WAR WOUNDS AND AIR RAID CASUALTIES

The following is one of a series of lectures on the Treatment of War Wounds and Air Raid Casualties recently delivered at the British Postgraduate Medical School

THE PREVENTION AND TREATMENT OF SHOCK

BY

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The term "shock" should not be used unqualified. In civilian surgery it should be preceded by the word "surgical" or "traumatic," and in military or air-raid surgery the term "wound-shock" (1917) is accurate and descriptive. This terminology avoids confusing the condition with "shell-shock" or shock resulting from a transient psychical disturbance.

Wound-shock is not a nervous phenomenon; indeed, the nervous system occupies only a small part of the picture. The conception of wound-shock as being a condition of *failure of the circulation* is all-important. It may be defined as a condition of lowered vitality of the body resulting from injury or accident, which leads to failure of the circulation, with lowering of the blood pressure, reduction of the body temperature, diminution of the blood volume and concentration of the blood, intracellular anoxaemia, and, in untreated cases, subsequent death. An excellent discussion of the theories of traumatic shock may be found in Cannon's book (1923a). None of the theories, however, were very helpful in the matter of treatment, and vast numbers of wounded died from shock in the first years of the great war.

Findings of Shock Committee in 1917

Early in 1917 a Shock Committee was established in London, and the first memorandum on the subject was published. Experimental work was undertaken by Bayliss and others in this country, and clinical observations were made by Fraser, Hooper, and Cowell in France. W. B. Cannon arrived from Harvard and took an important part in the investigations, working with Bayliss in London and Fraser in Béthune. It was felt that much might be learned from studying the actual conditions under which men were wounded, and by making clinical observations immediately the man was hit and in the next few hours while he was being transported to the casualty clearing station. No. 33 Casualty Clearing Station was the receiving hospital where Fraser and Cannon worked in the operating theatre and laboratory respectively, and Cowell made observations in the trenches on Hill 70, following the casualties to the regimental aid posts and advanced dressing station in Loos. From this study it became clear that wound-shock could be classified into two types: primary, which was rare, and occurred only in wounds, which were almost immediately fatal; and secondary—the common type—which was of slow onset, and occurred in the presence of one or more of four definite factors.

Cold

Observations were made in September, 1917, on Hill 70 in front of Loos. It was a cold moonlight night, with a chilly wind blowing. A soldier's blood pressure had just been taken when a hand grenade was thrown over from a German post and wounded him in the foot and neck, relatively trivial wounds. The blood pressure, which was 110 mm. a short while previously, was at the same

level immediately after the wound. A bearer party carried him shoulder-high through shallow trenches over the hill to the regimental aid post. He had no blankets and became steadily colder and colder. When he arrived at the regimental aid post an hour later he was pulseless. Two hours afterwards at the advanced dressing station, which he reached on a wheeled stretcher, he was still pulseless, and a serious view was taken of his condition. He was hurried off to Béthune in an ambulance car, and was found at the casualty clearing station to have a pressure of 80 mm., with no palpable pulse. After being warmed up in bed and being given hot drinks the shock soon passed off in the absence of any heroic measures of treatment.

McDowall (1923) quotes work by Dale and others which shows that histamine shock can be induced in certain carnivora only when the suprarenals are destroyed. He also states that Cramer and Crowden have shown that these glands are exhausted by cold. Holt and Macdonald (1934) also say that, in experimental shock, "if no attempt was made to sustain the normal body temperature, shock was maintained much more readily."

Pain

In war wounds pain is always present, but it is difficult to estimate this factor by itself. An opportunity, however, arose of observing the blood pressure in a case of renal colic. The pressure dropped from 130 to 60 and only rose after fifteen minutes, when the patient could no longer stand the pain and morphine was given. A few minutes later the pressure rose to its original level. Crile has advised blocking the afferent nervous impulses in order to prevent shock. This is not necessary provided that pain is checked by the administration of morphine or a suitable general anaesthetic. I performed a fore-quarter amputation in a feeble lady of 70 for sarcoma of the upper end of the humerus. Gas-and-oxygen was administered and the pressure taken every five minutes. The brachial plexus was left intact until every other structure had been divided, and no fall in blood pressure occurred.

Haemorrhage

There is bleeding to a variable extent in all war wounds. In air raids, where the wounds are generally severe and multiple, and when immediate first aid is difficult owing to the large numbers of casualties that may occur at one spot, bleeding is an important factor in the initiation of shock. The quantity of circulating fluid becomes diminished, leading to deficient intracellular oxygenation. This weakens the heart's action, so establishing a vicious cycle. Bodily fluid is also lessened by the profuse sweating which accompanies shock. In the case of the fighting soldier an anhydraemia may exist before he is wounded and be an important pre-wound factor in the production of shock.

Toxaemia

Early one morning I met a stretcher party carrying a strong burly lance-corporal who had just had his left leg blown off by a trench mortar. Efficient first aid had been applied, and I saw him attended to by the regimental M.O., who readjusted the dressing on a stretcher heated by a primus stove placed underneath. The man was quite

fit, the blood pressure was 115 mm., and the pulse rate 96. I accompanied him on his two-hour carry to the A.D.S. in Loos, and found on arrival there that the blood pressure was maintained but the pulse rate had crept up to 120. He was not in pain, was quite warm, and there was no bleeding. At the casualty clearing station two hours later the pressure had fallen and secondary shock was present. Early gas gangrene was found; the stump was reamputated and he recovered. This case I regarded at the time as an example of bacterial toxæmia. Another case was seen where the arm was amputated for a shattered humerus soon after the receipt of the injury. Four hours later I saw the man on his way down the line, and found him surprisingly fit, with a blood pressure of 140 and a pulse rate of 90. Here all traumatized tissue had been removed and the toxic factor eliminated.

Much experimental work has been done on the absorption of toxins produced by trauma of the tissues. Bayliss and Cannon showed in 1918 that shock followed severe traumatization of the animal's leg with nerves cut but blood vessels intact, and concluded that this shock resulted from toxic absorption. Holt and Macdonald in 1934 repeated these experiments with negative results. M. I. Smith (1927-8) claims that "direct methods have failed to demonstrate a depressor substance in the blood of a shocked animal." McDowall (1923) admits that toxic or chemical shock exists, and refers to the well-known fact that shock may "occur acutely when a tourniquet is removed from a severely damaged limb and the products of damaged tissue are allowed to enter the circulation." This author also agrees that this shock is enhanced by cold and by chemical poisons such as ether and chloroform. From the experimental point of view toxæmia is not yet accepted as a causal factor of shock. Clinically, however, there appears to be no doubt in the matter.

Pathological Findings in Wound-shock

Reduced Blood Volume.—Some of the most important observations in wound-shock were made by Keith (1919). This observer measured the blood volume in a series of cases and found it reduced to 52-85 per cent. of the normal; at the same time there was a plasma reduction ranging from 62-90 per cent. He described three groups:

1. Compensated cases, with slight symptoms; pulse 90-110 and blood pressure above 110 mm. The blood volume never falls below 80 per cent. of the normal, and the plasma is not reduced in proportion.

2. Partially Compensated Cases.—There is a history of a small hæmorrhage; the patient is restless, cold, thirsty, and he vomits; pulse rate 120-140, blood pressure 70-80, and blood volume 65-75 per cent., with slow dilution of the plasma, 70-80 per cent. reduction only.

3. Uncompensated Cases.—Condition very serious, with extreme restlessness, thirst, and vomiting. The extremities are cold and the pulse impalpable. The blood pressure may be as low as 60 mm., and the heart rate 120-160. The blood volume is below 65 per cent. and the plasma volume correspondingly reduced.

Cannon (1923b) concludes his chapter on blood volume: "The dictum uttered by the older generation of surgeons, that 'shock is hæmorrhage and hæmorrhage is shock,' is true."

Where is the Lost Blood?—A certain amount of loss may be accounted for by bleeding. However, shock may occur without hæmorrhage, and in these cases there is evidence to show that the lost blood accumulates in the capillaries. Simultaneous red corpuscle counts of blood from the veins and capillaries show a greatly increased count in the latter.

Transudation of Plasma.—Blalock (1930) found that trauma in the thigh of an animal results in extravasation of serum into the loose tissues of the groin and flank. On weighing both lower limbs after careful amputation he found the difference in weights amounted to at least 4 per cent. of the body weight, or about half of the total calculated blood (blood being one-thirteenth of the body weight).

Increased Viscosity of Blood.—Cannon points out that the viscosity of the blood is complex, consisting of (a) the internal friction of the plasma, (b) the friction of the corpuscles with the plasma and with each other, and (c) the frictional contacts of the corpuscles with the vessel walls, especially in the capillaries. Trevan (1918) states that internal friction rapidly rises as soon as the corpuscles reach a concentration of 60 per cent.; they have a tendency to stagnate, especially when the arterial pressure is decreased. This stagnation, in addition to hæmorrhage and loss of plasma, would further augment the amount of blood which is out of currency and consequently conduce to failure of the circulation.

Effects of Reduced Blood Volume and Blood Pressure.—Vasoconstriction occurs in certain organs, reserving the diminished blood volume for essential organs (Cannon). As the blood volume continues to diminish, the pressure falls and all parts of the body begin to suffer from disturbances of the circulation. From his study of the subject of cerebral anoxæmia Cannon concludes: "It is probable that, as the result of reduced blood volume and lowered blood pressure, the transportation of oxygen is greatly decreased in amount." Many observations on the reduction of the alkali reserve, basal metabolism, and changes in blood and urine are described in Cannon's book, but will not be discussed here. With regard to the importance of the time factor in the development of shock, the gradually damaging effect of persistent low pressure is of the greatest consequence in both understanding and treating shock. When the vasomotor centre has lost its capacity to maintain vascular tone there is no known remedial agent that will bring back the blood-flow to its normal condition. Even blood transfusion leads to no permanent gain. At this stage the damage due to insufficient oxygen is too great to permit of resuscitation. From the practical point of view a pressure of 80 mm. or lower, if not raised within four hours, will have a fatal result.

Prevention of Wound-shock

The Clinical Picture.—The main symptoms are well known. In looking round a resuscitation ward filled with wounded awaiting anti-shock treatment, the most striking features are the cyanosis of lips and finger-tips, the coldness of the extremities, and the restlessness. Sweating and vomiting are seen in the earlier stages.

When the causal factors of this condition became clear, and with the recognition that secondary wound-shock was the commoner variety, the conception of the idea of prevention occurred. This gave great encouragement to the war-weary regimental medical officer, and a new campaign to combat shock was begun with enthusiasm. All concerned in the early treatment of wounded, both medical officers and other ranks, were taught the four causal factors. Every endeavour was made to get the casualty to hospital before shock could develop. Cold was prevented by supplying hot-water bottles, hot bricks, and hot drinks. Stretcher parties were encouraged to carry a blanket-packet in forward areas. This consists of a blanket folded in a waterproof sheet to the same size as a stretcher pillow, and is carried in the same way in a

closed stretcher (*R.A.M.C. Training Manual*, 1935). In the regimental aid post the man was given three blankets, folded in such a way that there were four thicknesses behind him as well as in front. Also before being sent on he was thoroughly warmed by a stove under his stretcher and by a drink of hot sweet tea. The ambulance cars were warmed as well, and cases were actually observed where wound-shock disappeared on the journey, entirely owing to the warming measures adopted.

Pain should be prevented by efficient first aid, careful handling, and adequate splinting of injured limbs. If these measures are carried out properly morphine will not be necessary. Bleeding is treated by efficient first aid, the judicious use of the tourniquet, and possibly by simple surgical intervention at a forward dressing station. Toxaemia may be minimized by efficient immobilization of a damaged limb, but is chiefly combated by rapid evacuation.

The front-line application of the Thomas splint for wounds of the lower limb affords an illustration of the use of the above-mentioned methods of preventing shock.

Treatment of Established Wound-shock

Treatment depends on a recognition of the four factors and a knowledge of the pathology of the condition. When large numbers of wounded are being received, and if the military situation permits, definite resuscitation wards are organized for the treatment of wound-shock, both at the main dressing station and at the casualty clearing station. Careful judgment and close watching will determine the right moment for surgical intervention, when the cause of the condition will be dealt with and removed. To operate in shock is dangerous; but in certain cases and with adequate precautions surgical intervention must be risked to save the patient's life. For example, after a massive blood transfusion and with gas-and-oxygen anaesthesia it is justifiable to perform an amputation, open an abdomen, or close an open pneumothorax.

In the resuscitation ward the patients are warmed by hot-water bottles, electric cradles, hot-air cradles, or stoves under stretchers on trestles. Morphine is given for pain, in repeated small doses if necessary. The deficiency of circulating fluid (anhydraemia) is made up by giving hot drinks, saline by rectum, and, in severe cases, intravenous injections of hypertonic glucose saline with insulin, gum, or blood. In Spain, where blood transfusion was highly organized, it was found that 10 per cent. of wounded required blood, and in the resuscitation wards, where blood was given to all moribund cases and to those considered hopeless, some 20 per cent. recovered sufficiently to stand operation.

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A special cruise has been arranged by the *Bruxelles-Médical* at the end of August in connexion with the New York Exhibition. Starting from Havre on August 29 on the steamship *Champlain*, visits will be paid to New York, Philadelphia, Atlantic City, Washington, Chicago, Detroit, Toronto, and the Niagara Falls. The price for first-class travel and hotels will be 747 dollars and the tourist class 585 dollars. A detailed programme of the cruise may be obtained from the travel section of the *Bruxelles-Médical*, Boulevard Adolphe-Max 29, Brussels.

THE NEW "WESTMINSTER"

FEATURES OF RECONSTRUCTED HOSPITAL

The new Westminster Hospital, which the King opened on April 20, stands near the Thames at Millbank, about six hundred yards from the site of the old hospital in Broad Sanctuary whose quasi-Gothic embattlements have fronted the Abbey for over a hundred years. It is a nine-storied structure on an island site bounded on three sides by quiet streets and on the fourth by St. John's Gardens. The gardens separate it from the nurses' home and medical school, a block of similar construction opened about a year ago.

Tradition in hospital planning is broken in several respects in this new building. The most obvious architectural departure is the making of a private covered carriageway and footpath right through the hospital from Horseferry Road to Page Street. Along this road, the foundations of which are buried in anti-vibration material, are various entrances—for out-patients, for in-patients, for visitors, and for accidents and emergency cases, with separate doors for those brought by ambulance and for the walking casualty in order that the latter may not be unduly distressed by the sight of someone gravely injured. There is also a separate entrance for laundry, leading direct to the sorting-room, and another for goods. In time of war this road can be sealed at either end by air locks so that gassed patients may be received and decontaminated before being taken to the wards. Again with a view to emergency the whole structure of the hospital has been specially buttressed against air attack. The three top floors are of solid concrete, able to resist incendiary bombs, and the walls of the whole of the steel-framed structure have never less than 14 inches of brickwork, which is considered sufficient to protect the building from splinters and blast.

Out-patient Departments

An original feature is the arrangement for out-patients. The depressing hall where patients with sundry ills mingle and wait is no more. It is replaced by a distribution centre on the ground floor, where the out-patients, according to the obvious nature of their case, are sent at once in lifts to the appropriate consulting-rooms on the upper floors, where each out-patient department is in structural contact on the same level with wards devoted to similar cases so far as this is possible. In this way a common medical, nursing, and auxiliary service staff is available for both in-patients and out-patients, thus saving the staff some fatigue, promoting economy in space and in other directions, and also assisting continuity of treatment should the out-patient in time become the in-patient. On the first floor are the ophthalmic and the ear, nose, and throat departments, both of them excellently equipped with the most modern apparatus for examination and treatment. On the floor above are the children's department and the orthopaedic department, to which latter is attached a fracture clinic, a gymnasium for remedial exercises, a ward unit of twenty beds, and a plaster room with special apparatus. The third floor is devoted to the surgical department, the fourth to the medical, and the fifth to the gynaecological and maternity department, with a treatment room for minor operations and investigations.

The hospital contains just under 400 beds, as compared with about 250 on its old site. Westminster has always believed in the small ward, and the typical unit ward in the new building consists of twenty-five beds—eleven on the male side, eleven on the female, and three single rooms—all being under the control of the one medical and nursing administration. In each of the wards two beds at one end are partitioned off to secure privacy for the very ill. The wards throughout are so arranged that so far as possible cases of the same type are grouped together, with, as already stated, the related