CLINICAL MANAGEMENT

Clinical management—the series

Edited by Jim Wardrope

This is a new series in the journal whose main theme is management of “every day” clinical problems that come to our departments. “Doctor, my head/chest/hip hurts”. Patients present to us with symptoms and symptom complexes rather than in defined diagnostic groups. Biological diversity ensures that these symptoms will vary between patients; this is the challenge of accident and emergency medicine. The aim of this series of articles is to take a common presenting symptom, pleuritic chest pain for example, to give a pragmatic view on the management of this condition, examine the investigations useful in reaching a diagnosis, and to give guidance on the options for ongoing care of the patient.

These suggestions are not the only way to manage the conditions but the authors have been briefed to examine current evidence and guidelines and produce a workable framework of care of these problems. Some approaches will stimulate discussion and this is welcomed.

The second aim of the series is to attempt to further engage the readership in continuing medical education (CME). Reading the journal is most definitely CME and I am sure that you all read each issue from cover to cover. However to assist further education in each topic I have asked authors to highlight three key references that they consider essential reading around the subject. The authors have

also provided three questions, two that are answered by reading the text and one that is answered by reading the key references. If you wish to participate in this experiment, and it is an experiment, then you can send your answers to me. I will send you back an answer sheet. Those submitting answers will be able to enter this into their CME logbook as one hour of external CME.

Subjects in this series have been suggested by the editors and editorial board. If you wish to see other topics then please write to me with suggestions. Articles in the series include transient ischaemic attack, pleuritic chest pain, neck injury, vaginal bleeding, ischaemic chest pain, calf pain/deep venous thrombosis, and acute “hot joint” and abdominal pain in childhood. Many of you will have an area of expertise that you think would merit inclusion and may wish to volunteer to write an article. All expressions of interest are welcomed but be aware of the tremendous work involved and often countless redraftings after editorial and peer review comments.

An “interest in management” conjures up long hours of paperwork and endless committee meetings, but this series will hopefully stimulate interest in the clinical management of some of the difficult and controversial areas of our practice.

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Investigation of the head injured patient

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Two areas of clinical concern for both accident and emergency (A&E) and radiology staff are the investigation of head injured patients who attend acutely (within three days of injury) and, less frequently, the evaluation of those who present later with head injury symptoms. UK guidelines for clinical assessment¹ and radiological investigation² of head injury were introduced in 1984. Since then computed tomography has become increasingly available to A&E departments and in the light of more recent studies of their use it is appropriate that the guidelines are updated.

We present a review of recent studies and recommendations for the use of imaging and

other diagnostic techniques in acute head injury and in the following article deal with later presentation.

Patterns and mechanisms of injury

Of the million patients presenting to UK hospitals each year with head injury, almost half are children less than 15 years. Most injuries are due to falls (41%) and assault (20%) but road traffic accidents account for 58% of deaths and one third of those referred to neurosurgery.³

The case mix of head injury varies from centre to centre and this influences the yield of positive findings produced by the use of the

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same guidelines. Hence sometimes the perceived value of and the interpretation of these guidelines will vary. Radiologists are often concerned about the cost effectiveness of "low yield" investigations.^{4,5} Questions commonly posed by A&E doctors concern what constitutes "significant scalp swelling" or when to "suspect a penetrating wound" or even what is meant by an "unclear story".

Although children have a lower overall risk of intracranial haematoma, skull fracture and conscious level remain risk factors in both groups and common guidelines exist for their management.⁶ Young children are similar to the intoxicated adult in being notoriously difficult to assess and it is generally accepted there should be a low threshold for investigation of suspected child abuse particularly in infants.⁷

Units which serve a catchment area where assault is prevalent will favour a low threshold for investigation (skull radiographs including tangential views or computed tomography) to supplement wound exploration when penetrating trauma is "suspected".⁸⁻¹⁰ The biomechanics of the injury as well as the nature of the scalp wound need to be taken into consideration when selecting patients for skull radiography.¹¹

If all head injuries were witnessed by reliable bystanders, enabling the nature and severity of the impact to be accurately described, the need for investigation would be more easily determined and may be less frequently employed. Unfortunately this is not the case, moreover patients' amnesia for the event due to the injury, alcohol intoxication, or both often makes clinical assessment difficult or unreliable.

Definition of severity

It is surprisingly difficult to find two articles by different authors that define and describe head injury in the same way. For the purpose of this article, the severity of injury is defined by the Glasgow coma score (GCS) *at the time of presentation to A&E* as "severe" (GCS 3-8), "moderate" (GCS 9-12), "mild" (GCS 13/14), and "minor" (GCS 15).³

Resuscitation phase

In dealing with a seriously injured patient, the severity of the head injury may not be immediately obvious. For the resuscitation team the question whether or not they are dealing mainly or at all with a head injured patient is secondary to sorting out life threatening problems in a systematic way. The advanced trauma life support approach is now extensively practised and treating life threatening airway, chest, and circulation problems should be identified and treated as the first priority in any patient.¹²

The first investigations to be carried out in the severely head injured patient are the same as for any other seriously injured patient but of special importance are:

- Standard trauma radiographs (chest, pelvis, and cervical spine).
- Blood glucose, to exclude a readily treatable cause of coma.

- Arterial blood gases, to assess the adequacy of ventilation.

- Cross matching.

- Coagulation screen; abnormal coagulation and fibrinolysis is a potential cause of intracranial haemorrhage and an additional index of prognosis of severe head injury.¹³

Toxicology and other biochemistry may be helpful in further investigating a persisting cause of coma once head injury has been excluded but alcohol or drugs should never be assumed to be the cause of coma in an injured patient. Serum alcohol concentrations of <200 mg% are unlikely to be the sole cause of altered consciousness.

Frequent observation of vital signs, GCS, pupil reactions, and limb movements is essential. Monitoring of electrocardiography, oxygen saturation (maintain at >95%), expired carbon dioxide, central venous pressure (CVP), and ideally of mean arterial pressure (maintain at >90 mm Hg) should be carried out.¹⁴ Arterial blood gas analysis guides oxygenation and ventilation, aiming to maintain arterial oxygen tension >13 kPa and arterial carbon dioxide tension 4-4.5 kPa.

Cerebral perfusion pressure (mean arterial pressure - mean intracranial pressure + mean CVP) is a useful parameter available in the neurosurgical intensive treatment unit but intracranial pressure monitoring is not usually initiated in the A&E department. The cerebral perfusion pressure should be kept at 60-70 mm Hg and intracranial pressure rises above 20-25 mm Hg should be treated.¹⁵

Establishing adequate tissue perfusion is of crucial importance to the already damaged brain that may have lost its normal ability to maintain constant perfusion in the face of hypoxia and hypotension.

In the hypotensive patient with blunt trauma and suspected head injury one dilemma is whether the delay of a scan of the head is justified before an urgent chest or abdominal operation. It is generally agreed that those with shock that is unresponsive to fluid resuscitation will usually warrant immediate surgical intervention but what about those who respond to initial resuscitation? A recent registry based review of 212 such patients from a level 1 trauma centre in California found that no patient who responded to initial resuscitation experienced haemodynamic instability in the computed tomography suite including 15 with positive diagnostic peritoneal lavage. Of the 16 patients who had computed tomography before surgery there was an average delay of 68 minutes. The likely need for craniotomy in patients with a GCS 13 or less was comparable with the likelihood of a general surgery operation and the conclusion was that computed tomograms of the head were recommended before surgery in this group.¹⁶

Many UK A&E departments lack access to 24 hour computed tomography or ultrasound support¹⁷ and the luxury of a computed tomography scanner next to the resuscitation area commonly does not exist and therefore it remains to be seen if similar results could be obtained in this country.

Secondary survey

Once immediately life threatening conditions have been treated or excluded clinical assessment and investigations can continue in order to establish a more detailed diagnosis of the head and associated injury or medical conditions. Look for signs of a basal skull fracture (a clinical diagnosis) remembering to look for haemotympanum if there is no bleeding from the ears.

Detailed discussion of the investigation of extracranial injury is outwith the remit of this article but both the referring A&E doctor and the receiving neurosurgeon will want to be assured that major extracranial injury has been excluded or "dealt with" and a plan of action agreed before transfer to the neurosurgical unit takes place.^{18 19}

Of the many compounding factors making diagnosis more difficult the association of alcohol or drug intoxication is the most common. A comatose drug or alcohol abuser may well have an intracranial haematoma, conversely a patient who has collapsed and suffered a minor head injury may harbour a serious medical condition such as spontaneous subarachnoid haemorrhage.

Radiological investigation

CERVICAL SPINE

There is some debate about the value of routine "cross table" lateral cervical spine radiographs in the resuscitation room as they do not completely exclude significant injury—according to Streitweiser *et al* the standard three views only detect 93% of neck injuries.²⁰ Logically we should maintain neck immobilisation until "clearance" can be assured on clinical grounds (which assumes normal mental status) or on a comprehensive series of radiographs. Nevertheless, current practice is to obtain the standard three views including an adequate lateral view with shoulder traction. If this fails to visualise the C7/T1 junction it may be necessary to use supine oblique views or swimmer's views. Supine oblique views provide more information about the posterior elements and facet joints thereby rapidly excluding major C7/T1 dislocation. In one survey they were more likely to be successful than swimmer's views.²¹

When a cervical fracture is demonstrated on plain film, computed tomography is of great value in further assessing the extent of the bony injury at the appropriate vertebral level. The bony injury is usually shown to be more extensive than the plain film appearance.

HEAD

There is little place for skull radiography in the patient with obvious serious head injury because it is unlikely to alter management. Such patients usually require urgent computed tomography of the brain, neurosurgical assessment, or both. A scanogram (the initial image carried out to allow planning of the computed tomography study) resembles the plain film lateral skull radiograph and it may be helpful to reveal fractures.

In the minor and mild head injury groups (GCS 13–15) the skull radiograph, used in a selective manner, allows more confident discharge of patients who have no other indicator for admission but in whom the impact was either severe or uncertain. It is also of value in identifying patients who will benefit from frequent observation and/or early scanning.^{1 22}

In our institution the standard skull radiographs include lateral, fronto-occipital, and Townes' projections. These are all performed in a supine position to minimise patient movement. The lateral projection is taken brow up with a horizontal beam which may allow demonstration of air/fluid levels in the basal sinuses in the case of basal skull fracture and may occasionally show a traumatic aerocoele. It is however questionable whether three views are required in cases where a single site of injury is known. In a study of 250 skull series McGlinchy *et al* have shown equal fracture detection on only two views (frontal plus lateral or Townes' projections plus lateral).²³ Tangential views may be helpful in doubtful cases of depressed fracture and to exclude scalp foreign bodies.

The ability to detect skull fractures by radiography requires the correct selection of patients at risk, the production of relevant films of adequate diagnostic quality, and the accurate interpretation of those films. The induction training of A&E doctors should include the recognition of the normal view and the poor quality radiograph, which in one study occurred in one quarter of fronto-occipital views.²⁴ The ability of A&E doctors to interpret radiographs of diagnostic quality has been shown to be inadequate²⁵ and to improve with clinical experience and a teaching programme.²⁶ Nevertheless even with experienced staff false negatives may still occur and there is a need for a routine reporting system that will allow rapid identification and recall of missed injuries.

Development of guidelines for imaging in acute head injury

Traditionally in the UK, plain skull films have been performed as a means of identifying patients at risk of intracranial complications because of the association between a skull fracture and intracranial haematoma.²⁷ Studies from Seattle⁴ and Liverpool⁵ advocated a more selective use of radiographs because of the low yield of fractures obtained by routine use of radiographs for minor head injury. The UK guidelines from 1984 which are still in use,¹ are based upon the research²⁷ and views of a group of neurosurgeons and took into account guidelines from the Royal College of Radiologists.^{2 28} The effect of introducing them to a large A&E department in Cardiff led to a reduction in the use of radiographs by 51% without an increase in head injury admissions.²⁹

These guidelines stressed the importance of detecting skull fractures as an effective screening mechanism to select patients for a scan, which in 1984 were mainly carried out in neurosurgical units. Also by lowering the threshold for neurosurgical referral the assumption was that more computed tomography would be

carried out and there would be earlier detection of intracranial haematomas before significant deterioration occurred. This had been first shown to be the case in Glasgow in 1982.³⁰ It was confirmed in a paper published in 1988 from Edinburgh.³¹ This demonstrated a gratifying improvement of both mortality (reduced from 18% in 1981 to 9% in 1986) and morbidity (81% had a good/moderate outcome in 1986 compared with 53% in 1981) associated with an increase in the percentage of minor head injuries with fracture admitted to the neurosurgical unit (17% in 1986 compared with 9% in 1981) and a much greater number of these investigated by computed tomography (16% in 1986 and 3% in 1981).

Guidelines for imaging from the USA²² were published in 1987 based upon a prospective study of 625 patients with more than a trivial injury. They divided patients into three groups: low, moderate, and high risk of intracranial injury.

The *low risk group* had less than one in 200 chance of a fracture and a probability of intracranial haematoma of 8.5 in 10 000 at the 95% confidence level. It was considered safe to discharge such patients with advice and a second person to observe them.

The *moderate risk group* comprised 300 patients, 4% of whom had intracranial injury. They are recommended for close observation, consideration of computed tomography, and sometimes skull radiography. They include any patient with suspicion of assault with any object, an unreliable history, alcohol or drug abuse, history of altered consciousness, or post-traumatic amnesia.

The *high risk group* (29% had intracranial injury (ICI) include those with any of the following: depressed consciousness not clearly due to alcohol, drugs, or other cause; focal neurological signs; palpably depressed fracture. They require neurosurgical consultation and/or computed tomography.

This study showed a 64 times greater chance of having an ICI with a skull fracture than without, yet (in the moderate risk group) the role of skull radiographs is rarely advocated.³²

The admission of a patient with unsuspected intracranial haematoma to a non-neurosurgical unit does not necessarily confer an advantage over discharge and observation at home. Miller *et al* analysed the clinical features of 183 patients with a normal GCS on initial presentation to hospital who required neurosurgery for acute intracranial haematoma. Six months after surgery 23% had a poor outcome whether or not they had been admitted and observed until the time of transfer to the neurosurgical unit. A fracture was shown radiographically in 109 (60%), and most of those with no clinical signs of intracranial haematoma had a fracture on radiography. They concluded that skull radiography retained a useful place in the investigation of selected patients with minor head injury.³³

It is important to have a clear policy for early computed tomography and identification of patients at risk of harbouring intracranial haematoma before deterioration occurs.^{30 31 34} One

Table 1 Risk of an operable intracranial haematoma in head injury in adults; data from Teasdale *et al* 1990⁶

GCS	Risk	Other features	Risk
15	1 in 3615	None	1 in 31 300
		PTA	1 in 6700
		Skull fracture	1 in 81
		Skull fracture and PTA	1 in 29
9-14	1 in 51	No fracture	1 in 180
		Skull fracture	1 in 5
3-8	1 in 7	No fracture	1 in 27
		Skull fracture	1 in 4

PTA=post-traumatic amnesia.

conclusion to be drawn from these data is that patients with skull fracture should be observed and further investigated in the neurosurgery unit. Most UK neurosurgeons would find that this is not a practical proposition, but they are likely to agree with the 1995 Royal College of Radiologists guidelines³⁵ recommending that computed tomography should be available within four hours in all patients with a skull fracture.

Two US studies have recently advocated routine computed tomography for mild head injury with only a history of loss of consciousness,^{36 37} but this is not a viable policy for many UK hospitals.^{16 38} The more liberal use of computed tomography presents a challenge in calculating its cost efficiency.³⁹

The radiation dose should also be considered for both plain skull films and computed tomography.³⁵ Computed tomography accounts for much of the rapidly rising medical radiation dose to the public. Computed tomography of the brain carries a radiation dose of 2.0 mSv (approximately 20 times that of skull radiography).

In 1990 a paper was published from Glasgow based upon a prospective study over 11 years including 8406 A&E attenders and 1007 operations for intracranial haematoma.⁶ The risks of patients developing operable intracranial haematoma were calculated and are summarised in table 1.

Modifications and clarification of the 1984 UK guidelines for skull radiography have been suggested by MacLaren *et al*,⁴⁰ Nee *et al*,¹¹ Swann and Yates⁴¹ and the Royal College of Radiologists (see table 2).³⁵

There is little difference between these guidelines, much depending upon the interpretation of some of the terms used.

The significance of "vomiting" as an indicator for investigation or admission following mild or minor head injury has been explored by several authors. Lee *et al* in 1995 found that vomiting occurred in 15% of adults after mild head injury with GCS 15, and the risk of deterioration was 15 times higher compared with those without post-traumatic vomiting.⁴² Miller *et al* advocates computed tomography for patients of all ages with nausea or vomiting.⁴³

Hughenoltz *et al* in 1987 found that the presence of a skull fracture did not influence the incidence or duration of post-traumatic vomiting in children⁴⁴ but Nee *et al* 1997⁴⁵ found that a single post-traumatic vomit was associated with a twofold increase in the relative risk for a skull fracture in patients who

were fully alert at presentation (child and adult) and their results support the inclusion of post-traumatic emesis in the guidelines for skull radiography.

Dershewitz *et al* in 1983 reported a survey of 957 US paediatricians who did not routinely hospitalise all children with uncomplicated loss of consciousness: 90–99% would admit a child with post-traumatic vomiting.⁴⁶ Hugenholtz *et al* found that children older than 2 years who had a mild injury within one hour of a meal and then vomited could be expected to improve quickly, in about three hours. Those injured more than one hour after a meal or snack were best admitted for more prolonged observation as the vomiting was more likely to persist.⁴⁴

The significance of vomiting in the young child remains contentious. Insufficient detail about the nature and timing of vomiting has been presented in the above studies. In our view a single vomit immediately after injury in a young child who is subsequently found to be well (with no other indications for skull radiography) is of doubtful significance. Persistent or late vomiting is of much greater concern in all ages. If in doubt about the significance of vomiting a period of neurological observation, for example on a short stay ward, for at least six hours with reassessment by an experienced doctor is a wise precaution.

On the basis of our interpretation of the preceding evidence we present a version that is sufficiently detailed to give more clear guidance for A&E staff on which patients should and should not have radiography (see boxes 1 and 2).

Computed tomography of the brain

Computed tomography has the advantage of direct brain imaging, is sensitive to detection of intracranial bleeding, and can identify and quantify fractures and intracranial foreign bodies. With modern scanners axial images can be acquired in sub 1 second scan times thus

Box 1

Those who **should** have radiography after acute head injury (patients with any of the following):

- Any LOC/PTA or vague history of event
- Mechanism implying a particularly strong force of impact on the skull (especially the temporal area), for example a road traffic accident, fall >2 metres, medium or high velocity contact with broad hard surface or small hard object, assault with any hard object, animal bites
- Symptoms at time of examination, for example severe or generalised headache, nausea, or dizziness
- Vomited once (see above comments for young child)
- Suspected skull vault penetration or foreign body injury
- Scalp wounds: with divided aponeurosis or associated with periorbital bruise/swelling or a boggy haematoma
- Difficult to assess due to alcohol*, drugs*, age, epilepsy, stroke, or mental handicap

*If radiography is not tolerated and GCS 13–15, admit for half hourly neuro-observation and consideration for investigation thereafter. If GCS ≤12 or there is any deterioration in consciousness or development of a localising sign immediate neurosurgical consultation is required. Even if there is no deterioration an experienced doctor should reassess at least every two hours and serial alcohol breath tests may assist clinical judgment.⁴⁷ If the patient has not become fully orientated eight hours after arrival consider immediate computed tomography.

LOC = loss of consciousness; PTA = post-traumatic amnesia.

minimising motion artifact in restless patients and avoiding the need for sedation, even in paediatric practice. It is recommended that all computed tomograms for trauma are viewed

Table 2 Published modifications of the 1984 guidelines for skull radiography²¹

Group of neurosurgeons ¹ 1984	Royal College of Radiologists ³⁵ 1995	MacLaren <i>et al</i> ⁴⁰ (adults >13 years) 1993	Nee <i>et al</i> ¹¹ 1993	Swann and Yates ⁴¹ 1989
LOC/PTA Neurological symptoms	LOC/PTA Neurological symptoms: including headache, vomiting more than twice, return visit	LOC/PTA Neurological symptoms other than: mild headache, dizziness, and blurred vision	LOC/PTA>5min Neurological symptoms	LOC/PTA Persistent generalised headache or vomiting within the past 12 hours
Suspected penetrating injury Scalp bruising or swelling	Suspected foreign body or penetrating injury to the skull Scalp bruise, swelling or laceration down to bone, fall >50 cm or onto hard surface	Suspected penetrating injury Scalp or periorbital bruising or swelling	Suspected penetrating injury to vault Skull contact with a broad hard surface or a small hard object at medium or high velocity	Open scalp wounds unless demonstrably superficial Heavy or hard injuring agent; RTAs and falls >2 metres; impact injuries to the temporal area
Neurological signs CSF leak from nose or ear Difficulty to assess (child, epilepsy, alcohol)	Focal neurological signs or symptoms, seizure CSF leak from nose or ear Inadequate history or examination (epilepsy, alcohol, child etc), child <5 years: suspected NAI, ² tense fontanelle If no fracture on skull radiograph, observation by responsible adult at home.	Neurological signs CSF leak from nose or ear Elderly, history of seizure. If any of the above cannot be reliably excluded	Neurological signs Basal skull fracture Difficulty to assess (epilepsy, alcohol, drugs)	Neurological signs Basal skull fracture Difficulty to assess, vague history (young child, epilepsy, alcohol, drugs)

Some of the indications for radiography are recognised as appropriate for computed tomography and have been highlighted in bold print. CSF=cerebrospinal fluid; LOC=loss of consciousness; NAI=non-accidental injury; PTA=post-traumatic amnesia; RTA=road traffic accident.

Box 2

Those who should not have radiography after acute head injury (all five of these must apply)

- Good memory of the incident and subsequent events
- Known to have a benign mechanism (low energy impact with broad object, not due to a road traffic accident or assault with hard object)
- Mild or transient or no neurological symptoms (headache, nausea, or dizziness)
- No vomiting (see above comments for young child)
- Demonstrably superficial scalp bruise or open wound with intact aponeurosis*

or

If there is an indication for computed tomography including:

Signs of basal skull fracture, depressed fracture evident in a wound, confusion in the absence of other cause, for example hypoxia, alcohol/drug intoxication, or acute neurological signs

*All wounds should be thoroughly explored with a sterile gloved finger and a good light.

on both brain and bone windows plus the scanogram for fracture detection. Computed tomography is limited by availability and high cost (relative to skull radiography). Technically, it may miss non-haemorrhagic infarcts, haemorrhage adjacent to bone surfaces that are parallel to the axial plane, brain stem contusion, and isodense haematoma.

Magnetic resonance imaging (MRI) has been shown to be more sensitive than computed tomography in detection of non-haemorrhagic brain injuries and has similar sensitivity for haemorrhage.⁴⁸ MRI also has higher sensitivity for axonal "shear" injuries plus brain stem injury⁴⁹ and has value in further assessment of the patient with normal computed tomography but positive neurological findings. Although there are technical advantages with MRI it is limited in the acute setting by availability, cost, MR compatibility of monitoring and support equipment and safety concerns (unconscious patients cannot complete the prescan questionnaire). Additionally, demonstration of non-haemorrhagic lesions missed by computed tomography is not likely to change acute clinical management. Therefore, computed tomography remains the imaging modality of choice in acute head injury in most institutes.

Indications for computed tomography and neurosurgical referral have been proposed in 1990 and are applicable to current UK practice (see boxes 3 and 4). The importance that Teasdale *et al* attach to diagnosing a fracture and using this as a screening mechanism can be appreciated in box 3.⁶ All fully conscious patients with a fracture should have a computed tomogram in the referring hospital to ensure that high risk patients are directed to

Box 3

Indications for computed tomography in general hospitals

- Skull fracture and full consciousness (GCS = 15)
- Confusion persisting after initial assessment and resuscitation
- Unstable state precluding transfer to neurosurgery
- Diagnosis uncertain

Box 4

Indications for neurosurgical referral

- Coma after resuscitation
- Deteriorating consciousness or progressive neurological deficits
- Open injury: depressed vault or basal skull fracture
- Patient fulfills criteria for computed tomography in a general hospital when this cannot be performed in a reasonable time, for example three to four hours
- Abnormal brain computed tomography
- Normal computed tomography but patient's progress is unsatisfactory

the appropriate neurosurgical facility promptly. Those with a fracture and a negative scan require continued observation for at least 24 hours.

Conclusion

The threshold for investigation of acutely head injured patients must be updated according to recently published evidence. It must also be considered together with guidelines for admission and neurosurgical referral. The integration of these modes of evaluation and their effective application requires interspecialty cooperation.

The important role of skull radiography as a means of early identification of patients at higher risk of intracranial complication has been stressed. Definitive diagnosis of intracranial complications does however require cross sectional direct brain imaging.

MRI scanning is potentially the most powerful imaging modality and can demonstrate haemorrhage, non-haemorrhagic lesions, the brain stem, and the posterior fossa which are poorly seen on computed tomography. With lower field strength magnets safety issues are likely to diminish with time. At the present time however MRI in the acute setting has many practical limitations, is expensive, and is not readily available in most centres. With increased availability and its ability to demonstrate haemorrhage computed tomography is the imaging modality of choice for acute severely head injured patients and those at high risk of intracranial haematoma.

In future, we should aim to provide the necessary imaging equipment and staff in viable centres and, by implementing the best guidelines, to provide a high quality service for all head injured patients.

Box 5

Question 1

Vomiting after mild head injury:

- A. Occurs in 15% of adults
- B. Is a risk factor for deterioration
- C. Is an indicator for skull radiography
- D. Is likely to last >3 hours in a child who has eaten half an hour before the injury
- E. Is an indicator for computed tomography

Question 2

Indications for computed tomography of the brain in acute injury include:

- A. Signs of basal skull fracture
- B. Suspected penetrating scalp wound
- C. Confusion
- D. Severe headache
- E. A story of assault with a hard object

Question 3

MRI scanning is superior to computed tomography in detecting:

- A. Skull fracture
- B. Non-haemorrhagic brain injury
- C. Brain stem lesions
- D. Cerebral contusion
- E. Intracranial metallic foreign body

Three questions relating to this article are listed in box 5.

The key references are Teasdale *et al.*,⁶ Nee *et al.*,¹¹ and Gentry *et al.*⁴⁸

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