3 Head injuries in sport Paul McCrory

In sport medicine, doctors must be able to recognise and manage a spectrum of brain injury. Fortunately, serious brain injury is rare in sport (outside motor sports) and most head injuries seen are mild in nature. All people involved in the care of athletes need to have a thorough understanding of the early management of concussed athletes and the potential sequelae of such injuries that may impact upon the athletes' ability to return

Epidemiology

Traumatic brain injury is one of the leading causes of morbidity and mortality worldwide. The crude incidence for all traumatic and morally workfields: The cruck insidence for all remainsfer instinuing the strength of the strength of the strength calibracy this varies from commy to country. In hospital based surveys of heat intrasm, sporting injuries countries approximately 1635% of all cases. Interestingly, they optic home ending, and monomia chimaling, sporting related to them studied relation injury are care, although these have not here studied relations of the strength of the strength and American and Amerikani to though a strength of the patient are also all strength of the strength of the strength and the strength of the strength of the strength of the patient are units, which is a strength of the strength of the patient are units, which is a strength of the strength of the

is a subset of mild brain injury, needs accurate diagnosis and management to avoid long term problems.

Classification of head injury

The most widely accepted and validated method of classifying the spectrum of brain injury is the Glagow coma scale. This scale uses see opening, verbal reproses, and motor response to standard stimuli. These responses are measured six hours after injury after any resuscitation has been completed. The score is then used to separate the categories of injury severity. A score of 13-15 is degimented as an did loging s-812 as a moderate

of 1345 in designated as a mild injury, 842 as a molerane injury, and <3 as as ever injury. The Gauges com scale also muy be used for virtual measurement of the highly status, shere an immediate score them performed existly no mainter progress. Milliongh the Gauges com scale is extremely medial for measuring molerate to severe tranumic brain injury, in suchines in injury in the assessment of million in jury.

usefulness is limited in the assessment of mild brain injury. In sports, most concusive injuries have recovered from their acute symptoms within six hours and as a result are unable to be classified under this scale. This group provides sports medicine practitioners with the greatest management dilemmas in terms for terms to play decisions. Alternative classification systems have been proposed to assess concusive injurice, however, more of these have been validated vicentifically:

Pathophysiology

An on-percentaing brain injury (or closed head injury) may be divided into primary and secondary injuries. Primary higher has a the moment of injury. These deformations may result in either functional disturbance or structural disruption of edi membranes. The injury may also set of a complex cacade of biochemical, immunological, or coagulopathic charges that may further composite cell ingrity. Secondary damage irs as a complication of primary injury.

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Traumatic intracerebral haematom

d rule enforcement have little effe

Traumatic intracerebral haematoma and contusion Trainatic intracerebrait nanematoma and coliditation Trainantic intracerebrait nanematoma are dividual delayed types. Clinical signs and symptoms depend on the size and location of the intracerebra language and size and speed of development. In most cases, at least a brief period of contission or loss of conscionaness is reported. Only one third of patients remain lacid threagheat the goot course. Overall cognitive impairment and the spheet and quality of recovery are cognitive impairment and the speed and quality of recovery an related strongly to coexistent createrial liquity. An intracreebral haematoma that occurs in isolation with a volume <30 m lis compatible with a dowardabe recovery. Overall, death rates are in the range of 25% to 30%. Medical management of intracerebral haematomas is directed primarily at reducing post-traumatic ordema and cerebral ischarenia.

Subdural haematoma

Subdurble International Subdurble Theorem source the result of non-penetrating or penetrating trauma to the head. In both cases, extensionation of a formation because of arteriological subsuper requires of biological cerebral version. These impires are repically seen after fails, none hard unreface or analist with some observation after fails, none hard unreface or analist with some observations, as well as the speed of development. In most case, at least a hief period of containion or loss of concisionness is reported. Sub-tional supervised in the second supervised on the speed and supervised the speed on the speed of the substrate of the speed period of containion or loss of concisionness is reported. Sub-taining spinor of the speed on the speed on the speed of the speed of the speed of the speed on the speed on the speed on the speed of the speed of the speed on the speed on the spinor of the spinor spinor of the speed on the speed on the spinor of the spinor of the spinor spinor of the spinor spinor of the spinor of

tissue injuries usually are seen at the site of impact. Enlargement of the haematoma, or an increase in oedema surrounding it, produces an additional mass effect. Often, the impact produces a coexisting severe brain injury that explains, in large part, the poor outcome of acute subdural haematoma. Extradural baematoma

Extradual haematoma terrepective of the same of inciting trauma, a direct blow to the head is essential for extrainal haematoma formation. An the skall is deformed by the impact and the addrerest durat foreefully detached, haemorrhage may occur into the performed extrachula pace. The source of debeding may be arterial or wronso, or both. Haemorrhage from a fracture line may also accommised to create an assisterio in the extraording space. The expending extrachula lesion only partially accomms paraterial or expending extrachula lesion only partially accomms becautions. Contract the extra partial debug in the extraording the meantoning. Contract mixing the partial debug in the partial debug in the source of the meantoning. Contract mixing the partial debug in the partial debug in the partial debug in the partial debug in the partial debug in the partial debug in the partial debug in the parti haematomas. Coincident intradural pathology is encountered in up to 50% of cases. In general, sequelae of these lesions dictate the degree of residual functional impairment in patients who survive extradural haematoma. The clinical variability who survive extradural haematoma. The clinical variability associated with extradural haemortrage is remarkable. Rarely, extradural haematomas may be asymptomatic; most, however, present with non-specific signs and symptoms referable to an intracranial mass lesion. Alteration in consciousness is a

re more than twice as likely to have a traumatic brain injury than 1, with a peak incidence among those aged 15-24 years; the most on cause of these injuries is more vehicle creation¹ Glasgow coma scale

Category Response Score response (E) No response Oriented Confused, disorientated Inappropriate words Verbal response

No response Obeys commands Localises Withdraws (flexion) Abnormal flexion (posturing) Extension (posturing) Score = E + M + V (maximum 15)

Secondary damage⁺ Hypoxic and ischaemic damage Brain sweelling Hydrocephalus Infection

Concussive injury by definition has no macroscopic neuropathological damage and it is speculated that the critical physiological change occurs at the cell membrane level. Recent evidence also indicates a substantial genetic basis to the outcomes in people with head injuries²

ation of players, parents, coaches, and other staff plays portant part in ensuring that fair play and respect for nents are implemented on the field of play

Acute—occur at the time of the initial head injury
 Delaved—reported to occur as early as six hours after injury to

puted tomogram of tranial bleed

d by sporting associations. ng may be of value in reducing

Signs of substantial head trauma that can result in subdural haematomas Periorbital and postauricular ecchymoses
 Haemotympianum
 Cerebrospinal fluid otorrhoea or rhinorrhoea
 Facial fractures





In the supratentorial compartment, basemorrhage from the middle meningeal artery contributes to at least 50% of extradural haematomas; bleeding from the middle meninges veins accounts for an additional 33%



chare for equinising outcome. Transmic subarchicold hearonrhage musily is consequence of vertical arterylogical and an end of the second second second repeating preserves with flowid metalized second second second particle preserves with flowid metalized second second second initial sequences in the second second second second second initial sequences in the second second second second second initial sequences in the second second second second second initial sequences in the second second second second second initial sequences in the second second second second second initial sequences in the second second second second second initial sequences in the second second second second second initial sequences in the second second second second second initial second second second second second second second second initial second second second second second second second second initial second secon

Specific injuries

wmediate management This is where the medic is i

his refers to the situation when an a

hospital emergency department).

cility after the injury. Asse

ractitioner. If no doctor is available for this assessment, the thlete should be referred to a suitable facility (for example, a

eques menical room rather than the file ent should be performed by a medical yetor is combined by

Most texts tend to focus on neurosurgical head injuries, but >95% of brain injuries seen by sports physicians and trainers are concussive injuries. In some sports, such as motor racing, more severe brain injuries occur more often, but this chapter focuses on the commonplace injuries and their management.

Concussion More than 35 years ago, the Committee on Head Injury

And the days by any age, the Committee on Head Light? Morenthation of the US Congress of Northcodycal Surgeon proposed a variant sensitive of Institutions indication and the US Congress of Northcodycal Surgeon proposed and the US Congress of Northcody of Institutions indication indications and the US Congress of Northcody indication indications and the US Congress of Northcody Northcody Congression in Sport van Heid In Versing and the Northcody Congression in Sport van Heid In Versing Institution in Sport van Heid Institution in Sport Institution in Sport van Heide Institution in Sport Institution in Sport Versing Institution in Sport Institution in Sport Versing Institution in Sport Institution in Sport Versing Institution in Sport Versing Institution in Sport Versing Institution in Sport Versing Institution Institution in Sport Versing Institution in Sport Versing Institution Institution in Sport Versing Institution in Sport Versing Institution Institution in Sport Versing Institution in Sport Versing Institution Institu

Incl. moreast, the outcome or stars improve others is posed. **Diffuse cerebral codesta** The higher default has long been known to well in the cranid or The higher of hash has long been known to well in the outcome of the stars of the stars of the stars of the stars of all stars of the stars of the stars of the stars of the stars of all stars of the stars of the stars of the stars of the stars of all stars of the stars of the stars of the stars of the stars of all stars of the stars the correly has possible the star blank. Downset diplocements in compression of the starbinstic models the teritorial tandors of orders are clicken as and releast the integral to the teritorial tandors of orders are clicken and releast the integral cause of the orders are clicken and releast the integral cause of the orders are clicken and releast the integral cause of the orders are clicken and releast the integral cause of the orders are clicken and releast the integral cause of the orders are clicken and releast the integral cause of the orders are clicken and releast the integral cause of the stars generally is poor and reflects the initiating cause of the ordema, as well as the variable response to treatment.

Management of traumatic brain injury

Acute management The management of an acute brain injury largely follows the approach for concussion. The so-called primary and secondary survey of injurices, although popular in the literature about ramand, does not reflect current particle in sports medicine. Vital signs must be recorded after an injury. Anormalities may reflect brain sem dyfanticular. Although head injury Anecdotal evidence shows that massive traumatic cerebral oedema, documented by computed tomography, occurs within 20 minutes of cerebral injury may reflect brain stem dyfunction. Although head ingyr produces several by or frepinstroy patients, an acute rise in interarand pressure with central hermitates using market reproposel. Hypersension rarely because althous high system as a terminal event, and alternate sources for the drop in blood pressure should be agressively sought and trends. Thus pion byposis are be main determinant of unrenore after train byposis are be main determinant of unrenore after train burger and a result over a the Gages contact. Brinding maximum and the strends the source of the fourty in the assumement of the strends the contact. The fourty of the source of the Gages contact. Brinding the maximum and the strends the strends the strends the strends the source of the strends the strends the strends the strends the source of the strends the s The history of the injury often gives important clues to its nature. This often needs an eyewimess account; in the case o professional sport, videotape analysis may be available

The importance of the initial neurol examination is that it serves as a ref of this examination must be recorded, so that an overall trend in improving or deteriorating mental function can be documented clearly and objectively. In addition, palpation of the skull, which is quick and simple, should be a component of every physical examination in patients with head trauma. against which other serial neurological examinations may be compared

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Vienna expert consensus definition of concussion

Concussion is defined as "a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces: Several common features that incorporate clinical, pathological

and biomechanical injury constructs and may be used to define the nature of a concussive head injury including:

the nature of a convessive head injury including: Contension may be caused by a direct blow to be brack, face, measured in the brack. Concursion projectly results in any direct direct the impairment of the brack. Concursions projectly results in any direct of abort lived in the second second second second second second second concursions of the second secon

Initial on field assessment of concussion

ABC of first aid Check for spinal injury Transport to hospital

Yes Net concussion • ther injuries

Initial injury suspected by observation of injury, presence of phy (eg loss of consciousness, headache) or cognitive symptoms (eg amnesia attention drawn to player because of behavioral abnormality (eg disorie)

e. assion typically is associated with grossly normal structural imaging studies

D—Danger: ensure no immediate environmental dangers that may potentially injure the patient or treatment team. This may involve stopping play in a football match or marshalling cars on

involve stopping play in a football match or marshalling cars of a motor racettrak. R—Response: is the patient conscious? Can they talk? A—Airway: ensure a clear and unobstructed airway. Remove any monthguard or dental device that may be present. B—Breaching: ensure patient is theraking adequately. C—Circulation: ensure adequate circulation.

Suspected head injury* Unconscious

Maddocks questions

.

No

Concussion

Remove from event Medical assessment Observation Serial assessment

Head injuries in sport

13

14

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on that loss concusion assessment. Numerous studies have shown that loss of consciousness in sor prognoucie in this setting, and, accordingly, injury classification and management algorithms should not be based on this symptom. A full methodogical examination is important shere a concussed athlete is examined. (The major management

memory and memory a times in the lace or concussed injuty and should not be incu-fined as the memory of the properties sublices, are questions of recent memory. A typical question battery is rapid to administer and validated scientifically in making a diagnosis of concussion. Alternative systems have been proposed, but these are lengthier to administer and not suited to most sports.² these are lengthier to administer and not suited to most sports². Although a trainer or non-medical person may use the Maddocks questions, or other similar tools, to diagnose concusion (or suspect the diagnosis), all concussed athletes should be referred for ungent medical assessment. Most high level annateur and professional teams in fact will have their own medical staff to make the diagnosis, however, where teams lack this fachily, concussed athletes needs to be referred to a local

undrating, to under or hospital emergency department to undergo a full assessment. When the presence of a concussive injury is determine

ry, they she e card upon discharge.) ating doctor also must decide who should be:

the province of a medical practitioner, ideally with experience of these sporting injuries, and it should not be undertaken by non-medical personnel.

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Cn

When time permits, a more thorough physical examination should be performed to exclude consistent injuries or detect of performance of the performance of the performance of the winh a belignerent patient who is presumably invokicant. If the patient is unconsecution be realism, attended housing be given to bladder, painful works, or right casts. Only these are definitely ruled out should be greatment be considered.

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Management of acute post-transmitic sciences At described providends, impart sciences or concusive downloans are are able world recognition exopland of head impacts. These occur within seconds of impary, are not epilepide, the underlying consultance in the science of the transmits of the underlying consultance in the science of the number of the science of the science of the science of patient is a lucerased risk of hepota, with resultant cascerbains of the underlying consultances. A convolution patient is a lucerased risk of hepota, with resultant cascerbains of the underlying constraining. Maintenance of the critical in the management of such patients

Non-brain head injury

As well as the various brain injuries described above, sports As well as the various brain injurice described above, sports doctors should be familiar with the various soft tissue, how, ocular, and other injuries that may occur to the head. Soft tissue injuries (such as contusions) and sense organ injuries (such as eep injuries) are discussed in chapters 5 and 6. Scalp wounds, although dramatic in appearance, usually head well if good wound management is followed: Bood toos from scalp well if good wound management is followed. Blood loss from scal wounds may be extensive, particularly in children, but it rarely causes shock. In the case of severed large vessels (for example, superficial temporal arrery), the arterial bleeder should be located, clamped, and ligated. The wound abuys should be inspected carefully and inside the laceration should



Skull fracture
 Progressive or severe headache
 Persistent nausea or vomiting
 Post-traumatic science

Early assessment of concussion-history

Early assessment of concussion—history • Time and place of injury • Mechanism of injury (cycwiness or video) • Presence or duration of loss of consciousn • Behaviour after injury • Presence of convulsions post-injury • Past medical history

Post concussion memory assessment (Maddocks questions)

Head injury advice

Other important points: • No alcohol

Patient's name: Date and time of injury: Date of medical review: Treating doctor:

• Drug use

Post-traumatic seizure
 Mechanism ofinjury that suggests high risk of intracranial haemorthage
 Examination obscured by alcohol, drugs, metabolic derangement, or post-tral state
 Patient inaccessibility for serial neurological examinations
 Coagulopathy and other high risk medical conditions



Magnetic resonance imaging is best suited to defining associated parenchymal injuries after the acute event

Drugs used to treat post-traumatic epilepsy Intravenous phenytoin (or fosphenytoin) usually is the drug of choice in this situation, because a loading dose can be administered intravenously to rapidly achieve therapeutic concentrations and because phenytoin does not impair

consistences organization of example of the second secon

(Maddocks questions) • Which ground are we at? • Which team are we playing today? • Who is your opponent at present? • Which quarter is it? • How Far into the quarter is it? • Which start the quarter is it? • Which start dhe scored the last goal? • Which team did we play last week? • Did we win last week? This patient has received an injury to the head. A careful medical examination has been carried out, and no sign of any serious Recovery is expected to be rapid, but in such cases to be quite certain is not possible. If you notice any change in behaviour, vomiting, dizziness, headache, double vision, or excessive dronsiness, please telephone department immediately. No analgesics or pain killers
 No driving



n sport, this strategy has been rejected by the Vienna Exp isensus Group.³ Use of individualised neuropsychological

esting in conjunction with clinical assessment currently is th ecommended basis for return to play. Where any doubt exi linical judgment should prevail. Neuropsychological testing to determine recovery and

Neuropsychological tesuing to theoremute receivery and guide return to play is increasingly accepted worldwide. In Australian and American football, such strategies have been used since 1998. More recently, professional horse racing, ice hockey, and a number of other sports have followed similar strategies. Powrhingiv tests usually are compared with a player

baseline or preseason performance. Th

ch as football and rugby, no n to be of proven benefit in believe that the use of met has been shown to be of p Helmets
 Mouth guards

adopt risk taking behaviour when wearing protecti



Head injuries in sport

be plaqued with a settle light of agent of an anderblying a functure. It answer that how for a planet are subscription of a settle sett

1995;12:903-6 McCrory PR, Berkovic SF. Second impact syndrome. Neurology 1998;50:677-83
 McCrory PR, Bladin PF, Berkovic SF. Retrospective study of concussive convulsions in elite Australian rules and rugby

Statistical injury represents one of the most common types of injury in sporting situations. Although most such liquires are mild concussions that recover without long terms may have a catastrophic outcome. Sports medicine doctors should be familiar with the clinical situation doctors of such liquires and have a clear, well practiced management algorithm.

The photograph of the racing car crash is courtesy of Getty

a sterile technique. The scalp and soft tissues of the head and neck are evremely well vascularised, and this often results in extremely well vascularised, and this often results in copious bleeding if these structures are injured. The doctor should adopt universal precautions against blood borne infections such as hepatitis B virus, hepatitis C virus, and HIV. concussive convulsions in clite Australian rules and rugby leagues footballerse phenomenology, aetiology, and outcome. BMJ 1997;514:1714
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Summary

Possible methods for preventing concussion

Guiding policy for return to sport

Guiding policy for return to sport = Unail completely symptom free, concused adhetes should no resume any training or competition = This should be assessed initially at rest and then after a protocative carries challenge the activity of the second = This is recommended to be aerobic exercise, and the athlete should exercise until their heart rate reaches 80% maximum

Predicted heart rate
 Once the acute concussive symptoms resolve at rest and

concerning a graduated plan of return to low level aerobic training, followed by non-contact drills and finally contact play will allow close monitoring of the development of any adverse

wat anow cose monitoring of the development of any adverse symptoms Persisting or newly developing symptoms need further follow up and detailed medical evaluation

Although repeated concussive injuries have been proposed as the basis for second impact syndrome, the evidence is not compelling. More likely is that a single impact of any severity may result in this rare complication, but that participation in sport draws attention to incidental accessibility of the second second

ions, the universally good ence of structural injury uropsychological damage

Head injuries in sport

oncussed athletes should not