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THE DIAGNOSIS AND TREATMENT OF MAJOR INJURIES*

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The modern treatment of major and multiple injuries dates from the development of blood banks and the growing use of stored blood since the late 'thirties. During the past ten years at the Birmingham Accident Hospital we have shown that blood is lost to the same extent in civilian injuries as in war wounds, and these injuries often require large, sometimes very large, transfusions of blood during the resuscitation phase (Clarke and Fisher, 1956; Clarke, 1958).

Clinical observations reinforced by studies of the blood volume have helped us to estimate blood loss and transfusion needs, so that, from careful and repeated examination of the nature and extent of the local injuries in association with systemic signs of what is still loosely called shock, we can now often assess the amount of bleeding that has taken place and the probable further bleeding. We suggest that no fit young or middle-aged person should die from haemorrhage or shock following injury confined to the limbs, provided he reaches hospital alive within a short time of injury. This is in marked contrast to the expectation of survival for single severe open fractures or double closed fractures of the femur a couple of decades ago. The same applies to relatively straightforward trunk injuries and to many multiple injuries.

But even these moderate but potentially lethal lesions may urgently need active treatment as soon as the patient arrives in hospital. We are only beginning to realize what is required for the treatment of severe multiple injuries, especially when haemorrhage is complicated by cerebral damage or a major chest injury.

We are no longer concerned with "shock" in the abstract, nor are we helped by thinking in terms of irreversible shock. We are beginning to tackle the particular effects of a given set of injuries in a particular patient. The first effects concern the circulation, sometimes the respiratory apparatus. The first need is often an appreciation of the role of haemorrhage. Once bleeding and its effects can be controlled and an airway established we are in a position to diagnose and treat individual lesions and to prevent their complications and interacting systemic sequelae. But diagnosis itself can be difficult.

The complexity of some of these problems and the nature of the therapeutic advances that can be applied to them are illustrated by some of our successes. The nature and extent of the problem can be seen more clearly against the background of our failures.

From 1947 to 1956, 845 deaths from injury, excluding burns, occurred in the Birmingham Accident Hospital (Table I). In the younger age groups the males predominated, but there were twice as many women as men over 75. From 1947 to 1950 the annual number of deaths rose, even in relation to the number of

TABLE I.—B.A.H. Deaths by Age and Sex (1947-56)

	0-14	15-34	35-54	55-74	75-	Total
Male	32	99	103	141	99	474
Female	12	7	28	121	203	371
Total	44	106	131	262	302	845

admissions, but percentages can be misleading. In fact, we were receiving a larger proportion of major injuries. From 1952 to 1956 the deaths were 0.2% of new patients, 1.4% of admissions, and 1.3% of in-patient operations. Road accidents accounted for 370, domestic and other falls for 346, industrial injuries for 64, and sports injury for only 1.

Can such local figures be usefully related to national statistics? The total deaths from injury for England and Wales by age groups for 1955 (Registrar-General, 1956) show a double peak: in the 'twenties and again for the elderly (Fig. 1). The females show the later peak alone; the males show a minor peak for the aged, another for the youngsters, and a plateau between. The male pattern (Fig. 2) is largely accounted for by head injuries, trunk injuries, and fractured femurs in the elderly. In the females (Fig. 3) the peaks for head injuries and femurs coincide. The age distribution is clearly related to causative factors—motor vehicles for the men and falls in the elderly females (Fig. 4), the preponderance of the latter being due to the fact that women live longer rather than to their falling more easily.

There was a discrepancy between the national age distribution pattern and an average of the Accident Hospital deaths for 1951-5. This was due to the fact that we do not get all the accidents in the city, while some patients never reach hospital at all. The 1955 figures from the Birmingham coroner (Table II) showed

TABLE II.—All Birmingham Accident Deaths (1955)

	B.A.H.	Other Hospitals	Dead on Arrival
Shock, haemorrhage, multiple injuries	21	17	29
Head and brain injury	25	33	30
Pulmonary embolus, fractured femur, toxæmia, hypostatic pneumonia	53	82	9
Total	99	132	68

*Read to the Section of Accident Surgery at the Annual Meeting of the British Medical Association, Birmingham, 1958.

that two-thirds of those with major injuries reached hospital alive, while older people with lesser but fatal injuries rarely die before reaching hospital.

This does not help us to see if our treatment is doing any good, and, in any case, the frequency and diversity of multiple injuries make the study of case mortality impossible or almost useless. Nevertheless, consideration of such figures suggests that we can usefully divide the deaths into three main groups for further analysis (Table III): (1) fractures of the femur, with a 3:1 ratio

TABLE III

	Male	Female
Fractures of femur	70	210
Other injuries, without brain damage	163	74
Head injuries	242	86

of women to men; (2) the remaining injuries, uncomplicated by brain damage; and (3) head injuries. Men predominate in the latter two groups, which can be usefully subdivided into three age groups—children under 15, those aged 15–54, and those of 55 and over.

Fractures of Femur

Deaths after fracture of the femur are the only section in which there is any uniform extent of injury, but even

this is vitiated by variation in the state of health of the elderly. Mortality is related to age. During the past eight years at the Birmingham Accident Hospital, hospital mortality for fractures of the neck of the femur was 14.5% of 1,542 patients—174 of the deaths occurred in patients over the age of 75. These injuries constitute a major risk which will increase with the rise in average age of the community.

There were 12 deaths in patients under 65: 2 from pulmonary embolism, the rest from coexistent medical illness. Most of the patients over 65 who died were already ill, often bedridden, before injury. The most important cause of unexpected death is pulmonary embolism, and we are engaged with our pathologists in a study of the preventive role of modern anticoagulants.

These patients do not die in the first few hours, but they do require early diagnosis, assessment, and treatment. Delay leads to decubitus ulcers, broncho-pneumonia, and a host of other complications. Careful but not leisurely preparation for surgery is indicated in most hip fractures in the elderly. The anaemic and the major trochanteric fractures *always*, the median fractures treated surgically *often*, warrant transfusion. The primary need is for orthopaedic care and medical supervision. At first these are problems for a traumatic unit; their subsequent disposal requires the co-operation of geriatric and welfare services.

Other Injuries Uncomplicated by Brain Damage

The next main subdivision is the "others" (non-femur and non-head injuries) with a total of 237 deaths—126 from road accidents. The younger adults are the most convenient to study because of their relative freedom from previous illness, but most of the lessons apply equally to the children and old people.

These cases may be further subdivided: first, minor and moderate injuries, usually localized, with no failure of resuscitation; and second, death from a specific complication. The majority of the 19 deaths can be regarded as accidents of treatment or errors of judgment. They include two more or less pure anaesthetic deaths (three in all among 60,000 anaesthetics), and one each from A.T.S., tetanus, fat embolism, and gas gangrene. In 10 years one patient died from an incompatible transfusion. There were four cases of pulmonary embolism in this subgroup.

About two-thirds of the deaths in patients aged from 15 to 54 without head injuries had severe primary haemorrhage, major multiple injuries, or both. Many of them appeared at the time to be hopeless, but reappraisal in the light of further experience suggests that the majority did not have lesions that were

FIG. 1.—Total deaths from injury in 1955. England and Wales.

FIG. 2.—Male deaths in 1955. England and Wales.

FIG. 3.—Female deaths in 1955. England and Wales.

FIG. 4.—Deaths from accidental falls and from motor vehicle traffic accidents in 1955.

inevitably lethal and that a sufficiently accurate diagnosis could have been made in time to start treatment with some hope of success.

Ten years ago five bottles of blood constituted a largish transfusion. To-day we have many people alive who required 12 to 20 bottles. But once we come to deal with this order of haemorrhage and injury, treatment is complicated either by the apparent inaccessibility of continued bleeding or by injury to vital organs. Sometimes it is just a question of more accurate observation, a more exact primary diagnosis.

Case 1.—A 50-year-old man involved in a road accident reached hospital 12 minutes later "gravely shocked," restless, and irritable, with severe fractures of the pelvis and both femurs. Transfusion was ineffectual and he died 45 minutes later. Necropsy revealed a 3-in. (7.5-cm.) laceration behind the knee dividing the popliteal vessels, and *air embolism*. He had been stripped of his blood-stained clothing and no blood was seen near his knee.

Such patients may not benefit from the disturbance, but they require detailed examination. It is also important to make sure that all relevant information is obtained from those on the site or who bring patients to hospital.

Case 2.—A man aged 43—blown up by gunpowder—had both hands blown off, burns of the face, an open fracture of the leg, a deep wound of the thigh, and numerous lacerations. Half an hour after injury his pulse was 108, blood pressure 95/75. A plasma drip was started. 30 minutes later his blood pressure was unobtainable. He was given another bottle of plasma and a bottle of blood. The systolic blood pressure hovered between 40 and 80 while he received five bottles of blood and six of plasma during the next 20 hours. He became restless and died.

This was in 1947, and no one recognized that his evident injuries could account for a 40% initial bleed. Rapid transfusion would have made him fit for surgery, which in turn would have controlled the bleeding.

Case 3.—A 19-year-old lad was struck in the abdomen by a packing-case. At hospital 15 minutes later he was pale, blood pressure 70/0, with air hunger, a laceration of the neck, a tender pelvis, and poor circulation to the legs. He was given six bottles of blood in 1½ hours, 10 in 2½ hours, 15 altogether in 3½ hours. He died seven hours after admission. At necropsy there was no evidence of brain damage, but a severe fracture of the pelvis, and several pints of blood in the abdomen in addition to the pelvic haematoma.

This patient died from haemorrhage despite what was probably a quantitatively adequate transfusion. On clinical grounds he had lost nearly half his blood volume on admission—say six bottles. Transfusion was fast enough to start off further bleeding before the blood volume was restored to normal. Thereafter the rate of transfusion trailed behind. We have enough experience now with similar patients to say that early and rapid transfusion can often restore the blood volume to a point where the circulation can be stabilized and haemorrhage controlled by surgery or natural processes. It is by no means rare for patients with fractures of the pelvis and associated injuries to require transfusion of their total blood volume or more, but often it must be given fast in the early stages, and this requires judgment. This "waste" of blood is often the price paid for survival.

Case 4.—A 30-year-old miner was crushed in the pit. Fractures of the pelvis, both femurs, and one tibia and fibula were diagnosed. There were no other injuries. He

was considered fit to travel, but reached us without transfusion five hours later, to die within half an hour.

We do not know how often such delays are fatal, simply because most people are not aware that so extensive an injury can recover with modern treatment. Contrast these deaths with some patients receiving adequate transfusion in time.

Case 5.—A 46-year-old woman, injured in a road smash, sustained a severe fracture-dislocation of the pelvis and fractures of both bones of the forearm and a midshaft femur with gross displacement and swelling. She travelled 40 miles (64 km.) by ambulance. On admission her pulse was feeble and blood pressure unobtainable. After four bottles of blood quickly, and 10 altogether in three hours, her condition stabilized. She would have needed further transfusion if surgery had been required.

Case 6.—An 18-year-old airman was the first patient to reach us from the Sutton Coldfield train disaster. He had a fractured pelvis and clavicle and the sort of crushed open fracture of both legs that obviously made amputation inevitable. He was put in an ambulance and brought straight to the Birmingham Accident Hospital, arriving 45 minutes after the smash. His condition was almost desperate, but he improved with rapid transfusion. Laparotomy revealed a large retroperitoneal haematoma and both legs were amputated through the thigh. A primary transfusion of 12 bottles, well over his normal total blood volume, left him anaemic. He left hospital within three months.

Case 7.—A 21-year-old man was transferred 15 miles (24 km.) from another hospital after a road accident—he had received ½ gr. (22 mg.) of morphine and a pint (0.5 litre) of blood in four hours. He had multiple right fractured ribs, severe lacerations, a middle-third fracture of the face, and a dislocated hip, with abdominal guarding and absent bowel sounds. His right chest was aspirated and he was transfused. At laparotomy profuse bleeding from tears of the liver was controlled by packing over gelatin foam. The hip was reduced and fixation of the mobile upper jaw deferred. Recovery was complicated by ileus, haemothorax, empyema, and subphrenic abscess, but he left hospital three months later. A year later he could do everything, including running and climbing. He received a primary transfusion of 17 pints (10 litres).

Occasionally we are faced with obvious major bleeding from a single artery such as the subclavian. An even more difficult problem is abdominal bleeding from major vessels, which is restrained by intra-abdominal pressure until released by anaesthesia or incision. We have failed at times to control bleeding from the superior mesenteric artery, a portal vein avulsed from the porta hepatis, intrathoracic bleeding from a torn diaphragm which extended into the vena cava, and complete rupture of renal and hepatic veins. We were transfusing too slowly, but the technical problem remains, although Hughes (1955), of the U.S. Army, experimented in Korea with an intra-aortic tourniquet consisting of a balloon on the end of a catheter run up the femoral artery.

Such problems verge on the insoluble, but are not at first distinguishable from other more readily soluble ones. Sudden bleeding can mimic head injury, by "violent restlessness" or "irritability" to coma. One patient whose violence preceded complete collapse recovered rapidly after transfusion and surgery. In any case, the presence of a head injury is no reason for not treating associated bleeding even when this is not likely to be immediately fatal.

In all, some 18 patients in the 15-54 age group died from major haemorrhage, mostly from the trunk, pelvis,

and abdomen. To these must be added 10 deaths following inadequate transfusion in elderly patients with moderate injuries; 8 after severe injuries to limbs, pelvis, and/or abdomen under 15, and 15 over 54.

Chest Injuries Without Cerebral Trauma

Another 10 patients under 15, 40 over 54, and 30 between 15 and 54 died with significant chest injuries without associated cerebral trauma—mostly from closed diffuse injury to the trunk, typically from road accidents. Some of these were unilateral, but the majority in the younger adults were bilateral, with additional damage to the juxtathoracic abdominal organs. In the less severe cases the chief mistake was an inadequate early appraisal of the extent of thoracic damage, with treatment too late or not at all. The more we see of major multiple injuries the more we find it difficult to make an early clinical diagnosis of all the important injuries. Early on, especially in the presence of collapse from bleeding or severe local pain, even without the added complications of unconsciousness from head injuries or anaesthesia from cord lesions, we have found that fractures of the pelvis, significant abdominal injury, multiple fractured ribs, and fractures of the spine can be present with no detectable signs or symptoms of any kind.

In the more severe injuries we have only just begun to appreciate the interrelation between the effects of oligæmia and the circulatory disturbances due to thoracic damage, even without major bleeding vessels or direct cardiac trauma.

Case 8.—A 42-year-old man was admitted 50 minutes after a car crash—cold, clammy, dyspnoeic, with no pulse or blood pressure. His right hip was dislocated. His abdomen became rigid and tender during transfusion. One hour after admission his blood pressure was 90/50. 12 oz. (340 ml.) of blood was aspirated from the right chest; later 8 oz. (227 ml.). He died four hours after admission. At necropsy there were several pints of blood in the peritoneal cavity from rupture of the liver, a large retrosternal hæmatoma, multiple fractures of the right ribs and a few on the left, with several pints of blood in each chest. Brain and lungs appeared to be intact.

Transfusion was slow in starting, but could hardly have succeeded without control of the chest injury.

Case 9.—A 24-year-old man had a motor-cycle accident. On admission his extremities were cold, he was pale and sweating, his blood pressure was 110/50 and pulse thin; he had pain in the chest, and was cyanosed and dyspnoeic. The chest moved equally. He had surgical emphysema of the right upper chest. Half an hour later his blood pressure was 62/30, and respiratory distress was increasing. The chest was needled high up on the right with decompression of a tension hæmopneumothorax and improvement. With transfusion his blood pressure rose, but it fell soon afterwards in spite of 7 pints (4 litres) of blood. He died three hours after admission. At necropsy there were extensive fractured ribs on both sides and 1–2 pints (570–1,140 ml.) of blood in each cavity; the lungs were bruised but not torn. The abdomen contained 2–3 pints (1,140–1,700 ml.) of blood from a ruptured spleen.

He required an earlier transfusion and abdominal surgery which was not possible without a new approach to the chest lesion.

Case 10.—A boy aged 15 was crushed between a lorry and a wall. He was admitted to hospital half an hour after the injury and died 45 minutes later. On admission he was pale, pulseless, conscious, and restless. His breathing was bubbly and laboured, and he had fractures of the clavicles and upper ribs on both sides and surgical emphysema in the

neck. Fifteen minutes after admission transfusion was started. Pulse 106, blood pressure 70/0. A second transfusion was started in the left arm. Forty minutes after admission a large swelling suddenly appeared over the right upper chest with spreading surgical emphysema. He died soon afterwards.

Transfusion was started early, but there was difficulty in keeping it running. More active measures for the chest condition were indicated.

Case 11.—A man aged 45 was run over by a car. He was admitted 40 minutes after the injury and died eight hours later. On admission he was unconscious, cold, pale, pulseless, with a dislocated right knee, compound fracture of the left leg, fractured left ribs, fractured right clavicle, stove-in right chest with paradoxical respiration. X-ray examination showed fractures of 3rd–9th left ribs and 3rd–10th right ribs, left pneumothorax, and right hæmopneumothorax. Two hours later, after 11 bottles of blood and 5 of plasma, his blood pressure had risen to 114/90, pulse 74. The chest was stabilized by traction, but he began to deteriorate. At necropsy the brain was normal; the right pleural cavity contained 1 pint (570 ml.) of blood, the left $\frac{1}{2}$ pint (284 ml.), the abdomen $1\frac{1}{2}$ pints (850 ml.) from laceration of the liver.

These and many other such apparently incurable injuries begin to fit into a pattern. The patients have lesions affecting one or both sides of the chest with abdominal damage usually confined to the liver and spleen, occasionally involving the suprarenals and kidney. No element of the complex appears in retrospect to be untreatable. They live long enough for a provisional diagnosis to be made; they may improve with time, transfusion, or aspiration of the chest, then they fade away.

The key to the situation is that they must be approached simultaneously from the point of view of their chest injuries and their bleeding. Their circulation cannot be stabilized unless the thoracic lesion is controlled.

The Boston surgeon E. D. Churchill, addressing the Rome Conference of Army Surgeons in 1944, described a change in emphasis in chest injuries between the first and second world wars. The first problem involved the pleura—the open chest, particularly at operation. We had moved on, he said, to focusing attention on the function of the lungs. This emphasis has developed so that we have learnt to suck out bronchi, remove air and blood from the pleural cavity, stabilize flapping segments of the chest wall, and use drugs to secure quieter respiration; more recently we have found that tracheotomy reduces the dead space, removes complications arising from spasm in the upper respiratory passages, and facilitates repeated aspiration of the lungs. We can get a dry lung that can carry out its normal gas exchange. If necessary the anaesthetists can take over the patient's breathing with help from new drugs. Which means that the more or less pure chest injury can be got under control.

When to the chest lesion is added major bleeding we must recognize that most of these factors also affect the pulmonary circulation. We advance from concentrating attention on the air passages to a recognition of the simple fact that *the left heart cannot put out what the right heart does not deliver, and that it is no use trying to restore the blood volume after bleeding if the blood cannot get through the lungs fast enough.*

Looked at simply, what are some of the factors in this situation which may impede the lesser circulation?

They are: (1) Obstruction in the pulmonary circulation, primarily arteriolar spasm, which may be due to (a) a reflex response to local trauma; (b) direct damage to the lung, with spasm and diminution of the capillary bed; (c) collapse of the lung with reduction of its vascular bed; (d) CO₂ build-up from paradoxical respiration or other mechanical inefficiency; and (e) some more general vasoconstrictive effect. (2) To which is added the effect of *increased* intrathoracic pressure that (a) impedes the venous return—the normal venous pressure is 6 to 8 cm. Hg in the I.V.C., 3 cm. Hg in the right auricle with a flow gradient—any obstruction decreases the venous return to the heart; (b) reflexly produces generalized venous constriction and dams the blood up on the venous side—25 cm. of water pressure in the pleural cavity halves the cardiac output (Funkhouser, 1957).

One way and another the various components of the injury affecting the chest wall and respiratory passages block transfusion so that it may even appear to be contraindicated. Everything needs to be done to restore the physiology of the lungs, not only for gaseous exchange but to enable blood to pass through and so on to the periphery, including the brain. Everything that leads to cerebral anoxia or ischaemia in turn increases the pulmonary disturbances. So we must do a tracheotomy early and keep the lungs dry, aspirate both pleural cavities, if necessary with apical and basal catheters, stabilize the flapping chest wall, relieve pain and spasm so breathing can be effective, sometimes with anaesthesia and controlled respiration, and all this even as a preliminary to a complete diagnosis.

If this is done early enough we will be able to replace the blood loss, and the patient will become fit enough to allow laparotomy, sometimes even thoracotomy as well.

Complex Chest Injuries

The effects of the modern treatment of localized unilateral chest injuries are already fully documented (Shefts, 1956; D'Abreu, 1958); but the cases I have in mind do not always get as far as the thoracic units, so here are two examples of more complex multiple injuries with chest components.

Case 12.—A man aged 37 was admitted to hospital directly after a car accident. He was pale, cold, sweating, with severe fractures of both jaws and an unstable depressed segment of the chest wall. He improved with rest alone, but later became restless, with obstructed respiration and vomited a pint (570 ml.) of fresh blood. His breathing became quieter with bronchial suction and morphine. Transfusion was started. After six bottles he was deteriorating in spite of a normal blood pressure, intercostal drainage, and tracheotomy. The chest was stabilized by traction on wires round the ribs. He gradually recovered consciousness from his head injury, the jaws being fixed on the tenth day. A clotted haemothorax needed decortication later, and a month after the accident he was noticed to have a fracture-dislocation of the hip which required open reduction. He was four months in hospital, back at a part-time light job in seven months, and back to full work within 18 months.

Case 13.—This case was even more complex and severe. A 32-year-old man was in a collision at 10 p.m. on April 16. He reached a local hospital in half an hour and was given gr. $\frac{1}{4}$ (16 mg.) of morphine. A team from the Accident Hospital reached him at 12.15 a.m. to find him stone cold, pale, and shivering, but conscious. His blood pressure was 60/0, pulse 136. After 6 pints (3.4 litres) of blood the blood pressure was 140/80. He was splinted and brought some 15

miles (24 km.) to Birmingham, where he was found to have a double fracture of the right femur, fracture of the right tibia and fibula, an open double fracture of the left tibia and fibula, fractures of five lower right ribs, extensive fractures of both sides of the pelvis, multiple lacerations, an open wound of the left elbow, and blood in the urine. At operation after 8 pints (4.5 litres) of blood he was found to have a ruptured spleen, torn outer coats of the transverse colon, and extensive bruising of the mesentery and stomach wall. Wounds were sutured and limbs splinted. A pint of blood (570 ml.) was aspirated from the chest. He became bubbly, so tracheotomy was added. After many adventures he is now well on the way to recovery.

Even here earlier tracheotomy was indicated, and anuria required careful biochemical handling for many days.

Head Injuries

The third section is the head injuries which so often complicate multiple injuries and add just one more set of major complications. The most significant new fact that emerges from a preliminary study of these deaths is the frequency with which they need early active treatment. Excluding all cases with injuries below the chin, there were 105 deaths between the ages of 15 and 54—21 had major bleeding from associated wounds; 16 fractured bases with bleeding from nose, ears, or mouth; 43 needed tracheotomy by our present standards; 14 had open fractures of the vault; 34 required operations on the skull; 3 had undiagnosed bleeding congenital aneurysms following definite histories of trauma; 6 had localized intracerebral haemorrhage. There were six extradural haemorrhages, with delay in operating in three and one missed at operation, and one subdural haemorrhage; four died from meningitis, one from pulmonary embolism. The records of only 18 showed no evidence of any treatable element requiring some action at an early stage.

FIG. 5.—Case 14.

Many subjects with head injuries might have been saved by more accurate early assessment. Here, and in many of the older patients and children, and especially those with associated and multiple injuries, the most important first step is to treat bleeding and perform tracheotomy whenever lung complications appear likely, *not* after they have developed. With early tracheotomy the state of consciousness in many cases of head injuries is transformed, so that it can be stated categorically that until this has been done the prognosis cannot be discussed (Maciver *et al.*, 1958). Deeply unconscious patients with head injuries have woken up after blood has been sucked out of their lungs. Tracheotomy will keep the lungs dry. With normal lung function they are better in every way, but require careful skilled nursing, tube feeding, and attention to secondary metabolic upsets.

Injuries in Children

Finally, here are the cases of two children.

Case 14.—A boy aged 7 had been run over and arrived at hospital in a grave condition with near complete amputation of the left leg (Fig. 5) and severe damage to the

FIG. 6.—Chart showing blood volume of children.

thigh, a major wound of the right leg with a fracture of the femur, and signs of suspected abdominal injury. With transfusion the abdomen was explored, the left leg formally amputated, the severed part cleaned, and its skin stripped to graft the severe wound of the right leg. He was back in the ward within three hours of injury and the next day was fit. He was given a transfusion of five bottles—well over his normal blood volume.

Incidentally, a chart (Fig. 6) of children's blood volumes hangs in our shock room and at times can be a decisive aid to assessment.

Case 15.—A 6-months-old child was admitted to hospital with a swelling the size of an orange on his head. He was pale, cold, sweating, and died within 50 minutes apparently from simple bleeding.

At that age the blood volume is about a pint (0.5 l.) (Fig. 6). A 50% bleed would be about half a pint (0.25 l.). The relatively large size of the child's skull means that in fact the closed haematoma probably constituted a fatal haemorrhage.

Conclusion

The improvement in the treatment of serious and multiple injuries requires many facilities—for immediate transfusion, diagnosis, tracheotomy, suction, blood-volume studies, metabolic checks, radiology, not the

least surgery—and these need a full team such as can be available only at a special centre. The provision of facilities for optimal care of the worst cases would improve the routine care of all the others. The problems of chest surgery, brain surgery, cardiac surgery, and severe poliomyelitis once seemed just as complex. To-day injuries are the biggest killers of all ages from 1 to 35. I am convinced that, whatever we may do to prevent them, accidents will remain with us. The surgery of trauma was the beginning of surgery. The day may come when it is all that is left. The full development of the services for the effectual treatment of injuries requires facilities and organization—it also requires experience and judgment. Finally, it presents a fascinating range of problems for combined clinical and physiological study. There is much to be done.

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REFERENCES

- Clarke, R. (1958). *Ann. roy. Coll. Surg. Engl.* In press.
- and Fisher, M. R. (1956). *Brit. J. clin. Pract.*, **10**, 746.
- D'Abreu, A. L. (1958). *A Practice of Thoracic Surgery*. Arnold, London.
- Funkhouser, R. K. (1957). *Cir. Res.*, **5**, 579.
- Hughes, C. W. (1956). *Battle Casualties in Korea: Studies of the Surgical Research Team*, 3, 48. Walter Reed Army Medical Center, Washington, D.C.
- Maciver, I. N., Lassman, L. P., Thomson, C. W., and McLeod, I. (1958). *Lancet*, **2**, 544.
- Registrar-General (1956). *Statistical Review of England and Wales for 1955*, Part I. H.M.S.O., London.
- Shefts, L. M. (1956). *The Initial Management of Thoracic and Thoraco-Abdominal Trauma*. Springfield, Ill., U.S.A.

The contributors to the second edition of *British Gynaecological Practice*, edited by Aleck W. Bourne, F.R.C.S., F.R.C.O.G. (pp. 877, illustrated, 105s.; London, William Heinemann Medical Books Ltd., 1958), the gynaecological volume of *British Obstetric and Gynaecological Practice*, have thoroughly revised their work to bring it into line with advances in the comparatively short time since the first edition was published in 1954. The authors are from almost all the teaching centres in the country, and thus the book reflects British practice to-day. It is essentially clinical in its approach, with such description of pathology as is necessary for understanding diagnosis and treatment. The subjects chiefly revised are disorders of menstruation, by Professor T. N. A. Jeffcoate; the treatment of carcinoma of the cervix, by J. B. Blaikley; and the treatment of genital tuberculosis, by J. Stallworthy. The late Sir Charles Read's chapter on the corpus uteri has been revised by the editor and C. A. Simmons. The useful chapter on the medico-legal aspects of gynaecology has been brought up to date by John B. Gardner.