asks whether they have had active immunization before, but all the casualty officers give A.T.S. and so our trouble is wasted. The child or adult is subjected to the risk of anaphylaxis to no good purpose, all quite unnecessarily. I think a good deal of propaganda needs to be done within the hospital as well.

The Chairman: The difficulty is to get a universal pattern right through the country. If everybody was doing the same thing it would be easy, but because we are all doing different things it becomes a little confusing.

Mr Lowden: I think the great difficulty is that patients do not know what immunization they have had; that is one of the reasons why they may get A.T.S. when they have in fact been actively immunized. Casualty departments are well aware that there is such a thing as active immunization and some of them carry it out as a follow-up process, but the great difficulty is to know whether it is all right to give toxoid or not, because the patient doesn't know what sort of immunological state he is in. It's altogether apart from the question of whether he is conscious or not; even when he is conscious he doesn't seem to be conscious of that.

THE MANAGEMENT OF BURNS

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Burns and scalds range clinically from some of the most minor domestic injuries to some of the most unpleasant and challenging causes of accidental death. Between these extremes come most of the industrial burns, due to a great variety of causes—molten metal, chemicals and electricity. In our burns unit, of the approximately 300 annual admissions, two thirds are of a domestic origin and one third industrial. Whatever the cause of the burn the clinical effects are surprisingly similar, and their severities are chiefly determined by the area of the injury and its depth.

There are three types of burns cases requiring hospital admission. First and most serious are the shock cases. These are the patients

whose lives are at risk owing to the circulatory disturbance following loss of fluid in the damaged tissue. A moderate loss of blood volume can normally be tolerated. A burn covering five per cent of the body surface loses perhaps a volume equivalent to a donation of blood, but a ten per cent surface area burn begins to be important and in a child often requires intravenous replacement of fluid. In adults 15 per cent of the surface area is a good limit. From the point of view of the practitioner wishing to decide which cases should be admitted to hospital on this criterion, it is useful to have in mind the approximate surface area of the different parts of the body. We use a special chart in the burns unit, on which we chart out the injury of the patient. More practical for the practitioner perhaps is to have in mind a diagram such as " the rule of nines " originating from Mr Wallace of Edinburgh, in which we say that the head and neck total about nine per cent and the arms each of them about nine per cent of the body surface; the front of the trunk is two nines or 18, and the back two nines or 18, and the legs similarly score 18 per cent each. From that you can obtain a sufficiently close estimate of the total area of burn. This is a guide to the marginal cases. Some cases are obviously very much larger than the limit, and they should be sent off to hospital as soon as possible.

In treatment of these large burns, maintenance of blood volume has priority. The fluid which leaks from the damaged capillaries consists of a rather dilute plasma which contains all the plasma proteins in about the same proportions as they occur in the general circulation and also the normal electrolyte complement of plasma. Satisfactory replacement fluid is reconstituted dried plasma which must be given by intravenous drip. This often requires a cut-down since veins are notoriously difficult to enter in patients with severe burns. Regulation of the amount of plasma which should be given is probably best guided in a centre treating these cases by following the haematocrit value at half-hourly to hourly intervals. There are also formulae which are acceptable, but we prefer to treat individual patients as individuals. Of the alternatives to plasma which have been tested dextran is probably the solution of choice and can be given in the same way and in about the same amounts as reconstituted plasma. For various reasons it is probably advisable not to give very large volumes of dextran, say, no more than about three litres in an adult or the equivalent of a plasma volume in a child. Dextran appears in the urine, and the patient may pass a thick urine obviously containing a foreign material during dextran infusion. This is to be expected, and it is due to the small molecules coming out through the kidney. The plasma protein during this stage will be diluted by dextran, and this is one of the rather obvious reasons for not giving too much dextran, for if you build up the plasma

dextran level, you will ultimately get even more dextran circulating than protein. This highly abnormal state of affairs may well account for some of the difficulties we encountered when we used dextran in very large amounts. But within the limits I mentioned it is satisfactory. When you give dextran it is as well to take a sample of blood beforehand because of the difficulty of cross-matching when dextran is actually present in the circulation.

Intravenous or oral saline solution is an alternative in a desperate position—for instance, if you are called to treat a patient for severe burns in a coal mine perhaps you can't get the patient out for a number of hours.

In addition to the loss of plasma, patients with larger and deeper burns also lose appreciable amounts of red cells, and whole blood transfusion is required for all the more severe cases. Only at the end of 24 to 48 hours of transfusion is it safe to disturb the patient for application of dressings. Prevention of infection in these large burns is a particularly difficult and important matter since with modern transfusion techniques very few, if any, patients need die of shock. Many, however, still do die of infection and of other late associated complications such as bronchopneumonia.

The second group of patients requiring admission are those with large areas of injury but not so large as to qualify as shock cases. Some such patients can be nursed at home, depending upon circumstances, but patients with burns of the face usually need admission because they are temporarily disabling and disfiguring and must be watched for eye complications. These are relatively rare and probably not quite so urgent as is sometimes thought, but, nevertheless, the condition of the eye must be watched and we find that use of penicillin cream locally in the eye will look after the immediate changes. Burns of both hands are very disabling and are better supervised in hospital. Burns of the buttocks are also difficult to manage except in hospital.

With all such cases, as with shock cases after transfusion, the main therapeutic aim is to obtain healing as early and as free from deformity as possible. The process of healing depends on the depth of the injury. When a burn has not destroyed the whole thickness of skin the surviving epithelial cells have a strong tendency to resurface the area and to heal spontaneously, no thanks to any particular local application. The small superficial burn often just denudes the stratum corneum which is very quickly replaced by regrowth within a day or two. The deeper partial-thickness burns going through the germinal layer such as this will only heal after the cells from the hair follicles and from the sweat glands have resurfaced the stratum

germinativum and produced a new stratum corneum. This will take 10 days to 3 weeks to complete. The full-thickness burns where all the epithelial elements have been destroyed will not heal spontaneously except very sluggishly from the edges, and they are very much better treated by grafting. The size of the burn which will heal spontaneously varies in different areas, and it depends somewhat upon one's forecast of the prosthetic result whether grafting is required. With industrial burns, many of which are full-thickness, the question whether the man can continue at work rather than be in hospital has to be considered. A small burn, for instance on the back, can usually be treated ambulantly, but if the burn is on the hand or other area of great importance then it is better treated by excision and grafting.

Diagnosis of partial or full-thickness skin loss is of great clinical importance since this determines the future of the healing of the lesion. In some cases the diagnosis is obvious but there are some cases which puzzle even the experts. The pain sensation test is useful in this connection; we worked this out experimentally, and were able to demonstrate that the full-thickness lesion is always insensitive to the pain of pinprick. There is no sensation of pain when the burn is pricked with a hypodermic needle. The partial-thickness burn is usually sensitive, and if the burn is sensitive then it will heal spontaneously, all being well. However, the test is not quite absolute. There are certain areas of the body which are difficult to test this way; the sole of the foot and the palm of the hand both tend to be insensitive when the lesion may still be partial, and there are certain types of burn, such as those with chemicals and anaesthetizing agents such as phenol, which will induce a state of apparent full-thickness burn when the burn is not actually full-thickness and will heal spontaneously. But in general a patient with a full-thickness lesion will not feel pain, and if the lesion is sensitive to pinprick it is of partial thickness only.

The greatest enemy of healing of partial-thickness burns and of the take of skin grafts is infection. The moist, dead tissue of the burn is an excellent medium for the growth of organisms and its exposure to the air and contact make such infection very easy. We have made many studies both of prevention and treatment of infection in burns and have demonstrated that various features of management can aid in prophylaxis. On admission, most burns are virtually free from organisms so that subsequent infection is attributable to treatment in the broadest sense. A physical barrier to shield the burns in the form of a closed dressing with layers of gauze, cotton wool, and crepe bandage is effective so long as the burn is on an area which permits such a dressing to be efficient. No-touch dressing technique and the use of a plenum ventilated dressing

station have been demonstrated to aid in the prevention of infection. We have investigated the role of many different forms of local prophylactic chemotherapy. Prophylaxis against *Streptococcus pyogenes* can be achieved with a number of agents and it's the main purpose of our continued use of penicillin cream. We have tested the suggestion that penicillin cream is a great danger in inducing sensitization of the skin and have not been able to confirm this. The staphylococci are of course resistant to ordinary penicillin and therefore some years ago we made a comparative trial, using a control of a similar cream without the penicillin. We very soon stopped that trial because streptococcal infection was beginning to be a problem and it is because of the continued effectiveness as a prophylactic against streptococcal infection that we continue to use penicillin cream as a routine. Polymixin provides an effective prophylaxis against pyocyanea, and neomycin or chlorhexidine provides substantial protection against staphylococcal infection. Recently we have had very encouraging results with a combined application of polymixin, chlorhexidine, and neomycin. With this treatment many burns remain sterile, and added infection with *Staphylococcus aureus* is greatly reduced. Another approach that prevents infection is to attempt to obtain a dry surface to the burn which is then not readily infected by organisms. Drying is particularly valuable against coliforms and *Pseudomonas pyocyanea*, but we have not been able to confirm the rather glowing accounts that exposure in itself prevents infection of burns. For instance, we have for many years treated facial and certain trunk burns by the exposure method but these burns have actually been more frequently infected with streptococci and other pathogens than burns of the hands and the feet treated with covered dressings. Even an eschar which grows few organisms on the surface may enclose a pool of highly infected pus. Optimal prophylaxis and therapy of infection in burns requires in our view continued vigilance and thorough laboratory investigation so that the most appropriate agents are used in individual cases.

The only reliable method for the healing of full-thickness burns is to cover the area with a graft from the patient's own skin; this underlies the reason for admission of the third group of cases. These are patients with full-thickness burns of more than, say, one inch diameter who require hospital admission for grafting. The exact indications for operation depend upon the site of the burn and the patient's work, as well as the total area. If such a burn is left for two or three weeks it can be seen which areas are healing spontaneously and which are confirmed as of full-thickness loss. Split-skin grafting at this stage, provided that streptococcal infection is not present, will usually be successful in closing the wound and

very often gives a sufficiently good result without further plastic surgery. There are theoretical advantages in grafting at an earlier stage. All the time that dead tissue is left in contact with the body harm is being done. The logical step on general surgical principles is to remove the dead tissue as soon as a full-thickness burn has been diagnosed. This has become routine practice both in our burns unit and elsewhere for years. It is particularly suited for molten metal burns and other small full-thickness burns commonly arising in industry. We have been trying very tentatively to extend this principle to larger burns and have just published our findings (Jackson *et al.* 1960). In brief, the results with immediate excision of large burns are sometimes extremely encouraging. Unfortunately good results are not uniform and we are still trying to work out the most satisfactory indications and techniques. With carefully controlled blood transfusion the actual operation can be made safe even in the most severe cases, but the subsequent course is sometimes stormy, particularly owing to loss of these primarily applied grafts. We feel that further work is needed before the method can be generally recommended, though it promises the most fundamental advance in burns treatment that can at present be anticipated.

We have recently been studying the mortality among 5,000 burns admissions. There are few deaths up to 30 per cent burns in children or young adults, a larger number in older adults and a considerable mortality for this size of burn in the oldest patients. Even among children there is a 50 per cent mortality at about a 50 per cent burn. This is also true for young adults, but for older adults the prognosis falls off rapidly so that a ten per cent burn as a 50 per cent mortality in patients aged 80 years. Thus prognosis of burns is very strongly related both to age and to surface area. Old people who die from burns die most commonly from being put to bed. Sometimes they die from their other diseases and injuries which may have led to the burning accident.

A further point I would like to make is that we would welcome the co-operation of all of you in an attempt to prevent these injuries. We have plenty of information as to how they are caused. By far the majority of the severe burns are due to clothes cacthing fire, the ignition coming from open coal, gas or electric fires. All such accidents can be prevented. Suitable guards are available for all types of fire, and fabrics are now on the market which would greatly mitigate the injuries. It is the common cotton or cellulose fabrics which are the chief culprits. Proofed cotton fabrics are now available which are particularly suitable for night wear, and there is a range of nylon and terylene cloths which also have a high safety factor. When we see a patient with severe burns our immediate

reaction is " This should never have happened ". I would like to ask that we all do our best to reduce these tragic accidents.

We could virtually eliminate all these big burns if only we set about it determinedly.

REFERENCE

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DISCUSSION

J. W. Hannay, M.A., F.R.C.S., D.Obst., R.C.O.G. (*Wimborne, Dorset*): When I was asked if I would open the discussion on burns from the general practitioner's point of view I said that there was not very much to say because nearly all burns should be treated in hospital, and I was told to get up and say that. So here I am saying it. If one is called to see a burn the first problem to decide is whether it is a case for hospital. I put down some categories for admission to hospital and I am glad to find that they correspond with Dr Bull's. Let me just recapitulate without saying exactly what he said. Patients with large areas of superficial or deep burns need admission to hospital because shock is bound to develop. Those with smaller areas of deep burns need admission to hospital because whole-tissue damage can be repaired only by scar tissue or by grafting, and it does make a certain amount of difference where the burn is. Any burn over joint surfaces is a functional disfigurement as opposed to an aesthetic one and burns of hands ought always to be sent into hospital. The area involved makes a difference. One ought to remember that the axillae in most people sweat quite a lot, and the occasional heavy-breasted woman with intertrigo and chest burns is another person likely to have to go to hospital. Some other concomitant injury may mean that a burn which might be treated at home needs hospital treatment after all. That does not leave much for the general practitioner to attempt to treat at home, but let us consider the first aid.

There are one or two factors which must influence a little the decision to send into hospital. We may be able to do the tactile test which I heard of for the first time, I regret to say, a few minutes ago, to determine whether or not the burn is of full-thickness. But it is not a very practical proposition, and most burns tend to be rather deeper than you think in the first place. At least that is my unhappy experience. Nearly all electrical burns are very much deeper than they look at first sight. Nearly all chemical burns are also very much deeper than they seem at first sight. Children's burns present a very difficult problem indeed. Obviously, if a