss of consciousness or amnesia at any time
2. Neurological symptoms or signs
3. Cerebrospinal fluid or blood from the nose or ear
4. Suspected penetrating injury
5. Scalp bruising or swelling
6. Difficulty in assessing the patient

**Table 8** Criteria for admission to a general hospital

1. Persisting confusion or other depression of consciousness
2. Skull fracture
3. Neurological symptoms or signs
4. Difficulty in assessing the patient e.g. alcohol, the young
5. Other medical conditions—e.g. haemophilia
6. Lack of a responsible adult/relative

**NOTE**
(a) Post-traumatic amnesia with full recovery is not an indication for admission
(b) Patients sent home should receive advice to return immediately if there is deterioration

**Table 9** Criteria for consultation with a neurosurgeon

1. Fractured skull
   - with confusion or worse impairment of consciousness OR
   - with focal neurological signs OR
   - with fits, OR
   - with any other neurological symptoms or signs
2. Coma continuing after resuscitation
3. Confusion or focal neurological persisting more than 6-8 h, even if there is no skull fracture
4. Deterioration
5. Compound depressed fracture of the vault of the skull
6. Suspected fracture of base of skull

Evidence in practice is that poor quality radiographs usually result from poor radiographic technique and good films can be obtained in most patients. Moreover, the relatively simple skills required to interpret good skull radiology ought to be readily acquired by the experienced personnel who now should form the backbone of an accident and emergency department staff. Indeed, the reporting of casualty radiology is commonly delegated to the most junior member of the radiological department.

**Admission to hospital for observation**

Traditionally, the advice given was that if a head-injured patient had experienced even
Table 10 Management of head injured patients in coma or with multiple injuries before transfer to neurosurgical unit

A
1. Assess clinically for respiratory insufficiency, for shock, and for internal injuries
2. Perform: (a) chest X-ray; (b) blood gas estimation; (c) cervical spine X-ray

B
Appropriate treatment may include:
1. Intubate (e.g. if airway obstructed or threatened)
2. Ventilate (e.g. cyanosis, PO$_2$ > 60 mm Hg, PCO$_2$ > 45 mm Hg)
3. Commence IV infusion (1500 ml/24 h)
4. Mannitol, after consultation with neurosurgeon
5. Apply cervical collar or cervical traction

C
The patient should be accompanied by personnel able to insert or to re-position endotracheal tube, to initiate or maintain ventilation, to administer oxygen, and fluids and to use suction.

brief loss of consciousness or amnesia, he should be admitted (Potter, 1974). This was irrespective of the patient having fully recovered at the time of attendance at hospital and whether or not there was a skull fracture. The value of admitting to hospital such adults, who have a risk of a complication of 1:1000–1:6000, is increasingly questioned. The evidence from studies in Birmingham (Totten & Buxton, 1979) and Nottingham (Weston, 1981) is that most can safely be discharged, provided that they are under the supervision of a responsible adult and are instructed to return in the event of deterioration. One justification for this action is that there would be savings in resources, which then could be used to increase the transfer and definitive investigation of patients at higher levels of risk.

Transfer to Neurosurgery, CT Scanning

There is general agreement that patients with a 1:4 risk merit urgent investigation by emergency CT scanning. Although such a patient should be transferred to the neurosurgical unit without delay, first a thorough assessment and resuscitation must be carried out. The purpose of this is to ensure that major extracranial problems are attended to, because these take priority over an intracranial lesion (Table 10). The routine scanning of high risk patients does not impose unduly on existing facilities. It is estimated that it would result in two scans per week in the average British neurosurgical unit serving a population of 1m. It would ensure the early diagnosis of more than two-thirds of patients with an intracranial haematoma. An increasingly liberal policy for admission was adopted by the neurosurgical unit in Glasgow in 1978. The initial results show that more patients were transferred sooner, and that this led to significant reductions in avoidable mortality and disability in patients with a haematoma (Teasdale et al., 1982) (Table 11).
Table 11 Effect of alteration in admission to Neurosurgery (for CT scan) and outcome of Intracranial Haematoma (Teasdale et al., 1982)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with a haematoma</td>
<td>76</td>
<td>126</td>
</tr>
<tr>
<td>Good/Mod Recovery</td>
<td>49%</td>
<td>60%</td>
</tr>
<tr>
<td>Talk→coma before operation</td>
<td>26%</td>
<td>17%</td>
</tr>
<tr>
<td>Talk→coma &amp; died</td>
<td>15%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Between 1974 and 1977 patients were usually accepted only after onset of deterioration or after prolonged failure to improve; after 1978 patients were increasingly accepted if they were considered to be at high risk of a clot.

Observation or Investigation?

How many patients with only a skull fracture or impairment of consciousness can be transferred and scanned, and how soon, depends entirely upon local facilities and resources (Bryden & Jennett, 1983). Clearly all such patients should be at least admitted to hospital but they may have to be observed for several days before discharge is safe. Scanning all such patients would have a yield of positive findings not dissimilar to the proportion of surgically remediable lesions discovered in patients who are currently investigated because of dementia or epilepsy! It should also be noted that the guidelines apply to adults, and more data are needed in order to adapt them to children.

Summing up and Sentencing

The judicial view undoubtedly would be that the charge that head injuries have been badly managed was well founded. It has been inefficient to admit some 150 000 patients to hospital each year in Britain, in order to identify the 2000 who developed an intracranial haematoma. It also has clearly been ineffective when many of the latter became irreversibly brain damaged by the time the diagnosis was made.

Nevertheless it is necessary to recognize the complexity of the head injury problem and clearly there are inadequate facilities to investigate fully every head-injured patient. Neurosurgeons and accident and emergency specialists can even be seen as victims, caught between the scale and complexity of the head injury problem, and the resources available to them. Neurosurgeons have played a leading role in highlighting the problem, in providing data from which to evolve solutions and in formulating guidelines to assist effective management. Accident and emergency specialists, in their turn, have also shown an appreciation of the importance of head injuries and less reluctance to accept a role in their management than certain other specialties.

Now that there is a factual foundation on which to base the major decisions in the management of head-injured patients, and national guidelines have been developed, the need is for local contact and collaboration. Neurosurgeons and accident and emergency specialists in each region need to determine the precise guidelines that are most
appropriate for their use, they also need to ensure that the agreed policies are made known to all concerned. There should also be close liaison about the management of individual patients. Neurosurgeons should be more ready to accept more patients sooner than in the past. For their part, accident and emergency specialists need to ensure that this trend is not abused; they should ensure against the tendency for junior staff to unload on to neurosurgeons patients suffering from medical, psychiatric or other problems and, in particular, must avoid sending a patient with undiagnosed extracranial injuries. They must also help to maximize the use of neurodiagnostic facilities, by accepting the return of a patient, once a removable intracranial complication has been excluded.

There are encouraging signs that both specialties are now facing up to their responsibilities and beginning to apply new knowledge and technical developments to best advantage. Therefore, if the verdict goes against them, the sentence will surely be a conditional discharge. The condition would be that they produce evidence that in future they do indeed achieve the improvements in management that recent developments promise to make possible.

REFERENCES


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The guidelines outlined in tables 7–9 have recently been approved by the DHSS and published as a report “Management of acute Head Injury” Harrogate Seminar Report 8, DHSS, December 1983, edited by A. Fenton-Lewis.’—Editor.
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