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Dr. DAVID LIVINGSTONE

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The Treatment of Burns

BY

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The increasing prevalence of burns constitutes a major problem for the doctor to-day. While there are many types of burns (i.e., thermal, electrical, chemical, radiation), all types result basically in the same pathological damage or destruction of the skin or underlying tissue. Fatal burns and scalds are largely due to home accidents, the causative agents being matches, unshielded fire places, hot metals or liquids, steam, overturned kettles of boiling water, explosions from oil or paraffin, volatile cleansing fluids, and even hot water bottles. Burns among Africans are quite frequent. The use of open fires, especially those in the huts during the cold season, involves many accidents, particularly for children, epileptics and drunks. Long-handled pots are easily tipped over, resulting in burns by scalding. Again, the increased mechanisation and industrialisation of the African increases the number of burn cases from accidents involving petrol engines and paraffin.

All of these types of burns may be considered together. In this article we will be especially concerned with burns among the young children and older people. Healthy individuals in the age group between childhood and old age have much greater burn tolerance (see Illustration No. 1). Let us consider the essentials of handling burns.

FIRST AID

The general idea of laymen is that an immediate application of some oil, vaseline or butter, etc., will relieve pain and benefit the burned area. However, only a narcotic will give much relief in burns, and any unsterile application serves mainly to contaminate the burn wound. It is of primary importance to realise that a burned area can be considered a sterile wound until contaminated and that the principal aim of first aid should be to keep the wound as clean as possible. This is increasingly important in an extensive burn of 8 per cent. or more.

If there is any danger of contamination by dust or other dirt it would be best to cover the area lightly with a clean, ironed cloth. Hospital ambulances should ideally carry such sterile coverings for burns.

Fortunately it has been our experience with African patients that most often they do not

apply anything to burns, though they occasionally use peanut oil, vaseline, paraffin or some unidentifiable medicine—all of which serve as a gross contaminant.

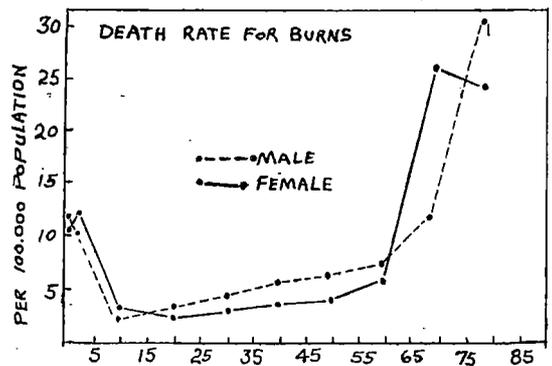
The patient should immediately be taken to a hospital where pain relief and definitive treatment may be carried out. Morphine sulphate or Pethidine may be given either intramuscularly or intravenously. The transport of African patients, frequently many miles by walking, carrying, lorries and bicycle, exaggerates the pain and causes increased contamination of the wound, resulting in more difficult conditions to handle. Some patients may even wait days in their village with extensive burns until they see that the wound is not healing well.

HOSPITAL ADMISSION

The patient should be made as comfortable as possible with a narcotic, if necessary, and sterile sheets to lie on, depending upon the area burned.

Preliminary Evaluation.

The doctor should immediately observe the patient for signs of shock and he must keep the possibility of the development of shock in mind. He then may proceed to estimate the percentage of the burn and to prepare a sketch of the burn as a matter of permanent record.



Illust. 1.—Typical graph of burn fatalities according to age.

Classification of Degrees of Burn.

The usual classification by Baron Dupuytier (see Illustration No. 2) serves quite well to classify the degree of burns. Clinically speaking, the division between second and third degree is the most important, as far as the ultimate healing and need for grafting are concerned. Burns of fourth degree through sixth degree, while causing more trauma and therefore resulting in greater shock and toxic reaction, involve complete destruction of the

epidermis and we know that the skin will not recover.

Classifying burns is often difficult. The degree can only be estimated. A final classification must await the recovery (or failure to recover) of the tissue after some two weeks. Another factor that may alter the degree of a burn is infection. An initial two degree burn may be converted into a three degree burn by bacterial infection.

Classification of Percentage of Burn.

Again, the doctor can only estimate the percentage of the burn, with tentative percentages set for the area that involves first to second degree burns and that which involves third degree and over. It must be remembered that the relative percentage of parts of the body vary between infants and adults (see Illustration No. 3). When the doctor calculates the original percentage of burn he should figure the total burned area. The first degree areas may be calculated separately, as they do not contribute much to shock or fluid loss, and the doctor will base his treatment largely on the findings regarding second degree and over.

Laboratory Tests v. Clinical Judgment.

Each half to one hour the vital signs should be observed and recorded. The first danger sign is an increased pulse. Falling blood

pressure will precede the most pronounced signs of developing shock (i.e., restlessness, thirst, weakness, sweating and air hunger). In general, it has been our experience that the African has a relatively lesser tendency to shock from either burns or haemorrhage than does the European.

HB, RBC and hematocrit determinations, along with chloride, iodine, K and CO₂ and blood urea, etc., may be of value, but the results of basing treatment exclusively on chemical determinants are often disappointing. The doctor should consider his own clinical judgment of utmost importance.

PARENTERAL FLUIDS

At the outset it should be realised that there are likely to be more deaths from over-treatment than from under-treatment (Ziffren, 1956). This is doubly so in cases of elderly patients over 60 years of age and of infants, particularly with a burn of between 8 and 24 per cent. Over-zealous administration and non-intelligent use of guide formulae constitute the main hazards of fluid therapy of burns today (Mason, 1956). The doctor should not forget the patient's ability to take electrolytic fluids (especially saline) by mouth before he resorts to the intravenous route.

Formulae.

These examples of calculated formulae for parenteral fluids are inserted for a study of the methods of treatment suggested and are not given as recommended procedures:—

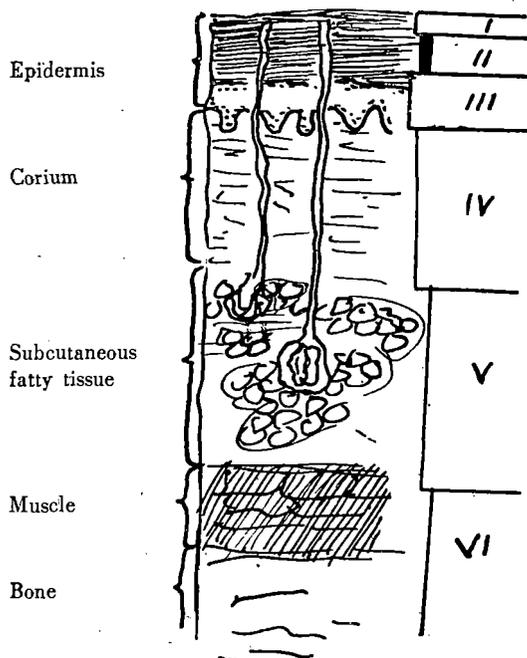
(a) For Adults (Cole and Elman, 1952)—

1. Harkin advocates the administration of 50 c.c. of plasma for each degree of burn.
2. Cope prefers 75 c.c. of plasma for each degree of burn.
3. Gibson and Brown give 100 c.c. of plasma for each degree of burn.
4. Pressman *et al.* immediately administer 50-60 c.c. plasma per degree. Follow this up with 20-30 c.c. for each degree (first 24 hours). Give 10-30 c.c. per degree (next 48 hours). All agree that electrolytic fluid may be used in addition as indicated.

(b) For Children—De Sanctis and Varga (1951) advocate:—

1. Initial dose of electrolyte—30-40 g. of 10 per cent. dextrose electrolyte in saline solution per minute (or faster in severe shock).
2. Initial dose of plasma according to Table IX:
3. Second dose of fluids (Table IX) if haemo-concentration is evident, using 10 per cent. dextrose in water (rather than in saline) if less than 24 hours has elapsed.
4. Subsequent electrolyte and plasma, according to Table X:

Note that none of these formulae takes into account the use of whole blood, which we will consider shortly.



Illust. 2—Degree of burns.

Table IX

TEN PER CENT. DEXTROSE.		
Weight (lb.)	Electrolyte in Saline, c.c.	Plasma, c.c.
100—149	1,000	500
50—99	500	250
35—49	250	250
20—34	150	150
5—19	20—50	10 per lb.

Table X

TEN PER CENT. DEXTROSE		
Weight (lb.)	Electrolyte in Distilled Water, c.c.	Plasma, c.c.
100—149	35	35
50—99	20	20
35—49	15	15
20—34	10	10
5—19	0.5 per lb.	0.5 per lb.

Adapting Calculated Formulae.

In order to overcome the tendency to over-treat a patient with parenteral fluids, the doctor should avoid the dogmatic use of formulae and give careful consideration to the age of his patient and to the degree and percentage of the burn:

(a) The Age Factor—

1. *The average healthy adult* will have a natural ability to adjust and to overcome shock which should not be underestimated. The calculated scales for fluid do not usually discriminate as to the age of an adult patient, and they are therefore applicable principally to the average healthy adult under 60 years. Even then the doctor should attempt to use only the minimum amount of fluid possible, while keeping himself alert to observe signs of developing shock.
2. *The infant, child and aged person* have a far greater hazard in burn treatment. The

chances of overloading a patient in these age groups are very great. Shock from overloading is a greater possibility than shock from insufficient fluid. Calculated formulae are of value, but our experience tends to follow that of Ziffren. Considerably less fluid will prevent or treat shock than is generally used. It is desirable to be in a position of knowing that when signs of circulatory collapse *begin* that *not enough* fluids have been given. Then it is a simpler matter to administer fluids and to slow or stop them as shock is controlled.

- (i) *The dangers of pushing fluids* cannot be over-estimated. If fluids are pushed on the assumption of preventing shock—or are used according to formulae without adaptation to the clinical picture—and shock does occur, then the doctor is in a dilemma. His position is one of *therapeutic confusion* and *no retreat!* Collapse as a result of overhydration is a difficult and often impossible condition to treat.
- (ii) *The advantages of minimal treatment* must be strongly stressed. The doctor is in a better therapeutic position in that he knows he has given too little rather than too much fluid. Our experience with African burn cases has borne this out repeatedly. We have been amazed at the minimal requirements in fluids, as compared to the standard calculations, that have served to preclude and control shock very adequately (see Illustration No. 4).

(b) The Factors of Degree and Percentage.—

Not only the age of the patient but the degree and percentage of his burn must enter into the calculation of fluid administration.

1. *Extensive burns* of over 30 per cent. (20 to 30 per cent. in an infant) are relatively certain to require electrolytes and fluids (preferably blood, as we will discuss soon). Fluids should be started immediately *before* the signs of shock begin. But fluids should not be pushed more than the minimum indicated by the vital signs.
2. *Less extensive burns* of under 30 per cent. (15-20 per cent. in infants) present the cases which have the greatest hazard of overtreatment and for which the calculated

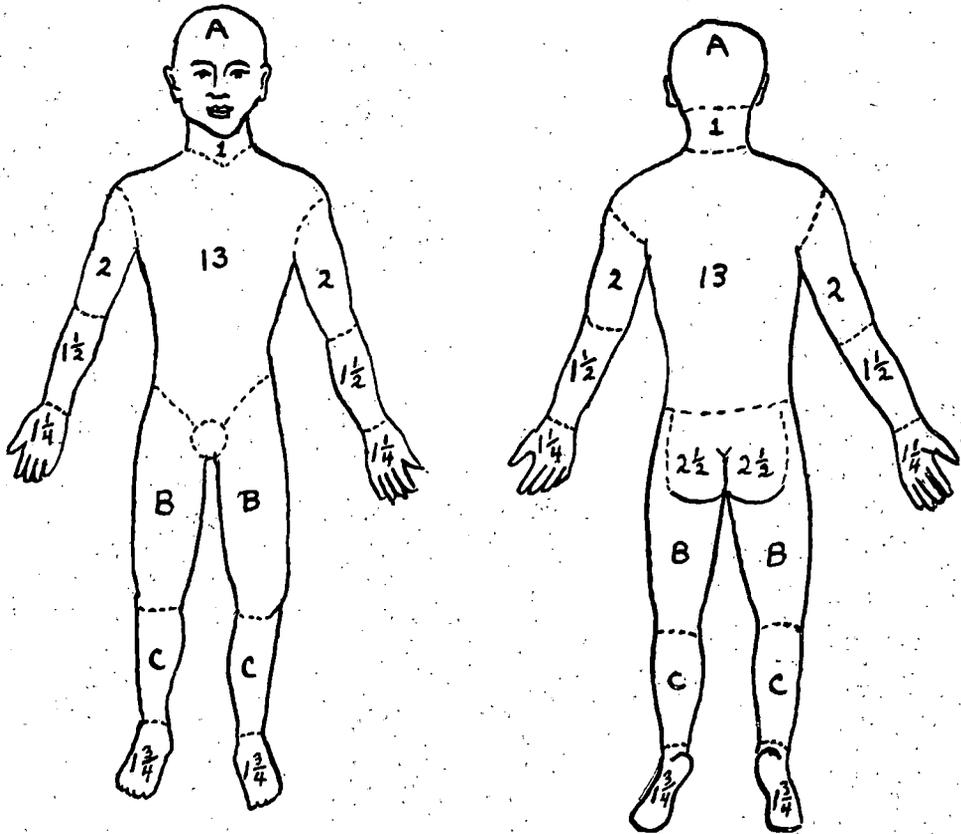


Illustration No. 3

RELATIVE PERCENTAGE OF AREAS AFFECTED BY GROWTH

Area	Age 0	1	5	10	15	Adult
A = 1/2 of head	9 1/2	8 1/2	6 1/2	5 1/2	4 1/2	3 1/2
B = 1/2 of one thigh	2 3/4	3 1/4	4	4 1/2	4 1/2	4 1/4
C = 1/2 of one leg	2 1/2	2 1/2	2 3/4	3	3 1/4	3 1/2

formulae are the least practicable. It is best to watch these patients closely for the deterioration of the vital signs (i.e., rising pulse, falling pressure, deficient output). The presence of any of these signs of hypovolemia indicates the need for parenteral fluids.

In an infant these signs are limited and require a great deal more clinical judgment. However, the doctor can calculate the amount of wetting, observe the respiration and note skin temperature and general hydration and colour much as he does in any case of dehydration (that may or does require parenteral fluids).

Choosing the Type of Parenteral Fluid.

Plasma and plasma substitutes have been widely used in burn therapy. While their use is of value, the usefulness of whole blood is often underestimated.

(a) *Plasma and Electrolytes.*—The administration of saline to cover the fluid loss from urinary output and other calculated loss and electrolyte balance is valuable when needed. Theoretically (because the chemistry of the fluid found in burn blisters of second and third degrees reveals it contains electrolytes as found in extracellular fluid and about one-half the concentration of blood proteins), it has been assumed that plasma and electrolytes (saline

especially) should be enough to combat shock. However, in actual practice the use of plasma, especially in infants and aged, has often been disappointing.

(b) *The Value of Blood in Severe Burn Cases.*—Experience has shown that the more severely burned cases need a supply of red blood cells. The need is probably due to an actual destruction of red blood cells, to haemolysis or to a depression of the normal haematopoietic function of the bone marrow (Cole and Elman, 1952). The laboratory findings of increased haematocrit and red blood cells have been shown

patient is putting out 20 c.c. per hour there is no valid reason to start flooding him with fluids to push his excretion rate up to 50 c.c. The important thing is that he is putting out urine regularly. Again, if the pulmonary tree or associated members is burned, it is absolutely necessary to avoid pushing fluids beyond what is minimally essential, because the burned tissues will only become wetter (Ziffren, 1956).

If saline is being given at a rate of 60-120 gts/min. and the urinary output continues to drop (to 5-10 c.c./hr.) along with an increase in pulse and decrease in blood pressure, a bottle



Illust. 4.—All burns including face healed well. Estimated area of burn, 16-18 per cent. No parenteral fluids were required.

by experience to be of questionable value in relation to the clinical picture.

Doctors often fail to realise that the red blood cell, if we think of it as a molecule, is about a billion times as heavy as the albumin molecule, and its osmotic effect in blood is great in contrast with that of plasma. It has been repeatedly shown that whole blood is much more valuable than plasma in other respects and it has the virtue of overcoming hypovolemia instead of increasing it, especially in infants and the aged (Ziffren, 1956).

(c) *Conclusions on the Use of Fluid Formula.*—A formula is often a valuable guide. If used, it should be used cautiously and sparingly, according to vital signs. Blood should make up at least half of the colloid requirement.

Adapting Fluid Administration to Clinical Findings.

It is generally accepted that 25-50 c.c. should be excreted as urine per hour. However, if a

of blood should be put on (Ziffren, 1956).

As the vital signs improve and urinary output continues, the fluids may be slowed or stopped rather than continued (by guessing the amount of shock to prevent). As long as urinary output can be maintained, the doctor will probably have a live patient. One might ideally desire 1,200-1,500 c.c. output in 24 hours, but the doctor should be prepared to accept an amount even half of this, or as low as 250 c.c. in an elderly person, if the vital signs remain good. The doctor should keep in mind that the first few days of a burn are relatively free from the danger of uraemia, while the risk of overloading the circulatory system is an immediate hazard, especially in the young and old (Ziffren, 1956).

Fluid formulae should always be subject to the clinical findings (blood pressure, pulse, respiration, urinary output, etc.), with due precaution given to the tendency to deterioration from overloading.



Illust. 5.—An extensive (C. 25 per cent.) burn is shown after several skin grafts. No initial I.V. fluids were required. Saline was given by mouth. Three transfusions between third and eighth week were given.

Duration of Fluid Administration.

Fluids given intravenously should be stopped after 48 hours, for invariably at the end of 36 hours burn patients have stopped the fluid shift.

Should the doctor find himself in the embarrassing position of having a patient who is overloaded and developing signs of pulmonary oedema, it is best to stop all fluids and to give oxygen, preferably under positive pressure. Autopsy on such cases usually shows that fluid collected in the body cavities, especially the thorax and peritoneal cavity. Therefore the doctor should consider aspirating fluid from these cavities in a live patient in order to help get rid of excess fluid.

CARE OF THE BURN WOUND

Immediate Treatment.

Debridement of the burned area by washing with soap and water, scrubbing or breaking blisters, though often thought to be beneficial, is actually likely to be fatal by causing additional



Illust. 6.—Crust of well-healing second degree burn of buttocks and thigh.

trauma and bringing on shock. True debridement would only consist of completely excising the burned area, turning it into an aseptic wound, but the patient has had enough trauma (Ziffren, 1956).

Baths have been used, supposedly to help combat shock (particularly in children), but these serve mainly as a gross contaminant. If shock needs combating, intravenous fluids are the only reliable method.

A burned area should be treated with as much simplicity as possible. If the burn is free from



Illust. 7.—An open buttock burn that healed nicely.



Illust. 8.—An axillary and chest burn left open by suspending arm from a frame over which a net was placed.

contamination and is not scratched by the patient or irritated by the bed surface, it may be left open and may need no further care prior to the final plan of treating the wound.

If there is gross contamination and loose dead skin, the wound can be gently cleaned and, under sterile conditions, irrigated with saline. The loose skin may be removed, although this is not essential and must be performed with all gentleness. The breaking of blisters is an elective procedure which is justified if it will simplify the dressings and avoid the spreading of the blister from pressure of dressings or the collecting of pus.

Final Handling of the Burn Wound.

The burn area now may be given final treatment, according to its location on the body and to the doctor's clinical judgment. There are several methods to choose from. There will always be oedema in burn cases, as oedema is the nature of burns, and dressings (even plaster) cannot eliminate oedema. Therefore the doctor should choose a method with the primary aim of preventing contamination and promoting healing of the wound:

- (a) *Vaseline Dressing* may be applied and left on 10-14 days provided there are few signs of infection, with the hope that all second degree burned areas will heal and third degree areas will stay clean and be ready for grafts.
- (b) *Fine Mesh Gauze Dressings* may be used, with or without antibiotics such as Bacitrysin, in much the same way as vaseline dressings.
- (c) *Continuous Moist Saline Dressings* may be applied daily and are of value, especially in grossly contaminated and infected wounds.
- (d) *Exposure Treatment* may be chosen, in which the wounds are left uncovered and the patient protected from contamination by cradles or frames over which nets are placed. If the wound can be postured so that the burned areas are not scratched by the patient and do not rub on the bedding, this is our choice of method. An eschar forms within 24 hours (see Illustrations Nos. 4-11) which acts as an effective protection. When the crusting comes off in two to three weeks (see Illustration No. 9) it is hoped that the second degree burns will have healed and the third degree areas will be clean for grafts.

The choice between these methods need not be dogmatic. Methods (a), (b) and (d) are all likely to give equally good or bad results. Infection is the great hazard in any method of treatment, and infection may ruin the final good outcome. There is no reason why any one of



Illust. 9.—The crust is coming off a second degree burn some two to three weeks after burn occurred.

these three methods should be more prone to result in infection.

In our experience the choice has usually been the exposure method, with the exclusion of burns about the hands, which seem to respond better to dressing, and burns grossly contaminated. Otherwise most burns, even those involving the face, neck and buttocks (even in children), have generally given excellent results with minimal infection when treated by exposure (see Illustrations Nos. 8 and 9). The percentage of infection occurring in cases treated by exposure is no more (perhaps less) than that occurring among cases of dressed wounds. The burns about the buttocks and legs of an infant will be contaminated with any method at any rate, and are less likely to become badly contaminated if the wounds are left open (see Illustrations Nos. 6 and 7).

The exposure treatment has these advantages: (1) it is simpler; (2) it uses fewer dressings; (3) it has less odour; (4) the results are at least equal to (and often better than) the results of using dressings; and (5) the hazard of infection seems to be no greater (possibly less) than treatment by use of dressings.

After the burns have been treated for some two to three weeks in any of these ways, and they are not healing satisfactorily, there is the need of treating either an infected burn or a third degree burn, or both. In any case, the original treatment ((a), (b) or (d)) is now terminated and sterile moist saline dressings are the most useful until grafting is indicated.

SKIN GRAFTING

The question of how long to wait before starting grafting is a problem, especially in the face of infection. Experiences with African patients have been gratifying. Often, after waiting indefinitely for infections to clear, grafting has been initiated with results far better than ordinarily expected in European patients. Grafts in the presence of frank pus (and sometimes severe infection) have as a whole shown a very good percentage of take, with the graft doing more to control infection and enhance healing than anything else possible (see Illustrations Nos. 10 and 11).

In general, when a third degree burn is granulating, and preferably while it is still clean, grafting should not be delayed.

A Simple Technique.

Without going into detail (i.e., plastic grafts, etc.), the essential aim of grafting is to get slit thicknesses of epidermis to grow on the burned recipient area. A dermatome, while standard equipment in most hospitals, is not essential, even for extensive grafts. The tool used is not nearly so important as perfecting an effective technique. An ordinary straight blade, knife or razor may be used. The pieces of skin obtained may not be large, but even quite small pieces may be used to advantage.

The donor area is first made as flat as possible by pressure (using two wooden blocks is one method; see Illustration No. 12). The knife is laid flat and, with the necessary pressure downward, a cutting motion is made to slice



Illust. 10—This picture shows grafts that took at least 80 per cent. on badly infected granulating areas.

off a piece of skin (it may be irregular in shape). The loose end of the skin, while it is being cut, must not be pulled, as this may result in too deep a cut, but the skin is allowed to rest on top of the blade until the complete piece has been cut off. The remaining hair follicles, etc., will tell the doctor that the blade has not penetrated too deeply. The pieces of skin are placed in a bowl of sterile saline until they are to be applied.

A simple yet effective way of applying small pieces of skin is as follows:—

- (1) Place the skin on a wooden block, with the outer surface upward, and cut multiple holes (to allow the escape of fluid and pus without elevating the graft) (see Illustration No. 13).
- (2) Place the thumb of the left hand in the middle of the skin, and with mosquito forceps and fingers plaster the skin up over the thumb, with the inner surface of the skin now exposed (see Illustration No. 14).
- (3) Now place the thumb with the skin firmly on the burned area and hold it there until the skin is removed from the thumb and applied to the recipient area. By depressing the thumb the wet skin can be easily placed on the granular area, and further straightening of the skin may be done with mosquito forceps (see Illustration No. 15).

Dressings.

After the grafting is completed, a vaseline gauze or fine mesh gauze or gauze impregnated with antibiotics such as Bacitrysin may be applied. Over this a good layer of cotton wool may be placed, and finally a firm pressure dress-

ing of elastic bandage is applied. Both the donor and recipient areas may be treated the same. The length of time to leave the dressings in place after a graft would perhaps ideally be ten days. However, if there is considerable pus, increased temperature, etc., it may be necessary to remove the dressings earlier. Even then the results are often satisfactory and the skin may continue to grow.

THE CONTINUED NEED FOR VIGILANCE

There are unforeseen pitfalls in the recovery of burn cases. It sometimes occurs after a very satisfactory care of the initial shock and toxic period of a patient with extensive burns that the doctor may relax his vigil. Then after some seven to fourteen days he is dismayed to find his patient dead. This is especially true in the case of a child or infant. Usually the reason for this is septic toxæmia. To avoid this development the doctor should keep a sharp look-out for anaemia, temperature curve, etc., with the adequate use of antibiotics and by changing septic dressings if necessary and cleansing the wound.

A gradual and progressive anaemia (especially in child or infant) may persist for some weeks and is a danger signal that transfusions are needed to maintain HB and higher resistance.

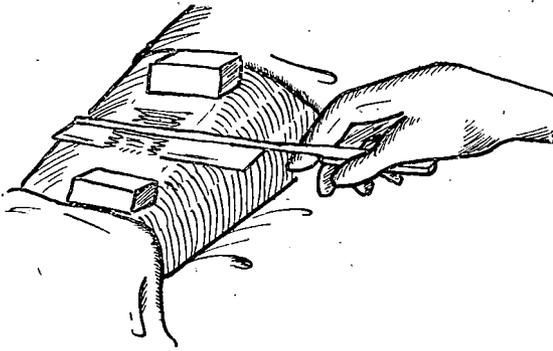
SUMMARY

Young and elderly burn patients have hazards over and above those of the age groups between them. This should be constantly taken into consideration during treatment.

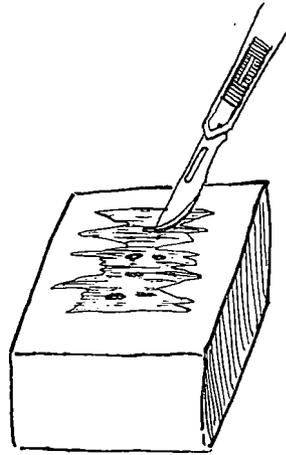
The first aid treatment of burns should be based on the principle that all new burns are sterile and should be kept as clean as possible, with minimum of additional trauma.



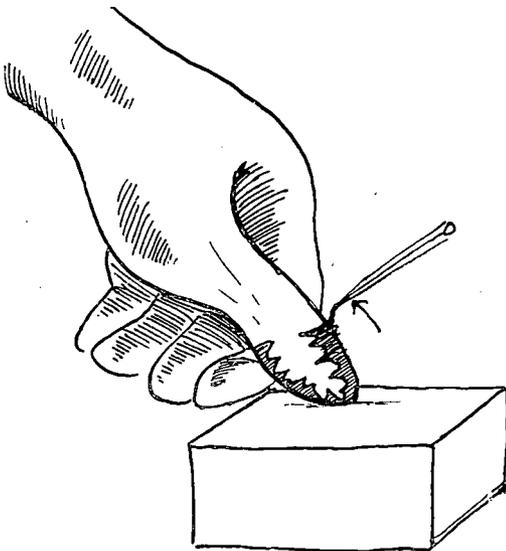
Illust. 11—Picture shows almost 100 per cent. graft take, done on a septic granular area some two weeks after amputation of gangrenous great toe and metatarsal (snake bite).



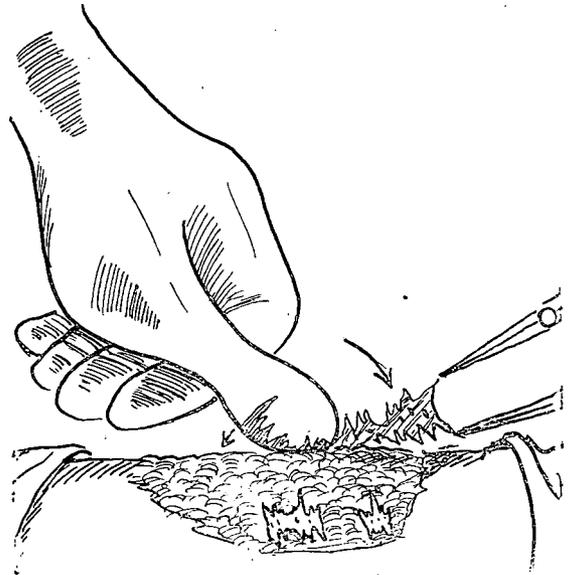
Illust. 12.—As the knife cuts, the skin is left lying on top of the knife.



Illust. 13.—Holes are cut in the skin to allow fluid or pus to escape without elevating the skin.



Illust. 14.—Wet skin can easily be lifted and it adheres to the thumb.



Illust. 15.—The thumb is placed on the receiving area. Then the thumb is depressed to put the skin on the granular area, assisted by forceps to hold the skin.

Hospital management should centre on keeping the wound clean, relieving pain with narcotics and preventing or treating shock. Reliance on formulae for fluid given intravenously and vigorous forcing of fluids to prevent shock should be discouraged. It is easier to manage the first signs of shock from insufficient fluids than it is to manage shock from circulatory collapse due to over-treatment. Pushing fluids to maintain a desired urinary output is also to be discouraged. As long as urine is being put out consistently and the vital signs are good, the doctor should not force fluids.

Generally, it was pointed out that considerably less fluids are often effective without the danger of overloading the circulatory system, particularly in the very young and the aged. The value of clinical judgment (vital signs and regular urinary output) was stressed.

The value of blood was emphasised, and its use may often be preferred, or it may be combined with the use of plasma instead of the use of plasma alone, which heretofore has been considered the standard treatment.

The final handling of the wound may be by dressings (vaseline on firm mesh gauze, gauze alone or gauze impregnated with antibiotics) left on some ten days or moist dressings changed often (for badly infected burns) or by exposure.

Exposure treatment is often the method of choice when positioning the patient permits its use, because (1) it is simpler; (2) uses fewer dressings; (3) causes less odour; (4) gives results at least equal to other methods (if not greater); and (5) gives no greater hazard of infection (and actually may lessen it).

A simple technique of applying skin grafts is possible with simple blades when more elaborate equipment is not available. The main concern is to develop a precise technique resulting in as little trauma as possible.

Vigilance should never be relaxed and treatment may include antibiotics, transfusion, sterile wet dressings to prevent septic toxæmia and to reverse progressive anaemia.

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