THE PROBLEM OF WOUND SHOCK AND RESUSCITATION IN RELATION TO THE SURGERY OF REPAIR*

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Repair is defined as restoration to a sound state after injury. Before discussing the subject shock, I feel it is pertinent to consider briefly the problem of injuries in general and their impact on the welfare of the State.

The term injury is usually associated with physical violence, and includes both the local and general effects of trauma. Grant and Reeve[30] have coined a more appropriate term 'the illness of trauma' to cover the whole picture of the illness, local and general, from the moment of injury to complete recovery. This illness includes the following:

1. Local tissue damage, usually a wound or a burn. This alone may be responsible for considerable disablement and, if a vital organ such as the brain is involved, for the death of the patient.

2. The state of shock. This follows every injury of any magnitude and accounts for more than half of the fatalities in accidental injuries[4,29,30,39,44] and for fully three-quarters of the deaths in burns.[11,23]

3. Widespread reactive changes with profound endocrinal, metabolic and hematological disturbances. These processes, which have been called *the metabolic response to trauma*[33,45] are closely related to the degree and duration of shock and have an effect on recovery from shock, wound healing, susceptibility to infection, incidence of complications and the whole question of morbidity after injury.[7-10,19,26,45]

In civilian practice *accidents* are the principal cause of fatal and disabling injuries. In South Africa more than half a million people are treated every year for injuries of various sorts. About 40% of these occur in our homes, and the rest, including most of the serious injuries, are due to industrial and road accidents, both of which have shown an alarming increase in recent years.[34,41] Since 1950 our road injuries have increased by over 50% and industrial injuries by 30%.

The result is that in our European population accidents rank only after circulatory diseases and cancer as a major cause of death.[2-4] About 7,500 people of all races lose their lives every year as a result of accidents. Many of them are men in the prime of life; indeed accidents rank as killer number one in males up to the age of 40 years.

The loss of life, however, represents only a small proportion of the enormous loss in working time, production, wages and compensation due to the subsequent illness of trauma.[41] Approximately 10-15% of the injured suffer some degree of permanent physical disability and many more spend long periods in hospital and in receiving treatment. Industrial accidents alone are responsible for the loss of 20 million man-days, costing the country approximately 20 million pounds every year. This is equivalent to the permanent loss of 3,200 persons or 50,000 workers stopping work for a year, or a paid holiday for every worker for 11 days every year.

The magnitude of the problem is obvious and its solution a question of national importance. We as a profession can contribute a great deal towards prevention but our main function is to lessen mortality and morbidity by assisting Nature in restoring the body to a sound state after the ravages of trauma, i.e. by the surgery of repair.

WOUND SHOCK

Many words whose significance is well understood are difficult to define,[12] and Wound Shock is one of them. In trying to understand the true meaning of the term it is important to appreciate that *every injury of any magnitude is followed by shock*. It is, therefore, correct and proper to assume that shock is present in any person who has sustained a major injury. In practice, wound shock is usually interpreted as a state of circulatory collapse after injury.[38] 'All we know when we are called to the patient's side is that he has been injured, that he has collapsed and that he lies apathetic with an ashen grey face and cold clammy hands'.[38] The initial diagnosis is essentially clinical and, having made it, it is then our duty to ascertain the exact cause of the collapsed state and institute appropriate treatment.

The Mechanism of Shock. What are the causes of shock?

This is best understood by considering what factors are responsible for an adequate circulation. Briefly, these are the action and force of the heart, the volume and viscosity of the blood and the peripheral resistance of the arterioles. Interference with any one or more of these may produce a shock-like state.

For many years it has been known that the essential feature in traumatic shock is a reduction in the volume of blood in effective circulation. This may be due to actual loss of blood

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or plasma or to a sudden increase in the capacity of the vascular bed while the actual blood volume remains unchanged or only slightly diminished. Thanks to the research work of Grant and Reeve[30] during World War II, we now know that actual reduction of blood volume is of the greatest importance. In the case of wounds, vast quantities of *whole blood* are lost, not only to the exterior but also into the tissues.[7,17,29,30] The latter is of particular importance because it is not obvious; e.g., a man can bleed to death into the thigh muscle[5] around a fractured femur without any external wound.[38] In the case of burns there is loss of *plasma* to the exterior and also into the tissues and in extensive burns this may amount to many litres.[7,11] *Today, we realize that the most important single factor responsible for traumatic shock and early death following injury is loss of whole blood from wounds and plasma from burns.*[7] In general, a sudden loss of 25% of the blood volume endangers life, and recovery without transfusion is unlikely with losses of 40% and more.

A sudden increase in the capacity of the vascular bed with 'pooling' of appreciable quantities of blood is of secondary importance. It may be due to:

(*a*) Neurogenic Factors. These produce a transient increase in vascular capacity and a shock-like condition which responds rapidly to rest, relief of pain, warmth and other simple resuscitative measures.

(*b*) Vasogenic Factors. These may play a role in crush injuries and abdominal trauma with peritonitis and are responsible for an increase in the capacity of the vascular bed at a somewhat later stage[7,17] They cause serious depression of arteriolar tone which does not respond to transfusion alone, but may be helped by potent vasopressors such as nor-adrenaline.

The Assessment of the Shocked Patient

Oligaemic (hypovolemic, haematogenic) shock, *must be assumed to be present in all cases that have sustained a major injury*, particularly where there has been much blood loss or tissue damage. Subsequent assessment depends on the following:

1. *Clinical evaluation.* This is obviously of importance, but clinical features may be conspicuous by their absence in the early stages after the injury or in cases of so-called subclinical or latent shock.[7] Among the various clinical features, the blood pressure is probably the best 'index of the blood volume' but it is not entirely reliable.[29,30] In general, if the systolic pressure of a normal adult has dropped below 100 there has been a loss of more than 2½ pints of blood.[30] It must be remembered, however, that the blood pressure is often unaffected by smaller losses and in children and young adults there may even be a rise of blood pressure with losses as great as 20% to 30% of the blood volume.[38] Occasionally patients manifest periodic rises and falls in the blood pressure and the fact that the patient might have been hypertensive also clouds the issue.[12] However, as indicated in Table I, the height of the systolic pressure affords some indication of the blood volume and the figure of 100 systolic can be taken as the critical level below which urgent treatment becomes obligatory. It is obviously better to correlate the blood pressure with other circulatory signs and clinical features which result from the injury. In this way various combinations of signs may be grouped together to form distinct patterns.[18] These, with their interpretations are summarized in Table II.

SHOCK – CLINICAL PATTERNS

CAUSE	SYSTOLIC B.P. (mm. Hg.)	PULSE RATE	SKIN	BLOOD VOLUME (per cent of normal)	PATTERN
A. External fluid loss (blood or plasma)	> 100	< 100	Warm extremities, good colour	> 80	Nearly normal
	< 100	> 100	Cold extremities, pale face	< 70	Cold hypotension
	< 70	Impalpable	Very cold and pale extremities and face	< 60	Extreme cold hypotension
	> 100	> 100	Cold extremities, pale face	70–80	Cold tachycardia
B. Neurogenic	> 140	< 100	Warm or cold extremities, good or pale colour	Adults > 80 Children < 70	Post-traumatic hypertension
	< 100	< 70	Cold extremities, pale face	Normal or almost normal	Vasovagal reaction 1

THE BLOOD PRESSURE AND BLOOD VOLUME

BLOOD PRESSURE	BLOOD VOLUME
> 140	> 80%
100 to 140	70 to 80%
70 to 100	60 to 70%
< 70	< 60% 2

2. *Evaluation from the extent of the local injury.* More accurate assessment can be made from the extent of the local injury, which affords 'an index of the blood loss'[7-9,13,19,29,30] This applies to both wounds and burns. In general, there is a close correlation between the local injury and the degree of shock—the larger the injury, the greater the blood loss and hence the more severe the reduction in blood volume.[7,30] In this connection it is important to repeat that fluid, blood or plasma, may be lost into the tissues without external loss and this loss must obviously be taken into account in assessing the degree of shock.

When the blood loss is entirely external, the amount of blood that has been absorbed by the clothes, dressings etc. affords a rough idea of the losses. In surgical operations, for instance, blood loss is estimated by the amount of blood that has been absorbed by the swabs and towels that have been used. We make use of this in certain circumstances by weighing the swabs before and after use and so obtaining a fairly accurate assessment of the loss. With experience one can learn to assess how much blood a swab contains by noting the amount of staining that is present.

In the case of open accidental wounds the size of the wound gives a fairly accurate index of blood loss. Using the hand as the unit of volume, it is in this way possible to classify wounds in terms of severity of blood loss.[30] The volume of an open hand or closed fist amounts to half a litre. Therefore a wound the size of an open hand in the case of superficial wounds or of a closed fist in the case of deep and lacerated wounds will be associated with the loss of about half a litre of blood. In general, wounds the size of one hand are not accompanied by any recognisable signs of shock, those of 2 hands are associated with moderate shock, those of 3 with severe shock, and those of 4 with a profound degree of shock.[38]

With closed injuries of the extremities an estimate of the amount of tissue damage can be made from the degree of

soft-tissue swelling and also from the situation and number of fractures that are present.[7,9,38,48] With experience it is possible to estimate the degree of swelling in terms of hand volumes and to classify the injury accordingly. Single fractures are associated with a blood loss of up to 1 litre, although a fractured femur may be accompanied by a loss of as much as 2 litres. With two fractures the blood loss amounts to 1-2 litres and with three or more fractures, more than 2 litres of blood are lost.[48]

With burns, the extent of body surface involved is equally important in assessing the degree of shock. This extent may be judged from Berkow's rule of nines. In adults, burns of less than 10% are associated with only slight shock, those of 10-15% with moderate shock, and those of 15% and over with severe shock.[11]

With penetrating wounds of the abdomen or chest the extent of the injury cannot be gauged by external examination and we have to rely on other signs.[7] In head injuries blood loss is usually small. This is important, because if a patient who has sustained a head injury is severely shocked, it is essential that other lesions should be sought for.

3. *Evaluation from changes in the composition of blood.* This is done by estimating the haemoglobin or preferably the haematocrit reading of a sample of blood. It must be remembered, however, that changes in haemoglobin or haematocrit concentration are often delayed for several hours and therefore may not be helpful in the early diagnosis of shock. Indeed, with wounds the readings are so fallacious that no reliance can be placed upon them.[30] With burns, on the other hand, the degree of haemo-concentration is of some value after a few hours and is most helpful in assessing the subsequent progress of the patient and the effect of treatment.

TREATMENT

In the treatment of wound shock *time is the most important factor*.[7,48] With wounds, approximately half the total blood loss that will occur takes place in the first 3 hours after wounding and massive quantities may be lost in a matter of minutes with sudden death if a major vessel is cleanly severed.[9] With burns, one-third of the total plasma that will be lost, is lost in the first 6-8 hours after burning, and in extensive burns as much as 20% of the blood volume may be lost in 15 minutes.[47] Delay is chiefly responsible for so-called irreversible shock, and injuries therefore present an urgency which seldom exists in other surgical conditions.

Blood Transfusion and Shock

The prime need in the treatment of wound shock is transfusion, which must be early, energetic and plentiful. Transfusion takes precedence over any local treatment except temporary splinting of fractures, covering of exposed wounds and arresting of violent haemorrhage. All other measures must be completely subordinated to transfusion.

As far as possible, blood loss from wounds, open or closed, must be replaced with cross-matched whole blood of the same group. In emergencies, low-titre group-O blood may be used, and if blood is not available plasma or serum should be transfused.[1,5,7,10,46,48] Where the blood loss does not exceed 1 litre, plasma alone may suffice.[35] When larger quantities of blood are lost then not more plasma than 1 part for every 2-3 parts of whole blood should be used. Plasma substitutes are, on the whole, unsatisfactory for the treatment of shock which is due to loss of whole blood.[38] They can restore blood volume temporarily but have many disadvantages; for instance, they interfere with compatibility, they do not carry oxygen, they do not provide any energy, they interfere with the clotting mechanism and their administration may be associated with severe reactions. However, if there is a desperate emergency and no blood or plasma can be obtained, plasma savers may have to be given, because desperate situations demand desperate remedies. In such cases it would be unwise to give more than 1 litre of the substitute.

Plasma loss from burns or crushing injuries must be corrected by transfusion of plasma or plasma substitutes. Plasma is the ideal fluid to be given. Serum is almost as good. When neither plasma nor serum are available, plasma substitutes may be given with a fair degree of safety and, in extensive burns, as much as 2-3 litres may be administered.[48]

As already mentioned, transfusion if it is to be effective must be early, energetic and plentiful.

Immediate transfusion is necessary in cases with a marked degree of circulatory failure if life is to be saved, and it is unwise to delay transfusion in any case with a blood pressure below 100 mm. systolic that does not recover promptly in the head-down position.[29,30] Any patient who has lost more than 1-1½ litres of blood must be transfused, especially if he has to be submitted to surgery or if further bleeding is likely to occur.[7]

Energetic transfusion is necessary in all cases with extensive injuries and a blood pressure below 100 mm. systolic. During World War II we often used to run in the first litre in 5-15 minutes and subsequent litres in 20-30 minutes. If necessary, 2 or more intravenous drips may be put up and pressure apparatus used. In this connection I would like to mention that intra-arterial transfusion has not much to commend it and is fraught with so many dangers that it is best avoided.

Plentiful amounts are required, particularly where there is continued loss of blood or plasma. The ultimate object is near-complete restoration of blood volume to render the patient fit for operation and to lessen the 'illness of trauma' and the incidence of complications. The immediate object is to restore the blood pressure to at least 100 mm. systolic.[30] Once this has been achieved, approximately 2 more pints of transfusion fluid will be required, even if there is no further loss. We frequently transfused amounts up to 10 pints during World War II and during the Korean War, 15 - 30 pints were often given to the critically wounded within the first 24 hours of wounding.[40] Indeed, in Korea massive transfusions up to 30 or 50 pints were sometimes given.[3] Incidentally, when such massive quantities of citrated blood are used there is a grave danger of citrate poisoning, which may be prevented by injecting calcium gluconate.

Ancillary Measures

These include relief of pain, proper posturing, warmth, the administration of fluids by mouth, the use of pressor drugs and, on rare occasions, the use of cortisone. *Relief of pain* is the most important. Morphine is the most useful analgesic but must be used with caution. It should be given intravenously since in the state of shock it is absorbed only very slowly from the subcutaneous tissues. *Elevation of the feet* is useful for assisting the cerebral circulation and may be all that is required to counteract the collapse of neurogenic shock. *Warmth* may be beneficial but excessive

heat which causes vasodilatation must be avoided at all costs. *Oral fluids* in the form of warm tea are of doubtful value and must definitely not be given to patients with abdominal injuries nor to those with a tendency to vomit nor where early operative intervention is contemplated. *Vaso-pressor drugs* are best avoided. In oligemic shock they may do harm and in neurogenic shock they are unnecessary. *Nor-adrenaline* is of value in cases with severe infection or extensive crushing of tissue where vasogenic factors play a role in the picture of shock[17] but this is seldom seen soon after an injury. *Cortisone* has no place in the treatment of traumatic shock *per se* and is indicated only in patients who have been receiving steroid therapy for some pre-existing condition. When, however, the patient manifests the so-called hypo-adrenal response to trauma, the administration of cortisone may be life-saving.

Operation

Operative intervention must be regarded in some cases as an essential part of the treatment of shock.[17,30] When there is severe and rapid blood loss from a divided major vessel, immediate intervention to arrest the haemorrhage is obviously a necessity because shock will not be controlled until the haemorrhage has been checked. Abdominal injuries, for instance, respond poorly to resuscitation until the source of bleeding has been found and controlled. Similarly, some patients with sucking chest wounds or very large limb injuries may have to be operated on at once if their lives are to be saved, and operation and transfusion for resuscitation may have to be carried out simultaneously.[7]

In general, however, the patient should be operated upon as soon as, but not before, he has been adequately resuscitated. Continual transfusion during the operation can enable even those with great blood loss to survive the operation with safety.

Controversial measures

In concluding my remarks on the treatment of wound shock, there are some controversial measures which may be mentioned:

Firstly, the contribution of bacterial toxins to the circulatory failure of oligemic shock. Fine and his associates in 1954 demonstrated bacteria in the blood stream and the tissues of animals subjected to haemorrhagic shock and showed that both bacteraemia and some of the clinical and haemodynamic features of the condition could be prevented by preliminary treatment with broad-spectrum antibiotics.[17] In clinical practice this bacterial factor is probably of very small significance, particularly where the patient has been resuscitated early in the course of shock. However, when hypotension is prolonged or when severe muscle damage with infection is present, a shock-like state may persist until the infection is brought under control or the damaged muscle excised.

Secondly, the use of drugs to protect the patient from shock. In recent years chlorpromazine has been shown to protect animals from the effects of graded haemorrhage and this drug has therefore been suggested for the treatment of patients suffering from wound shock. At present, however, the clinical use of such techniques as the 'lytic cocktail' does not appear to have any advantage over more conventional methods of prevention and treatment of shock.[7,17]

And lastly, there is the question of cooling. The rationale of this method of treatment is to reduce harmful excessive reactions on the part of the injured patient. At this stage it is fair to say that there is not enough evidence to warrant the use of hibernation in the treatment of severe injuries, with the possible exception of certain head injuries.[17]

THE MANAGEMENT OF SHOCK IN RELATION TO ACCIDENTAL INJURIES IN SOUTH AFRICA

At the beginning of this address, I indicated to you the great wastage of man power in South Africa caused by accidental injuries, particularly serious injuries occurring in our industries and on our roads. It was also pointed out that shock and the so-called illness of trauma which follows on shock were responsible for the majority of fatal injuries and for a great deal of subsequent disablement and loss of working time.

Then I have made an attempt to indicate what our modern concept of shock is; viz. that it is primarily due to blood loss and that the proper treatment of shock is, in the first place, replacement of the blood that has been lost. Our experiences have shown that blood replacement plays a vital part, not only in the treatment and prevention of shock, but also in allowing more adequate primary surgery and in influencing the whole pattern of the illness which follows on the injury.[7] In this way proper treatment not only saves lives but also shortens the convalescence which follows an injury and so saves man-power.

The recent wars have shown that if modern facilities for the treatment of the wounded can be made immediately available to the patient, the death rate can be considerably lessened.[20,45] Thus there has been a steady and constant improvement in the salvage figures from less than 40% saved in World War I to 97% saved in the recent Korean War.[18,19,44]

The lessons learnt during these wars have proved a tremendous boon to mankind. Their application to civilian injuries since the war has enabled us to save many more lives than before and to reduce the morbidity of accidental injuries considerably. Thus, in Birmingham, where a first-rate accident service has been established, the results of the treatment of civilian casualties are even better than those obtained during the Korean campaign.[22,27] Today it is generally accepted that if the patient can only be brought alive to a properly equipped hospital, his life will probably be saved.[25-27] This was well illustrated by a recent train disaster in the Western Cape.[18] Two trains carrying office workers home after the day's work came into a collison, in which 93 were injured. Of these, 18 died on the spot while 75 were taken to 2 neighbouring hospitals, one our University's teaching hospital and the other a suburban hospital. Although 20 of the patients admitted were seriously injured, with multiple fractures, etc. there were no further fatalities. One cannot do better than save 100% of the injured and so far as salvage of life is concerned, it would appear that our hospitals are indeed coming close to the ideal.[18]

Let us now consider briefly what were the main lessons learnt from recent wars and how we can apply these lessons to civilian injuries.

1. The *first* lesson to be learned from wartime experience comes from the forward field surgical units or field hospitals, which were placed close to the front line and within easy reach of war casualties. In these forward surgical units unhurried and perfectly organized resuscitation was regarded

as the essential step in the treatment of the injured and all facilities for the treatment of shock were immediately available.[15,16,27]

The counterpart of this in civilian practice is to be found in the establishment of accident hospitals and departments. As already mentioned, such an accident hospital organization has been established in Birmingham and has proved to be a great success. I should like to pay tribute to Mr. Gissane, who is with us today, for the most valuable work that he has done as Director of this hospital. As he points out, such a hospital must adopt a completely new tempo and quality of hospital organisation.[26] It should provide a round-the-clock service with skilled surgical teams, resuscitation units, and all necessary ancillaries. It consists essentially of a central accident hospital with full-time consultant staff linked peripherally with the casualty departments of neighbouring hospitals and centrally with a general hospital, preferably a teaching hospital, which has modern orthopaedic, plastic and other facilities.[20,26] To be really efficient the accident hospital should be not more than 70 miles, preferably only 40 miles, from any serious accident, and such a service is justified only in densely populated areas, i.e. in cities with a population of approximately 200,000 and an immediate neighbourhood population of about 2,000,000.[20,27] From the economic point of view, the hospital should treat *not* less than 25,000 patients per year.

Now let us consider the situation in South Africa and see what can be done about the establishment of such an accident service. On looking at a map of our country, it immediately becomes obvious that it is difficult to fulfil the requirements for an efficient service because of our vast distances and sparse population. We have only 6 cities with populations of 200,000 or more and only 5 with populations between 100,000 and 200,000.[6,34]

The Witwatersrand area is the only area in which the population is sufficiently dense to warrant a proper accident hospital. In this area we have Johannesburg with its population of 1 million and a population of about 2½ million in the surrounding area within a radius of 40 miles. In this area we also have Germiston with a population of over 200,000 and Pretoria with a population of a third of a million. Furthermore it is a great industrial centre and more than a quarter of all our industrial accidents occur here. The stage is therefore set for the establishment of at least one and probably two proper accident hospitals based on the pattern of the Birmingham Accident Hospital.

The next big centre to be considered is Cape Town. Here the city itself has a population of almost three quarters of a million and the hospitals in the area drain a population of over a million. Although an accident hospital as such will not prove an economic proposition, the establishment of a big accident department attached to the teaching hospital of the University of Cape Town at Groote Schuur now becomes an urgent necessity.

Durban has a population of over half a million and drains an area with a very large Native population. Here a large accident department attached to the teaching hospital is also an obvious necessity. Port Elizabeth—though its population is still small—about a quarter of a million—is a rapidly developing industrial centre and the establishment of an accident department connected with one of the larger hospitals would even at this stage seem highly desirable. Finally, there is Bloemfontein with a population of only just over 100,000 but centrally situated. An accident department to drain the central part of this large country of ours could profitably be established there.

The rest of our country is too sparsely populated to warrant an accident service on the above scale and we must therefore rather aim at improvement and elaboration of the existing facilities. The improvements should include the following:

(*a*) Improved design and equipment of all casualty departments, with provision of facilities for the treatment of shock on the spot.

(*b*) More attractive salaries for our casualty officers which would draw men of greater experience and with a surgical leaning.

(*c*) The establishment of proper orthopaedic and plastic departments, a burns unit, and facilities for rehabilitation, in all our larger hospitals.

2. The *second* lesson to be learnt from the wars concerns the immediate availability of blood and plasma for resuscitation of casualties on the spot where they have sustained their injuries. It has already been pointed out that delay in commencing resuscitation is the greatest enemy to life. The best surgical skill and hospital equipment in the world are of no use if the race with time is lost.[7] Our people in South Africa are scattered over an enormous territory with no abundance of fully equipped hospitals. There is obviously a great need for resuscitative centres and facilities at various vantage points in the country.

During World War II in the Western Desert, where the huge distances and rapidity of movement created great difficulties in supplies and evacuation, the situation was somewhat similar to that which obtains in South Africa. In the war the responsibility for early resuscitation often rested heavily on the battalion medical officer. The immediate availability of plasma or blood at regimental aid-posts and the efficiency of the battalion M.O., proved to be vital factors in the salvage of lives.[32] Thanks to the excellent organization of the 8th Army Transfusion Service a standard was achieved whereby not only plasma but also whole blood was provided to advanced dressing stations and even to regimental aid posts.[35,36] In desperate cases, transfusion was commenced on the battlefield and continued in the ambulances during evacuation.

In considering fatal accidents in South Africa, it immediately becomes obvious that most of the deaths on our roads and in our railway, flying, mountaineering and recreational accidents occur during the period immediately after the injury and before admission to hospital. In the railway disaster referred to before, 20% of the injured succumbed at the site of the accident and of these more than half died of shock. We might well ask ourselves whether those persons who died of shock might not have been saved had proper facilities been immediately available. The recent wars have shown that future developments in salvage of life will depend not so much on perfection of the already near-perfect hospital treatment but on attention to the patient on the spot.[32] In spite of the tremendous advances in the hospital management of civilian casualties, our profession has apparently not learnt this lesson and has consequently failed to put its energies into the problem of improving the care of the wounded during the earliest phase.[42]

The responsibility rests squarely on the shoulders of the general practitioner, who is usually the first doctor to reach the site of an accident. He should be thoroughly proficient

in the recognition of shock, the assessment of blood loss, and the early care of the wounded. Many a battalion medical officer transfused his patients in the heat of battle. There is no reason why the general practitioner cannot do the same at the scene of an accident. Dried plasma and plasma substitutes, which can be kept indefinitely and transported with ease are readily procurable and have proved their worth as life-saving measures. *Every doctor should have a supply of these, together with suitable giving sets, in his car as well as in his surgery.*

While very early transfusion of plasma will no doubt save many lives, it has already been pointed out that adequate treatment of wound shock demands whole blood in plentiful amounts. Thanks to the magnificient services of our blood transfusion organizations with their headquarters at Cape Town, Port Elizabeth, East London, Johannesburg and Durban, blood can now be provided in most parts of the Union.[47] However, the areas served are necessarily very large. The Western Province service, for instance, covers half the Cape Province. Here the difficulty of providing blood at short notice has been partly overcome by the establishment of branches with banks or donor panels in various Western Province towns.[47] Nevertheless, there are many areas where blood cannot be kept or obtained on the spot. In such cases, blood has to be transported from headquarters or from the nearest branch. This takes time and is burdensome and costly on account of the need to maintain the blood at a low temperature. The establishment of more donor panels in our country towns is an obvious step in rendering blood readily available and the ideal would be to have every town and village in South Africa provided with either a branch bank or a donor panel.

Other problems which arise in connection with the provision of blood on the spot concern the inherent risks attendant upon blood transfusion, and the need for grouping and compatibility tests. In emergencies low-titre group-O blood, which was used extensively during the wars, has to suffice, but in many instances it will probably still be most practical to treat the patient on the spot by the infusion of plasma or plasma substitute. There is no reason why dried plasma and plasma substitute should not be made immediately available even in the remotest parts of our country. Not only should every doctor have a supply at hand but plasma should be kept in every ambulance and train, in all large factories, at key points along the national roads, aerodromes, racetracks, mountain-club huts, fire stations and so on. This would obviously involve a tremendous organization, but it is a matter of national importance and deserves the attention of the State. Blood and plasma were made readily available during the wars and there is no reason why in a peace time organization a similar ideal cannot be achieved.

3. The *third* lesson to be learnt from the wars concerns the speedy evacuation of casualties to a hospital with continuation of transfusion, during transport if necessary. In World War II, ambulances with facilities for in-ambulance transfusion were always readily available and standing by to convey casualties to the nearest advanced surgical unit. The Korean war proved the value of helicopter evacuation, which made it possible to get all casualties back to a surgical unit within an hour of having been wounded.[3,26]

The safe transport of seriously injured patients to a hospital can only be effected by the provision of a mobile surgical unit, with staff who can continue the resuscitation during the journey. In Birmingham such a unit, with special stretchers and splints for comfortable travelling and all facilities for blood transfusion etc., has proved its value as a life-saving measure.[20,27] In Cape Town, we have now had 4 years' experience of a somewhat similar unit for obstetrical emergencies.[31] This *flying squad*, which was established from the University of Cape Town Students Hospital Rag Fund, operates from the hospitals which are attached to our medical faculty. It covers the whole of the Cape Peninsula and surrounding areas and can be called upon by any doctor or midwife faced with an obstetrical emergency. Usually the squad is on its way within 15 minutes of the call having been received. Many calls have come from our worst slums and in several cases, especially on the Cape Flats, it was necessary to carry the equipment, which always included a supply of blood, over a mile or more of sand and bush because the ambulance could progress no further. In some cases, it was necessary to transport the patient back over the same route, this time with intravenous drip in position. In the majority of cases the squad was faced on arrival with severely shocked and exsanguinated patients requiring immediate and energetic transfusion. The results of this work have been illuminating. In the first 200 calls there were only 6 deaths; 3 patients were dead when the squad arrived and the remaining 3 succumbed within 15 minutes of the arrival of the squad. The squad has more than justified its existence and it is high time for the service to be taken over by our Provincial Administration and extended to other branches of medicine. If this were to be done, properly equipped mobile surgical units built on the Birmingham pattern should be provided and attached to our larger hospitals, while all other ambulance units should carry blood, which can now be provided in convenient plastic containers suited for in-ambulance transfusion.

Furthermore, in our country with its vast distances, the possibility of air transport should be given serious consideration and the establishment of a helicopter ambulance service should receive our earnest attention. Helicopters have been tested not only in the wars but in other countries also in peace time and have already saved thousands of lives. Our country would be well-advised to try to improve upon the Australian 'flying doctor' service which has been using conventional aircraft, by setting up a similar organization equipped with helicopters.

Before concluding my remarks on the problem of resuscitation on the spot may I direct your attention to a few interesting speculations?

(*a*) Should specially selected laymen be trained in the discipline of blood transfusion so that the administration of plasma could become as routine as, for example, the injection of morphine in the treatment of the seriously injured?

(*b*) To what extent could bodies such as the National Occupational Safety Association and National Road Safety Organisation contribute to the immediate treatment of the injured?

(*c*) Could the services of flying, racing, mountaineering and other clubs be utilized to facilitate early transfusion and speedy evacuation?

(*d*) Should the Blood Transfusion Services enter the field of resuscitation more actively?

(*e*) Should the State supply standardized transfusion equipment, render blood and dried plasma readily available, and provide road and air transport for the injured?

As I see it, the problem hinges largely on the following two questions:

Firstly, what deaths are avoidable if, in the ideal state of organization, resuscitation can always be offered on the spot? Secondly, are the costs involved in providing the ideal state, justified?

The answers depend largely on the value we place on premature disablement and loss of life in terms of national economy. From the humanitarian point of view no effort is wasted and no expense too great; for, apart from the economic consequences, a serious accident is a major tragedy in the life and household of a person with a fit and healthy body.

SUMMARY

The problem of shock and resuscitation is considered in relation to accidental injuries in South Africa. Road and industrial accidents, which are increasing at an alarming rate, are generally responsible for the serious and fatal injuries which account for 7,500 deaths per annum and a great deal of ill-health and loss of man-power.

It is pointed out that every injury of any magnitude is followed by wound shock and that the essential feature is a reduction in the circulating blood volume due to loss of blood or plasma.

The diagnosis of shock is briefly considered in terms of clinical features, extent of the local injury, and changes in the composition of the blood. The close correlation between the size of the local injury and the degree of shock is emphasized.

It is pointed out that the prime need in treatment is transfusion, which must be early, energetic and plentiful, and time is the all-important factor in serious injuries. In practice this need may be met by:

1. Establishment of a comprehensive accident service with central accident hospitals on the Birmingham plan. This requires density of population and in South Africa is practicable probably on the Witwatersrand only. In Cape Town, Durban, Port Elizabeth and Bloemfontein, accident departments attached to general hospitals should be provided.

2. Improvement of facilities in the casualty departments of all our general hospitals.

3. Provision of blood, plasma and plasma substitutes 'on the spot'. In this connection the following suggestions merit consideration:

(*a*) Availability of dried plasma and plasma substitutes in all doctors' cars and surgeries, in every ambulance, train and factory, and at various points where accidents might occur.

(*b*) Establishment of branch blood banks or donor panels in all our country towns and villages.

(*c*) Provision of mobile surgical units with 'flying squads' and introduction of air ambulance services.

The possibilities of utilizing the services of specially trained laymen, the Blood Transfusion Services, and various organizations and clubs, are mentioned and it is urged that no effort should be spared in providing prompt treatment to all casualties.

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REFERENCES

1. Allen, G. and Stemmer, F. A. (1955): Surg. Clin. N. Amer., 35, 1597.
2. Annual Report of the Department of Health (1954): Pretoria: Government Printer.
3. Artz, C. P., Howard, J. M., Sako, Y., Bronwell, A. W. and Prentice, T. C. (1955): Ann. Surg., 141, 285.
4. Blackburn, G. and Rob, C. G. (1945): Brit. J. Surg., 33, 46.
5. Bull, J. P. (1956): Brit. J. Clin. Pract., 10, 743.
6. Bureau of Census and Statistics (1957): Personal Communication.
7. Clarke, A. R. (1957): Brit. Med. J., 2, 721.
8. Clarke, A. R., Topley, E. and Flear, C. T. G. (1955): Lancet, 1, 629.
9. Clarke, A. R. and Fisher, M. R. (1956): Brit. J. Clin. Pract., 10, 746.
10. Clarke, A. R. (1956): *Ibid.*, 10, 777.
11. Colebrook, L. (1949): Proc. Roy. Soc. Med., 42, 209.
12. Cope, V. L. (1944): Brit. Med. J., 2, 35.
13. Davies, J. W. L. (1956): Brit. J. Clin. Pract., 10, 785.
14. Derby, A. C. (1957): Canad. Med. Assoc. J., 76, 371.
15. Dick, D. S. (1944): Lancet, 2, 170.
16. Drye, J. C. (1956): Surg. Clin. N. Amer., 36, 1209.
17. Dudley, H. A. F. (1957): J. Roy. Col. Surg. Edinb., 2, 202.
18. Editorial (1957): S. Afr. Med. J., 31, 468.
19. Flear, C. T. G. (1956): Brit. J. Clin. Pract., 10, 787.
20. Gissane, W. (1948): *Ibid.*, 5, 106.
21. *Idem.*, (1949): Proc. Roy. Soc. Med., 42, 207.
22. *Idem.*, (1950): Brit. J. Plast. Surg., 2, 224.
23. Gissane, W. and Jackson, D. (1952): Ann. Roy. Coll. Surg. Eng., 10, 357.
24. Gissane, W. (1953): Proc. Roy. Soc. Med., 46, 453.
25. *Idem.*, (1954): Practitioner, 172, 620.
26. *Idem.*, (1955): *Ibid.*, 175, 450.
27. *Idem.*, (1956): Brit. J. Clin. Pract., 10, 739.
28. Gold, A. (1956): Canad. Med. Assoc. J., 54, 477.
29. Grant, P. T. and Reeve, E. B. (1950): in British Surgical Practice, vol. 7, p. 396., London: Butterworth.
30. *Idem.*, (1951): Spec. Rep. Ser. Med. Res. Coun. (Lond.) No. 277.
31. Hagberg, C. J. (1956): S. Afr. Med. J., 30, 1140.
32. Lindsey, D. (1956): Surg. Clin. N. Amer., 36, 1191.
33. Moore F. D. and Ball, M. R. (1951): *The Metabolic Response to Surgery.* Springfield, USA: C. C. Thomas.
34. Official Year Book of the Union of South Africa No. 28 (1954-1935). Pretoria: Government Printer.
35. Ogilvie, H. (1945): Edit b Med. J., 52, 193.
36. *Idem.*, (1945): Lancet, 1, 757.
37. *Idem.*, (1954): Brit. Med. J., 2, 1435.
38. *Idem.*, (1955): *Ibid.*, 1, 159.
39. Porritt, A. E. (1946): Brit. J. Surg., 33, 267.
40. Prentice, T. C., Olney, J. M. Artz, C. P. and Howard, J. M. (1954): Surg., Gynec. Obstet., 99, 542.
41. Rehabilitation in South Africa (1957): Year book of the Union of South Africa, 1, 49. Pretoria: Government Printer.
42. Royster, H. P. (1956): Surg. Clin. N. Amer., 36, 1173.
43. Snyder, C. D. (1956): *Ibid.*, 36, 1171.
44. Stammers, F. A. R. (1948): Brit. J. Surg., 274 (War Surgery Suppl. No. 2. Wounds of the Extremities).
45. Topley, E. and Fisher, M. R. (1956): Brit. J. Clin. Pract., 10, 770.
46. Tovey, G. H. and Maycock, W. D. 'A. (1954): in Suppl. to British Surgical Practice, Surgical Progress, p. 194. London: Butterworth.
47. Rudman, E. R. (1957): Personal communication.
48. Wound Shock Working Party (1957): Med. Res. Com. (Lond.) Mem. No. 34.