THE COMATOSE INJURED PATIENT

T. SCHRIRE, M.A., M.B. (CAPE TOWN), F.R.C.S. (ENG.)

Casualty Department, Groote Schuur Hospital, and Department of Surgery, University of Cape Town

One of the benefits accruing from organizing a multiple injury unit (MI unit) is that it has been possible to study a large number of comatose patients with multiple injuries who are all attended by the same group of doctors. A considerable amount of experience has now become available in the management of these very difficult cases.

For the purpose of administrative classification, we have labelled every case at Groote Schuur Hospital in which more than one system of the body has sustained any trauma as one of multiple injury. This type of case is dealt with by the MI unit and not by the surgical or orthopaedic firm on intake for that day. It was felt that, while the special individual injuries were being managed with great competency and with no trouble in finding beds by the general surgical firms and the surgical specialities, difficulties in administration arose and beds were difficult to find if more than one system of the body was injured. The formation of the MI unit has resolved these troubles; it falls directly under the Division of Surgery and has the right to admit patients to any empty available bed. In addition, one of the casualty registrars has been detailed to deal with these patients on a rotating basis so that gaps in the treatment should not occur.

Most of the patients who come under this grouping are not seriously injured people, a fair number being handled in the casualty department itself, but a significant proportion are gravely ill and require every facility which is at the hospital's disposal if their lives are to be saved.

Statistics obtained from this unit indicate that almost 70% of the patients with multiple injuries have sustained a head injury and have, at one time or another, been unconscious after the accident. By far the largest number of patients with multiple injuries are admitted in an unconscious state, and for the first few vital hours after admission their treatment must be organized without their active cooperation.[1] The surgeon in charge of an injured but unconscious patient must therefore have the state of the patient's consciousness constantly in mind, and must always be aware that other injuries may be present as well as the head injury; he must for that reason not only keep an eye on the state of the central nervous system, but should also make a complete examination of the whole body before allowing the patient to be moved from the casualty department.

EXAMINATION AND TREATMENT OF A COMATOSE INJURED PATIENT

Examination should always be carried out with the patient *completely stripped*. Removal of clothing should be done gently so as not to disturb the intracranial condition more than is necessary. The examination starts with a complete check of the central nervous system, testing for reflexes (noting especially the state of the pupils), movements and sensation. This is followed by examination of the skeletal system, the chest and the abdomen, in that order. All findings should be noted down immediately, as well as the exact time of the examination, since these will be required for comparison with findings later on, as the state of consciousness deteriorates or as recovery takes place.

Maintenance of a Clear Airway

Whether the patient is unconscious or not, the first consideration is to establish and maintain a clear *airway*. Many patients with head injuries have sustained a fracture of the base of the skull with bleeding into the mouth and pharynx. The mouth is opened, any blood is sucked away or mopped away, and a large airway is inserted. The head of the table is lowered and the patient's head turned to one side to allow blood to run out of the mouth. Should this be ineffective, e.g. when blood trickles down from a fractured base of skull, the airway is removed, the mouth is once again cleared with suction or swabbing, and a large cuffed intratracheal tube is passed. The cuff is inflated and respiration proceeds without risk of obstruction from further bleeding into the mouth. A small catheter may be passed down the intratracheal tube, and with suction on this any blood in the bronchial tree can be removed.

Should it not be possible to pass an intratracheal tube, either because of lack of experience on the part of the operator, because of excessive bleeding from the basal fracture of the skull, or because an injury to the cervical spine does not permit the neck to be extended, an attempt should be made to pass the intratracheal tube through the nose; if this is unsuccessful, one should not allow the stertorous noisy respiration to continue any longer, but should perform a tracheotomy immediately. It is never too late to do a tracheotomy on a breathing patient, and a large-sized cuffed tracheotomy tube should be used and tied in with tapes.

Treatment of Shock

The next consideration is to maintain the circulation and the *blood pressure* and to treat *shock*. In cases of trauma, a head injury by itself is almost never the cause of shock, which is almost always oligaemic in character, i.e. it is due to loss of fluid from the circulation. This fluid is almost always blood, although in the case of burn-shock it may be plasma. There is no substitute for blood in the treatment of oligaemic shock, and it should be given copiously, energetically and quickly. The aim should be to get the first bottle of blood into the circulation of the shocked patient within 10 minutes of his arrival at the casualty department.

An 'intravenous life line' is set up using a short-bevelled No. 15 gauge needle which is tested and sharpened every time after it has been used. Five ml. of blood are drawn off for cross-matching, and saline is connected up to the intravenous needle. This is run in slowly while a bottle of powdered plasma is being reconstituted and made ready. The plasma can now replace the saline and is run in at a fast drip; by the time the bottle of plasma (250 ml.) is finished, a bottle of low-titre O-negative blood in the case of females, or either O-negative or O-positive blood in

the case of males, should be used; it is connected up and run in at full bore in an unbroken stream. If any venospasm is encountered, the blood should be pumped in by hand at the beginning of the transfusion.

By the time the first bottle of blood is near its end, an unlimited amount of cross-matched blood should be available. One bottle of this blood is now run in, and this is a good opportunity for pausing to take stock of the situation. The patient's airway is now in order and he has had about 2,500 ml. of fluid, of which 2,000 ml. are pure blood and the balance saline and plasma, so that his position is a far better one at this particular moment than it was on his admission. The rise in his blood pressure should reflect this improvement.

Level of Consciousness

The central nervous system is now re-examined and the findings are recorded. Particular care is taken to note the state of the level of consciousness and also any changes that might have taken place since the first examination half an hour or so earlier. For purposes of record, the following classification of the general *state of consciousness* is used;[2] although it is of necessity a rough method, it is effective and is definite enough to be worth while noting down, since the information given can be understood by anyone:*

A. Awake: The patient responds to questioning. He may, however, be aphasic and unable to understand or to answer. It is easy enough to assess that he is conscious or awake by his demeanour, or by his actions when questioned.

B. Drowsy: He responds suitably to commands or questioning, but if left alone will immediately go to sleep.

C. Stuporous: He will respond only to painful or unpleasant stimuli. His attention will be held only temporarily or he will try only to escape the stimulus.

D. Comatose: He will not respond to any stimuli.

E. Irritable: This state does not describe the degree of wakefulness, but may be additional to stages A - C above. It describes the reaction of the patient to stimuli, light, command, touch or pain. It may be of importance in assessing the extent of injury and should be noted.

The decision for or against operative interference is often made on deterioration of the state of consciousness. It is therefore vitally important that this should be noted down and that the position be assessed from time to time. This can only be done if the findings are recorded and the record is observed over a period.

At the end of the first half hour, therefore, the blood pressure should have started to rise and particular care should be taken to make sure that all the injuries which may be present are under consideration.

Systematic Bodily Examination

The greatest misfortune that can overtake an injured person is that one of his injuries should be overlooked. In the conscious patient this happens infrequently, because the patient is able to complain and call attention to the injured part. The unconscious patient is in no condition to make such complaints and it devolves upon the surgeon-in-charge to find out whether all injuries are under consideration and under control.

The only way to make sure that nothing is missed is to make a systematic and complete examination of the body, system by system. We have found the following routine of examination to be helpful:

1. *Skeletal system:* Arms and clavicles, legs, pelvis, ribs and sternum, spine.

2. *Chest:* (*a*) position of trachea; (*b*) shift of apex beat; (*c*) hyper-resonance or dullness; and (*d*) loose fragment, i.e. uncontrolled loose fragment of chest wall (stove-in chest).

3. *Genito-urinary system:* Check the pelvis by springing; examine the urine, taking a catheter specimen. If blood is found, or if no urine at all is drained off, leave the catheter *in situ*.

4. *Abdomen:* Careful palpation of the abdomen is essential; it is seldom that anything abnormal can be felt in an unconscious patient, because rigidity and tenderness cannot be elicited until consciousness returns. However, a preliminary examination should be made at this stage to feel for fractured lower ribs or for a fractured brim of the pelvis major.

5. *Maxillo-facial injuries:* These should be observed and noted. Their importance in the early stages only obtrudes if obstruction to the airway develops.

6. *Injuries to the spinal cord:* These are very difficult to diagnose in the unconscious patient because movements are not present and sensation cannot be examined. However, it is advisable at this stage to palpate the dorsalis pedis arteries in both feet and to note whether the feet are warm or cold. In the case of transection of the spinal cord, unusual warmth of the feet is an indication that the vascular tone has been released from its normal control.**

Additional Factors to be Considered

The following factors should be taken into consideration at this stage:

1. *Alcoholism or the previous administration of morphine:* Drunken patients or those to whom morphine has been given previously show diminished reflexes. An abdominal injury, a head injury or the significance of a head injury, can be overlooked very easily. Such patients should be kept under observation until the effect of the alcohol or morphine has passed off, and they must then be re-assessed.

2. *Delay in recovery from shock:* Normally, injured patients in shock recover from this state within a relatively short time and, if two pints of blood are given, recovery should be both prompt and continuous. If they fail to make the expected recovery, some other cause must be present to account for the persisting shock. The condition of the abdomen, the head and the chest requires careful re-appraisal. An intra-abdominal haemorrhage is particularly likely to be missed in these cases. The following possibilities must be considered:

(*a*) *Intra-abdominal bleeding:* In the case of patients who are suffering from loss of consciousness, as we

* I am grateful to Mr. A. Gonski, F.R.C.S., for permission to quote from his published writing on this subject.[2]

** I am grateful to Mr. W. M. Roberts, F.R.C.S., who first noted this sign as a result of his own clinical observations and informed me about it; it had previously been unknown to me.

have previously noted, tenderness cannot be elicited and rigidity is not observed, so that the only possible way of diagnosing whether an intra-abdominal haemorrhage is going on, after taking care to exclude a full bladder, is by observing increasing distension of the abdomen. This is done by passing a tape measure around the abdomen at the level of the umbilicus and writing the result obtained on the skin of the belly with an indelible pencil.

(*b*) *Bleeding into the tissues:* It should be remembered that a patient with a fractured femur can quite easily lose 2 pints of blood into his thigh with very little external evidence to show that this amount has been lost to the circulation. Patients with bilateral fractures of the femur may well lose 4 pints of blood into their thighs, and a fractured pelvis can be responsible for the loss of up to 8 or 10 pints of blood by internal bleeding, not necessarily into the abdominal cavity, the haematoma filling up the iliac fossae and running up the posterior abdominal wall. In these instances it will often be observed that the only physical sign that can be elicited is an area of rigidity and dullness about two fingers in breadth above the inguinal ligament on one side or the other. The significance of this small sign should not be underestimated.

(*c*) *Lacerations or lacerated wounds*: The amount of blood that is lost from a lacerated wound is generally far more than is usually estimated. In general, a working rule is that if the area of the wound is that of the palm of the hand, one pint of blood has been lost; the loss from larger areas can be measured by this rough-and-ready method.

(*d*) *Injury to the spine:* Spinal injuries are particularly difficult to diagnose in patients with loss of consciousness or in shock. There is often no external clinical sign to give evidence that damage to the cord has taken place, the line of the spinous processes is not deviated, and carefully taken X-rays necessary to show various views of the spine are out of the question at this stage because of the poor general condition of the patient. However, transection of the spine implies that the vascular tone of the legs is lost, so that the feet feel warm by comparison with the rest of the patient's body.

(*e*) *Cardiac failure from coronary thrombosis:* The drop in the blood pressure that accompanies shock leads on occasion to a coronary thrombosis and a further drop in blood pressure. Failure to recover after ordinary resuscitative measures may well be due to this factor.

(*f*) *An excessive degree of shock:* If the degree of shock is disproportionate to the injury, or if recovery is not proceeding in the normal way, attention should be directed towards finding some other injury which may be responsible for the excessive degree of shock. Intra-abdominal injuries and haemorrhages can be fairly silent and may easily be missed, and it is particularly important not to overlook these conditions or haemorrhage into the chest.

PRIORITIES OF TREATMENT

Assessment of priorities for treatment is of paramount importance in the case of an unconscious injured patient. The acute need of one moment may be overshadowed by an even more urgently developing requirement a little later. For this decision — the most important factor in the successful handling of these cases — there can be no rule of thumb; each case is a law unto itself and requires careful, individual consideration. The changing requirements constantly confuse anybody who is not prepared to alter his mind and his treatment at a moment's notice.

Fractured limbs should be splinted at this stage, while the patient is still unconscious. The fractured legs should be placed in Thomas' splints, taking care not to apply too great extension in the case of a fractured femur because over-stretching of the sciatic nerve can easily occur and this may lead to paresis or even to a later paralysis. The arms, if fractured, may be bandaged over Cramer splints.

A wary eye must be kept on those patients who have had chest injuries, lest tension pneumothorax and mediastinal shift develops. Should this occur, and it is fairly easy to diagnose if the condition is borne in mind, the procedure of inserting a No. 15 needle (with no anaesthetic) into the pleural cavity in the second interspace anteriorly, and attaching a tube which is led under water, is a simple and life-saving measure. An artery forceps grasps the shaft of the needle near its hub, and the forceps may be strapped to the chest wall to stabilize the needle itself.

The treatment of *external haemorrhage* now demands attention. There are very few instances of external haemorrhage that cannot be temporarily and adequately controlled with a pad and a crêpe bandage. A tourniquet should never be used; more limbs have been lost than saved by the use of tourniquets — they should be considered dangerous and their use forbidden.

The next steps in the treatment depend on the observation of the patient's blood pressure and general condition. If everything is going well, the patient may be kept under observation and transferred to a bed for treatment, but if the condition is not improving, and especially if it is felt that the improvement that is taking place is not commensurate with the amount of blood that has been given, attention should again be paid to the state of the abdomen and thorax to see whether evidence of increasing haemorrhage into these cavities can be found. Measurement of the circumference of the abdomen now plays an important part; if it is significantly increased, it is an indication for laparotomy. Any increasing dullness of the chest or displacement of the thoracic viscera demands an explanation before an intra-abdominal lesion is diagnosed with certainty. However, it is better in certain cases, if the condition is not settling down, that the abdomen be opened and a negative laparotomy performed than that the patient be lost from an overlooked intraperitoneal haemorrhage. As a general rule, intraperitoneal haemorrhage can be controlled, and it is the duty of the surgeon to see that this is attempted before he gives up his patient.

THE HEAD INJURY

It is not the intention to discuss here the minutiae of therapy in head injury. Suffice it to say that there is no known treatment that can be given, with assurance, that will reverse the state of unconsciousness with any certainty.

The basic cause of the state of unconsciousness is still in dispute. Synaptic dissociation or momentary vascular spasm are still only theories, neither of which finds universal support, and they are anyway only applicable to concussion; the cause of unconsciousness itself after the state of concussion has been passed is unknown. Unconsciousness from trauma, however, is a self-limiting condition, and unless gross cerebral damage has been sustained or a progressive rise in intracranial pressure occurs, recovery tends to take place. While there can be no assurance that a state of unconsciousness will be reversed by any specific form of therapy, much can be done to assist the patient if focal signs develop. To recognize the development and importance of these focal signs there is no substitute for careful and intelligent observation over a period. Since memory is fallible, findings *must* be noted down and any alterations inspected with the keenest eye.

External wounds of the head require the same attention as wounds anywhere else. They must be closed within 8 hours or, if this 'golden period' is extended by systemic antibiotics, within 12 hours. Cleaning the wound, shaving hair around the area, and inspecting the depths of the wound are all required. If a linear fracture is observed traversing the wound, simple suture is probably safe enough; if there is a depressed fracture, this should be elevated with the usual precautions. If the dura is found to be torn, this should be sutured. If a fragment of bone is driven in deeply and the brain lacerated, the lacerated portion of the brain must be washed out with copious saline irrigations and the wound closed in anatomical layers. We strongly urge the use of polymyxin powder dusted into all the layers during the repair.

Since specific treatment for the general state of unconsciousness is not available, we should at least aim at diagnosing focal lesions as early as possible. The use of burr holes has now become less popular than it was several decades ago, and percutaneous cerebral angiography is found to be of greater assistance in localizing intracranial space-occupying lesions which can be evacuated if necessary. This, however, lies more within the province of the neurosurgeon and will not be discussed here.

X-rays

X-rays of the skull of the unconscious patient should be performed fairly soon and are routine in our neurosurgical department. The value of an X-ray taken soon after injury is that a fracture of the skull which could have been missed in the ordinary way of examination will be noted, the possible situation of haematomas can be predicted with better assurance, any depressed fracture of the skull with in-driven spikes or fragments can be observed, and the position of the calcified pineal gland in the case of an adult patient can give an indication whether there has been any shift of one or other hemisphere.

The dangers of starting up an intracranial haemorrhage as a result of moving the patient to take the X-ray are outweighed by the value of the information that can be obtained from the same X-ray, and can be lessened to a great extent by bringing the machine, a mobile unit, down to the patient in the casualty department as he lies on his trolley. The pictures that can be taken by such a machine are adequate for these particular purposes.

RESULTS AND DISCUSSION

An analysis of the statistics of 169 comatose injured patients has been made. The individual systems of the body which were injured are indicated in Fig. 1. It will be observed that the 169 patients sustained among them 419 injuries, which include the injuries to their heads; this gives an idea of the severity of the trauma inflicted on them.

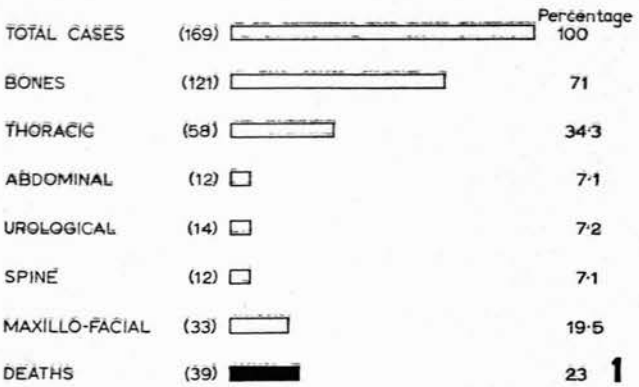

Fig. 1. Analysis of associated injuries in 169 unconscious injured patients.

We can confirm the well-known finding that the combination of a head injury with a thoracic injury has a particularly sinister significance. Thus, of 58 patients with this combination of injuries, no less than 18 died, a mortality of 31%. The reason for this high mortality is fairly clear; when the physical mechanism of respiration is made inadequate by a thoracic injury, and when this is combined with some compromise of the respiratory centre in the medulla arising from the head injury, the margin for survival becomes very small indeed. Since in the present state of our knowledge we cannot do very much more as far as the head injury is concerned, we must do all we can to assist the act of respiration itself, and for this reason we have paid particular attention to stabilizing the stove-in chest that has been responsible for at least 5 of the 7 thoracic deaths; the last 3 patients on whom we have used the Cape Town Limpet[3] have survived, and a series of successes like this can make a significant contribution towards improving our overall figures. Other methods of controlling respiration are of course

TABLE I. ANALYSIS OF CASES OF HEAD INJURY ADMITTED TO THE DEPARTMENT OF NEUROSURGERY, GROOTE SCHUUR HOSPITAL (1959-60)

	1959			1960		
	Number	Deaths	% Mortality	Number	Deaths	% Mortality
Admitted for observation	267	0	0·0	176	0	0·0
Simple fractures	117	0	0·0	182	0	0·0
Depressed fractures	64	3	4·7	103	4	3·9
Cerebrospinal-fluid leaks	7	0	0·0	8	0	0·0
Extradural haematomas	16	5	31·2	11	2	18·2
Subdural haematomas	22	4	18·2	36	9	25·0
Intracerebral haematomas	22	6	27·3	25	7	28·0
Severe, extensive injuries	56	37	66·1	48	35	72·9
Complications of head injuries	60	4	6·7	40	3	7·5
Early epilepsy	21	0	0·0	22	0	0·0
Total*	652	59	9·0	651	60	9·2

*Average stay in hospital 8·5 days.

used in combination with the Limpet, but it seems to us that the Limpet itself is likely to have a marked effect on our future results.

To show what a detrimental influence a thoracic injury exerts on a patient with a head injury, Table I gives, for comparison, the figures from the Neurosurgical Department of Groote Schuur Hospital for 1959 and 1960.[2] The personnel of this Department provides the neurosurgical consultants for the MI unit, so that the figures are comparable.

When the results in Table I are compared with the 31% mortality of combined head and chest injury, it is clear that the addition of a chest injury to the head injury raises the fatality rate very significantly.

The total number of deaths for the series under review has been 39, giving an overall mortality of 23%. Because these were all cases of accident or assault, official police postmortem reports are available on every one, so that the causes of death are all confirmed by postmortem examination. The following were the primary causes of death of the 39 fatally injured patients: Head injury 22, gross multiple injury 4, thoracic injury 7, abdominal injury 1, haemorrhage and shock 2, fat embolism 1, pulmonary embolus 1, and inhaled vomitus 1.

This analysis of the causes of death will show that if we wish to improve our results, we must pay particular attention to the thoracic injury. If we could suppress this factor from the clinical picture by adequate and successful treatment, we could perhaps reduce our mortality rate by more than half (from the reported 23% to that of the ordinary head injury, i.e. about 9%). This would be a significant achievement and it is with this in view that the problem is being approached.

Above all else, success in the treatment of the comatose injured patient can only come from alert and keen clinical observation over a period. Making one senior person responsible for the welfare of the whole individual patient and keeping him by that patient's side until the crisis is over, has had, in our experience, a marked effect in reducing morbidity and mortality. If the surgeon-in-charge is alert, willing to change his mind and to deduce correctly from careful observation, and modest enough to call in specialist assistance when the clinical findings suggest that this is required, a marked drop in the morbidity and mortality rates can be expected. We have ourselves experienced this and are prepared to recommend it to others.

SUMMARY

1. The clinical principles underlying the management of comatose injured patients are set out.

2. The routine examination and handling of these patients is discussed.

3. The priorities for treatment of the various injuries are considered.

4. The importance of the concomitant chest injury is stressed.

Thanks go to Dr. J. G. Burger, Medical Superintendent of Groote Schuur Hospital, for permission to publish, and to Prof. J. H. Louw for his interest and support. Messrs. W. M. Roberts, P. Willers, W. Silber, R. Ger, S. Cywes, surgeons, and the representatives of the Anaesthesia, Maxillo-facial, Neurosurgical, Orthopaedic, Thoracic and Urological Departments are thanked for their wholehearted devotion to this work. I am particularly grateful to Mr. H. L. de Villiers Hammann, Senior Neurosurgeon, Groote Schuur Hospital, for permission to use the statistics taken from his department's records.

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