THE ORGANIZATION AND CONTROL OF MULTIPLE INJURIES*

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Biologically speaking, our bodies are built to take strains and stresses of about the order of 1 G (G=the force of gravity acting on the body). In the primitive state, except in the rare instances of falling off a cliff or from a tree, a man's body was seldom subjected to stresses greater than this. Moreover, since even as slight an injury as a minor fracture in the feral state often meant the death of the injured creature, 'accident-prone' animals were quickly weeded out. With increased speeds of travel, individual injuries have become more severe and multiple injuries more frequent, but we have not developed any biological improvements in our bodies to cope with the extra strains to which we subject them.

Any casualty department can therefore expect to encounter patients with multiple injuries quite frequently. In the department at Groote Schuur Hospital about 150 of these cases are met every year. It is necessary that these particular injuries be differentiated from all others because of the difficulties associated with their management, both clinically and from an administrative point of view, although they need not necessarily be individually more serious than a major, serious, single injury. It is for this reason that we have classified these injuries into a separate group known as 'multiple injuries' and have put them under the responsibility of an organization known as the 'multiple injury unit' (MI unit) which undertakes their care and treatment.**

It is the considered opinion of most surgeons dealing with trauma that no single person can possibly be expert in all branches of traumatology. For this reason the MI unit has been set up to deal with these special patients so as to give them the benefit of team work in their treatment. From the organizational point of view, it is occasionally very difficult to know to whom these cases should be referred in the first instance, and we feel that it is essential for some senior person or a person with experience in traumatology in general to be in personal charge of these patients. He should be in attendance until the crisis is over and each individual injury has been attended to, in the correct order, by the experts concerned.

The MI unit has therefore been organized and has been made responsible for the management of all patients with injuries involving more than one system of the body, who are admitted to the casualty department. The unit consists of six general surgeons who are in liaison with the surgical firms on call and on intake for the day, and who are of sufficiently senior grade to have had experience in dealing with serious trauma. Associated with them as part of the same unit are nominated representatives from the maxillo-facial, urological, orthopaedic, anaesthetic, cardiothoracic and neurosurgical departments, each of which maintains a 24-hour-a-day service, which can be called on in case of need. Eye and ENT specialists are also available on call.

We feel that this type of organization is an ideal one, but that it can only take proper shape within the limits of a large hospital. However, any hospital, no matter how small, can create some sort of organization whereby cases of multiple injury can be attended to in an efficient way. All that is required is a friendly liaison between those surgeons who are willing to be called on in case of need and who are prepared to take their share in caring for a patient when called upon by an individual senior surgeon. There must of course be one or other casualty officer on duty at all times of the day and night to initiate the procedure. There is usually one surgeon in most towns who is more interested in doing general traumatic surgery than the other practitioners, and he should be designated as the chief of the hospital's MI unit.

When a patient with multiple injuries arrives at his department, the casualty officer proceeds with his normal duties of clearing the airway and overcoming shock, and calls on the designated surgeon to come and take the case over. The senior man in turn calls on the services of whoever he thinks is best able to handle certain individual injuries, and puts the patient into *any available bed in the hospital*. In this way the patient is not attended by a single surgeon, but by a team of doctors; this team work will result in a lesser strain on the individual surgeon and an increase in the recovery rate and a reduction of morbidity for the patient.

THE MANAGEMENT OF PATIENTS WITH MULTIPLE INJURIES

The clinical management of multiple injuries has been considered recently,[1,2] but it is necessary to examine the requirements that must be provided before an organization to undertake this form of treatment can be called into being.

The subject will be discussed under the following heads:

1. Diagnosis.
2. Provision of an adequate airway.
3. Assessment of blood loss and treatment of shock.
4. Emergency treatment of fractures.
5. Emergency treatment of head injuries.

1. Diagnosis

Before a patient can be treated as having multiple injuries, a diagnosis must be established. To do this, it is important that all patients in whom multiple injuries are suspected or who are unconscious, should be examined *completely stripped*. This helps the doctor to make sure that other injuries are not overlooked. Once the physical examination has been performed (it should be done as a routine and in a routine agreed way[1]) a note can be made on the patient's card stating what injuries he is suspected

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** This organization has now been extended to include all severely injured patients at Groote Schuur Hospital, even if they have only single injuries.

to have. The notes about various injuries can be amplified as more data become available.

Control of external haemorrhage. This must be done as soon as possible. It is never necessary to use a tourniquet. A sterile pad and a firm crepe bandage will control almost any haemorrhage from wounds of the limbs. Wounds of the trunk can be packed with a pad of sterile gauze and the lips of the wound can be drawn together firmly but temporarily over this pad with strong sutures.

2. Provision of an Adequate Airway

This is vital and urgently essential; the patient cannot live unless the airway is properly clear, and an adequate airway is the first care of any medical attendant.

(*a*) If the airway is not clear (usually owing to blood in the mouth) the patient's head is lowered and turned to one side; the blood is sucked away and an ordinary airway is inserted. If this is satisfactory all is well, otherwise

(*b*) a cuffed intratracheal tube should be inserted and bronchial toilet performed by passing a small catheter down the tube and applying suction. If this is unsatisfactory

(*c*) a tracheotomy should be done and a cuffed intratracheal tube should be passed into the tracheotomy opening.

(*d*) If respiration is still unsatisfactory, the tracheotomy tube should be cleaned by suction and intermittent positive-pressure respiration (IPPR) or mouth-to-tube respiration should be performed until it is possible to get assistance.

Every casualty department should have a properly labelled box containing equipment for intubating any patient and maintaining respiration. The contents of the box (Fig. 1) must be checked frequently to ensure their readiness at any moment. It is recommended that the box should contain: (*a*) Ruben resuscitation bag, (*b*) 3 masks (1 large, 1 medium and 1 small), (*c*) metal airways (large, medium and small), (*d*) intratracheal tubes (cuffed) in 5 sizes, (*e*) laryngoscope handle with spare batteries and spare lamps, (*f*) laryngoscope blades (large and small), (*g*) gauze bandage for use as a throat pack, and (*h*) a tube of lubricant.

3. Assessment of Blood Loss and Treatment of Shock

Coincidentally with the diagnosis of shock, an estimation of the blood or fluid loss must be made.

(*a*) *Estimation of the blood loss.* This is done by noting the injuries and adding the sum total of the estimated blood loss of each one. The following criteria may be used to estimate the quantity lost:

(*i*) If the patient has fainted from loss of blood, *three* pints of blood have been lost.

(*ii*) If the blood pressure (BP) remains at 50 mm.Hg persistently, at least *five* pints of blood have been lost from the circulation.

(*iii*) A swelling or an amount of bleeding equal to the size of a fist is equivalent to *one* pint of blood lost into the tissues and out of the circulation, and a wound occupying the area of the palm of a hand is also estimated to be responsible for the loss of *one* pint of blood.

(*iv*) A simple fracture of the lower leg accounts for the loss of *two* pints of blood.

(*v*) A simple fracture of the femur accounts for the loss of about *three* pints of blood.

(*vi*) A simple fracture of the pelvis may frequently account for the loss of anything up to *eight* or more pints of blood.

(In the case of compound fractures the estimated blood loss should be increased by 50%.)

(*vii*) If chest dullness on percussion extends up to the inferior angle of the scapula, *four* pints of blood have been lost into the chest. X-ray of the chest will assist in estimating the volume of the blood thus lost into the pleural cavity; X-rays must be taken with the patient erect. In the absence of a pneumothorax, no fluid levels can be observed and assessment is very difficult on radiology alone.

Intra-abdominal bleeding may well be massive before it can be diagnosed clinically with assurance. Diagnostic paracentesis or peritoneoscopy do not play any part in emergency clinical examinations and the only way (a rather crude one) of making the diagnosis a certainty in an unconscious patient (and at least two-thirds of the patients with multiple injuries are unconscious on admission) is to measure the distension of the abdomen that takes place as blood fills that cavity. This is performed by passing a tape measure around the abdomen at the

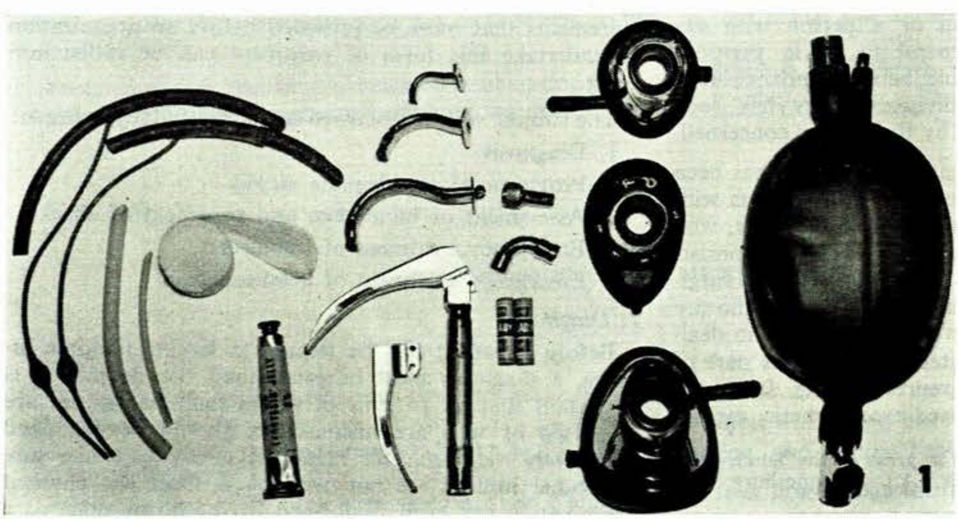

Fig. 1. Contents of IPPR box, showing Ruben bag, facepieces, airways, laryngoscope and various intratracheal tubes.

level of the umbilicus, writing down the figure obtained on the patient's abdomen, and repeating the measurement every half-hour. A filling bladder may have to be taken into account, though for practical purposes it may be remarked that very little urine is being secreted in the state of shock and with the low blood pressures under consideration.

(*b*) *Haemoglobin estimation*. Estimation of the haemoglobin content of the blood should be done on admission as part of the general examination of the patient. However, the results should be interpreted with caution; a high haemoglobin reading may be due to a large loss of plasma or compensatory haemo-concentration in haemorrhage of some hours' standing. A low haemoglobin reading may be due to a previously present anaemia, and the reading may be normal for the particular patient. Elderly patients often normally present with a relatively low haemoglobin. However, the best test of satisfactory circulating volume is restoration to normal by blood transfusion, which is recognized by clinical observation (particularly of the BP) as the transfusion proceeds. One pint of blood is seldom sufficient to give any information one way or the other; indeed, in shock from trauma, 1 pint alone is seldom indicated in adults. If blood is to be given at all, the surgeon should start off with two pints at least and re-assess the patient after this has been given.

(*c*) *Treatment of shock*. A sample of blood should be drawn from the patient's vein, using a No. 15 needle on a syringe. The sample can be taken from an arm vein if this is available, and the needle is left in place for transfusion. If it is difficult to find an arm vein, it is often possible to use one of the neck veins. If this is also impossible, it should be remembered that immediately medial to the femoral artery at the level of the groin, the femoral veins form a large subcutaneous pool of blood which can be tapped quite easily by placing the pulp of the left index finger over the pulsating femoral artery and inserting the needle vertically to the skin into the femoral vein just medial to the finger nail. Five ml. of blood are then easily withdrawn, and the needle can be left *in situ* to start intravenous infusions. The medical attendant should allow himself only 2 attempts at inserting an intravenous needle. Should both fail, he should immediately perform a cut-down, using one of the arm veins rather than a leg vein, where thrombosis is relatively more common. Once the intravenous cannula or needle has been inserted, saline is run in slowly to keep the intravenous life-line going. Plasma is substituted for the saline as soon as it can be got ready. Plasma should be kept in stock as powdered, dry plasma, which must be reconstituted as needed, and 1 or 2 bottles (each of 250 ml.) are run in slowly until a bottle of low-titre O-negative blood becomes available. This blood is allowed to run in or may be pumped in under pressure, and by the time the bottle is finished, grouped blood should be available. A pint of this is likewise run in, and after this bottle of grouped blood has been transfused, properly cross-matched blood should be available in almost unlimited amounts. Half the assessed blood lost can be given quickly, and the balance by a steady drip.

4. Emergency Treatment of Fractures

All fractures should be splinted as soon as possible, and a suitable supply of splints in various sizes should be kept available. Fractures of the upper limb can be splinted over Cramer wire splints. All fractures of the lower limb should be put into Thomas splints as soon as the patients are admitted. It should be noted that too much extension should not be applied to fractured femurs, because of the risk of overstretching the sciatic nerve. Splinting fractures reduces the shock immediately and prevents any further deterioration. The splinting itself is not the cause of further shock; this fact, often ignored, has been proved again and again in two world wars.

5. Emergency Treatment of Head Injuries

This requires:

(*a*) Continuous observation with notes of any alterations or changes.

(*b*) A general examination which includes the blood pressure, the pulse, the respiration and the state of the pupils.

(*c*) Observation of the general behaviour of the patient. This has been discussed in a previous article.[1]

(*d*) Particular care to see that the airway is clear and that the patient is well oxygenated.

RADIOLOGICAL REQUIREMENTS

Patients with multiple injuries must be X-rayed in the casualty department itself and *not* sent to what is often a remote radiology department for these investigations. A mobile X-ray unit should in all cases be brought to the patient in casualty as he lies on his stretcher and the exposures should be made there; the plates can be developed elsewhere if facilities for doing this are not available in the casualty department itself. The ideal position is to have a detail from the X-ray department working in the casualty department on a 24-hour basis with its own mobile unit and dark room.

BLOOD TRANSFUSION SERVICES

Requirements for different hospitals vary according to their locality and size.

Large Hospitals

In the normal large hospital the stock of blood kept on hand to provide for the needs of the casualty department is a relatively small proportion of the requirements of the hospital as a whole, and does not present a problem in itself.

Small Urban Hospitals

Smaller hospitals may use the blood bank of the larger hospital for blood-grouping tests and cross-match procedures, and do not carry stocks of their own. Full use is made of plasma until blood for cross-matching or cross-matched blood is delivered from the major hospital's blood bank.

Small Rural Hospitals

The more distant hospitals, particularly rural hospitals, must arrange to carry supplies of blood on hand. In some instances group-O blood, Rh-positive and Rh-negative of low titre, is collected every week from local donors. Blood which is not consumed during the week is despatched in refrigerated hampers to a large bank for disposal. Pretransfusion blood-group determination of the patient (where this is done) and cross-matching tests are left to the doctor in charge of the patient. Stocks of plasma and 'dextran' are carried and used when indicated, either alone or with blood.

The smaller hospitals which do not have a regular call for blood often arrange for an emergency panel of donors. These donors are grouped by the central laboratory and only group-O Rh-positive and Rh-negative donors are registered. They are bled as the need arises.

Hospitals in Backward and Undeveloped Areas

The most difficult situation is encountered by hospitals in areas which are fairly densely populated with people who are unwilling to donate blood. In *mission hospitals,* particularly, the economics of transfusion require to be considered. Dextran and plasma are the supportive therapies of choice in the majority of emergency transfusions in these circumstances.

RESULTS AND DISCUSSION

We are able to analyse the figures from a series of 300 consecutive patients with multiple injury admitted to the casualty department of Groote Schuur Hospital over the last $2\frac{1}{2}$ years. The mortality has been 17%, which, considering the serious injuries these patients have sustained, is not surprising.

Many of the patients are moribund on admission, having sustained such grave injuries that only a very efficient ambulance service enables them to reach the hospital with a spark of life still left in them. They can be and are kept going with IPPR and external cardiac massage, but the condition of many is clearly hopeless from the start.

An analysis of the injuries of these 300 patients has shown that between them they have sustained about 700 injuries to various systems altogether, i.e. that each patient, on an average, has sustained injuries to almost 3 different body systems in these accidents (Table I). We have shown, and it is already well known, that of all the combinations of injuries, a head injury combined with a thoracic injury has the most serious significance, and carries a mortality of 32%.[1] This is not suprising. When the vital respiratory centre is damaged and the mechanics of respiration are impaired, the margin of survival is very small indeed. We

TABLE I. ANALYSIS OF INJURIES IN 300 CONSECUTIVE CASES (ALL AGES) AND IN 56 CONSECUTIVE CASES (CHILDREN 0 - 12 YEARS)

	All ages (300)		Children (56)	
	No.	%	No.	%
Head	200	67	47	84
Orthopaedic	203	68	41	73
Thoracic	94	31	7	12
Maxillo-facial	68	23	21	37
Abdominal	34	11	4	6
Genito-urinary	32	11	4	6
Spine	18	6	3	5
Deaths	51	17	7	12·5

are therefore paying particular attention to the chest injury in patients with multiple injuries admitted in the comatose state, and have devised a non-operative method of dealing with the stove-in chest associated with paradoxical breathing.[4] Of 15 patients with stove-in chest, 7 have died, but of our last 5 patients, in which the 'Limpet' played some part in the treatment, 4 have recovered.

In children under 12, we present a series of 56 cases, with the rather smaller mortality of 12·5% (Table I). Since the child almost never sustains a thoracic injury, this factor is virtually eliminated. An analysis of the causes of death in our cases shows very clearly where the main differences occur.

In a motor accident the child's smaller body tends to be carried forward by the onrush of the motor vehicle, 'rides the blow', and thus absorbs less energy at the moment of impact than the larger and heavier adult whose greater mass resists the physical forces and absorbs more

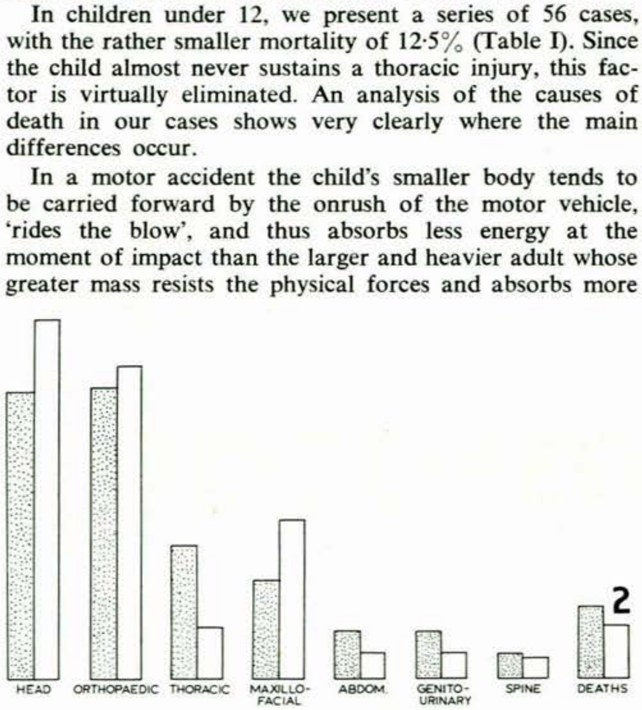

Fig. 2. Comparison of injuries of adults (dotted columns) and of children, in those suffering from multiple injuries.

of them. As a result, gross multiple injuries are relatively more severe in adults than in children, the increased absorption of energy probably accounting for the difference in the mortality rates (Fig. 2).

Of the 300 patients, no fewer than 66 (22%) had sustained a fracture of the femur. In the children's group, however, 25 out of the 56 had sustained the same injury, i.e. 37%. The larger proportion in children is probably due to the thigh of the child being more nearly opposite the point of impact. Not a few of these children had sustained fractures of both femora; this tends to confirm this theory. It is in the thoracic injuries that the major differences are observed. Of the 300 patients, 94 had sustained a thoracic injury (31%). Among the group of children, only 7 out of the 56, i.e. 12%, had sustained the same injury. This is because of the more flexible and elastic nature of the child's bony thorax, and it is for this reason that thoracic injuries have probably played a negligible part in the mortality among the children, whereas in the

TABLE II. PRIMARY CAUSE OF DEATH IN 51 CASES (ALL AGES)

Head injury	26
Gross multiple injury	17
Thoracic	5
Fat embolism	1
Pulmonary embolus	1
Inhaled vomitus	1
Total	51

adults they have played a considerable role (Tables II and III).

In an analysis of 1,300 head injuries it has been shown that the mortality rate is 9%.[5] This could well be considered as our basal figure, and it is towards the attainment of this figure that we should strive. As improvements in the treatment of acute head injuries become developed, it may be possible to bring down our mortality rate for multiple injuries nearer and nearer to this particular level.

TABLE III. PRIMARY CAUSE OF DEATH IN 7 CASES (CHILDREN 0 - 12 YEARS)

Head injury	4
Gross multiple injury	1
Thoracic	1
Inhaled vomitus	1
Total	7

Only 3 of the 300 patients developed *traumatic anuria,* with 1 death. All 3 patients had sustained fractures of the pelvis among their other injuries, but the fatal case had been transported for over 120 miles from the scene of the accident and had taken about 8 hours to reach the hospital. The patient arrived in a poor state with a very low blood pressure, and required extremely energetic resuscitation. In addition to his fractured pelvis, he presented with haematuria, loss of consciousness, and fractures of the humerus, clavicle, tibia, fibula and femur. Paralytic ileus developed some days later, and anuria occurred on the 5th or 6th day. He failed to respond to the treatment that had been successful in the other two patients, and died in spite of being placed on the artificial kidney. The other two patients recovered spontaneously on reducing the fluid intake, and within 24 hours their urinary output became satisfactory. They did not require to be put on the artificial kidney at all.

Fat embolism also occurred in 3 patients, 2 of whom survived and 1 died. All 3 were treated by the department of neurosurgery with intravenous alcohol.

Since the elimination of the effects of the thoracic injuries would affect our results profoundly, the mortality rate in children being only two-thirds that of adults, and since head injuries on their own have been shown to carry a mortality rate of 9%, we should be well advised to pay scrupulous attention, in cases of multiple injury, to the correction of the effects of the thoracic injury as early as possible.

Methods of doing this have been suggested,[4] and it is in this direction that we are at present moving.

SUMMARY

1. The organization of a multiple injury unit is described.

2. The functions of such an organization are outlined.

3. An analysis has been made of the injuries sustained by 300 consecutive patients (of all ages) with multiple injuries.

4. The mortality rate has been 17%.

5. In a group of 56 children (0 - 12 years) the mortality rate has been 12½%.

6. The differences in the 2 groups are pointed out, and the probable causes discussed.

7. It is suggested that failing newer and better methods of dealing with acute head injuries, the best hope for improving the results lies in paying more attention to the thoracic injuries.

I wish to thank Dr. J. G. Burger, Medical Superintendent of Groote Schuur Hospital, for permission to publish and to use the statistics obtained in his hospital, and Prof. J. H. Louw, Head of the Department of Surgery, University of Cape Town, for his interest in and support of this work.

Since a unit of this nature can only run as a result of the devoted services of the individual surgeons and specialists in charge of the patient, it is with particular pleasure that I pay tribute to the work of Messrs. W. M. Roberts, P. Willers, W. Silber, S. Cywes and R. Ger, the general surgeons who have been appointed to this unit, and to the representatives of the various specialist departments who have gladly come forward and assisted with their advice and work.

REFERENCES

1. Schrire, T. (1962): S. Afr. Med. J., **36**, 747.
2. Alexander, G. L. (1962): Lancet, **1**, 171.
3. Botha, M. C. *in* Schrire, T. ed. (1962): *Emergencies*. London: Staples.
4. Schrire, T. (1962): S. Afr. Med. J., **36**, 516.
5. Gonski, A. *in* Schrire, T. ed. (1962): *Op. cit.*[3]