unpredictable results are obtained. It might be expected that a fall of pressure in the sinus would bring about generalized vasoconstriction and the recovery of the blood pressure until all the vasoconstriction was used up, as it were. This is the general idea that may be read in most descriptions of the function of the sinus. Experimentally, just the opposite occurs. The blood pressure may fall 25% without the carotid sinus apparently taking any action in its recovery; indeed, the response to occlusion of the carotid may at first be even greater than before. The blood pressure may, indeed, be reduced by 30% before there is a significant fall in the responses of the sinus; while vagus restraint, which we believe is dependent on the depressor reflexes, although reduced, is still retained. A study of the currents of action of the depressor nerve indicates that if a fall of blood pressure is caused by placing the animal in the feet-down posture the electrical changes are reduced for a very short period but are resumed although the arterial pressure is low (Greenwood and McDowall, 1937). It would seem very doubtful whether the recovery from haemorrhage, at least from small amounts, involves the carotid sinus mechanism at all. All that can be demonstrated is that the reactions of the vasoconstrictor centre to falls of pressure in the sinus are increased. This is seen in the increased rises of arterial pressure which occur if the sinus is occluded and by the increased constriction of the spleen and the intestine.

Function of the Depressor Reflexes

We may ask, What, then, is the function of the depressor reflexes from the carotid sinus and cardio-aortic region? A clue would seem to be given by a detailed study of reactions of the aortic depressor or of the sinus, the nerve from the sinus being difficult of access. It is now evident that all procedures which reduce the restraining influence of the vagus on the heart reduce the reaction to carotid occlusion. Of these the most notable are a rise of venous pressure and the injection of small amounts of adrenaline, following which the response of the sinus to carotid occlusion is reduced and may even be abolished for a short time after the arterial pressure has returned to normal. Now, it has been amply shown that the normal vagus restraint of the heart is dependent on the depressor reflexes from the sinus and aorta, and that the most important cause of the acceleration in exercise is a reduction of vagus action. It is but a step to imagine that at the same time the vascular component of the depressor reflexes is reduced also, and that circumstances which reduce vagus restraint reduce general vasodilatation also. Thus as the heart beats faster the blood depots constrict and return more blood to the heart.

It appears, then, justifiable to assume that the function of the depressor reflexes is not to prevent a rise of blood pressure but actually to facilitate such a rise, just as the cardiac inhibitory reflexes through the vagus do not prevent normal cardiac acceleration but, by producing a low resting level, confer on the heart a large range of activity.

Various other pieces of evidence go to support this view. Bayliss, for example, found that stimulation of the aortic depressor nerve resulted in a fall of both arterial and venous pressures—i.e., a greatly increased capacity of the circulation—while it may readily be shown that the reverse occurs on cutting out the sinus. Recently Barry and Loughnan (1941) have demonstrated that carbon dioxide causes a reduction of the activity of the depressor nerve relative to the activity of an ordinary pressor nerve.

It may well be asked how this view of the carotid sinus action was overlooked by Continental workers; but the explanation is clear. In their desire to obtain the maximum responses from occluding the sinus the aortic depressor

nerves were cut at the same time—i.e., all the depressor reflexes were cut off suddenly and simultaneously—with the result that such an intense increase of the peripheral resistance occurred that there was a cardiac failure and, according to Heymans in his monograph, an accumulation of blood in the arteries—a fact which is a little difficult to conceive. If, however, less drastic procedures are adopted it is easy to demonstrate that there is a rise of venous pressure and increased cardiac output—a view with which Heymans subsequently agreed.

In exercise, then, it may be considered that the reduction of the sinus reflexes not only promotes acceleration of the heart but at the same time constricts the blood depots and makes more blood available to the active muscles. Thus we may understand that the right auricular reflex of Bainbridge, by which an increase of venous pressure reduces vagus restraint, also has a vascular component, and experimental evidence of this has already been put forward (McDowall, 1934).

The acceptance of this view of the function of the carotid sinuses has some important clinical corollaries. We see, for example, why it is that mental stress, such as that of recruits for the Services undergoing medical examination, a rise of systolic but not of diastolic pressure is commonly found. This must be produced by an increased output of the heart per beat, and, for reasons just indicated, is easily explicable as a result of reduction of the activity of the depressor reflexes and of more blood being returned to the heart. It would seem, too, that the depressor reflexes, by controlling the blood depots, make available a large quantity of blood which is available not only for exercise but for areas demanding blood, as in inflammation. All this conception of the function of the sinus depends on the existence of a circulation of variable capacity.

(The second of these lectures will appear in next week's issue with a short bibliography.)

THE LOCAL TREATMENT OF BURNS

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In dealing with patients suffering from burns two separate problems arise—the treatment of shock and the local treatment of the burnt areas. This paper is concerned only with the latter. Two recently introduced methods of treatment have been mainly employed, and these have been compared with each other and with other better-known methods.

The irrigation envelope introduced by Bunyan (1940) has been used for treatment of burns involving the limbs and the trunk, while the application of sulphanilamide powder and tulle gras as recommended by Matthews (1941) has been employed mainly for faces, but also for burnt areas on the limbs and trunk. In addition tannic acid and triple dye have been used. A brief description of the technique employed by us is given.

Technique

In all cases except two the burnt area was thoroughly cleaned under an anaesthetic as soon as the patient's general condition permitted. Soap and water or, in some cases, ether soap followed by spirit was used for this

purpose. Dead skin was cut away. These procedures were carried out with the least possible trauma, but preliminary cleansing was thorough. When the irrigation envelope was used any unburnt areas of skin to be enclosed in the bag were washed and, in the case of hands and feet, the nails were cleaned so far as possible.

The Irrigation Envelope.—After cleansing sulphanilamide powder was liberally sprinkled over the burnt area and the bag was then drawn on and fixed in position with adhesive webbing. Care was taken to avoid applying this too tightly in the case of limbs lest it should increase the oedema of the burnt area. The patient was then left for twelve hours, after which any oedema fluid that had collected was drained off and the first irrigation with electrolytic hypochlorite solution ("milton") carried out. This was used in the strength of 2½% of the actual solution supplied, made up with water, and when the envelope was nearly full a 5% solution was run in. The limb was immersed for twenty minutes or until pain was complained of. The irrigation was repeated two or three times daily. It has been found that the average life of a bag is two to three weeks, after which leaks appear. The application of a fresh envelope is often helpful, since it gives an opportunity for light mechanical cleaning of the burnt area, the removal of infected mucus with sterile gauze, and, in the case of deep burns, the removal of necrotic areas of tissue with scissors and forceps.

Sulphanilamide and Tulle Gras.—The cleansed area was thickly covered with sulphanilamide powder and tulle gras was stretched firmly over it in overlapping strips. A fresh application of powder was then made, and several layers of gauze superimposed and lightly held in position with a bandage or face-mask. The next day the gauze was usually moist with exuded serum. It was then removed and fresh powder applied to the tulle gras, followed by clean gauze. This is not necessary in every case, but the dressing should always be removed down to the tulle gras on the fourth day, as otherwise small areas of sepsis may be found to have developed unnoticed. If septic areas were seen the tulle gras over them was removed, they were swabbed with antiseptic solution, and fresh powder and tulle gras applied. In the case of uninfected superficial burns the tulle gras was removed after from five to seven days, when healing had occurred.

Tannic Acid and Triple Dye.—Tannic acid was used in a strength of 15 or 20%, being painted with a brush or sprayed on to the burnt areas after cleaning. Triple dye was applied with a brush. These processes were repeated until a firm crust had formed, when the tanned areas were left exposed to the air so far as was possible.

Depth of Burn.—In our experience the exact estimation of the depth of burning is very difficult to determine, since burnt areas are rarely involved to an equal extent over their whole surface. Moreover, what appears to be a superficial burn at the time of cleaning may subsequently prove to be much more severe owing to coagulation of protein in the deeper layers of skin. It is, however, easy after some days to distinguish surface burns which are superficial enough to allow regeneration of skin to take place from below, and deep burns in which the epidermis has been totally destroyed, so that regeneration can occur only by ingrowth from the healthy skin surrounding the burnt area. A surface burn, even if only of second degree, may, however, be converted to a deep burn as the result of sepsis, and must then be regarded as "a secondary deep burn."

The results of treatment are therefore arranged under three headings—superficial burns (first, second, and third degree), deep burns (fourth and fifth degree), and secondary

deep burns. We have records of 19 cases treated by various methods since October, 1940. Of these, 17 were originally superficial; 4, however, subsequently became infected, and are classed as secondary deep burns. One patient had superficial burns of the face and right hand and deep burns of the left forearm and hand, and his case is classified under both superficial and deep burns. There were thus three primary deep burns. Superficial burns were left to heal naturally by re-epithelization; but the treatment of deep burns, whether primary or secondary, was directed towards obtaining a clean surface suitable for skin grafting at the earliest possible moment. That inefficient treatment of superficial burns may, as the result of infection, lead to gross scarring and perhaps the development of a useless limb is well known, but cannot be stressed too much.

In comparing the progress of burns on two limbs treated by different methods it must be remembered that the more extensively burnt limb is also, as a rule, rather more deeply burnt. When hands and face are burnt while extinguishing an incendiary bomb the face is almost always less severely affected than the hands. Moreover, the face, except for the ears, tends to heal rapidly owing to its good blood supply, while the dorsum of the hand or foot, where the skin is only loosely attached to the underlying tissues and where the blood supply is poor, takes relatively longer. In addition, where the skin is thick, as in the palm of the hand, the depth of the burn will be relatively less than where it is thinner, as on the dorsum.

Superficial Burns

Of the 13 cases under this heading, the burns in 8 were acquired while dealing with incendiary bombs, 2 were due to an explosion in a gas oven, and 3 were caused by scalding with boiling water. Eight cases with burns of the face were treated with sulphanilamide and tulle gras, and these were healed within five to fourteen days, with one exception. This man developed a mild but persistent infection of the forehead and required sixty-four days, before healing was complete. Eight limbs were treated in the irrigation envelope, and required from nine to thirty-two days for healing; extensively burnt hands—one of which was completely "degloved"; and two almost completely—took twenty-one, twenty-two, and twenty-three days to heal. Sulphanilamide and tulle gras were used on ten limbs that were less extensively burnt, and the time required for healing varied from twelve to twenty-eight days. Tannic acid or triple dye was employed on small areas in three cases, which required fifteen, seventeen, and thirty days before healing was complete. In addition, tannic acid was used in three of the cases of more extensive superficial burns, all of which became badly infected; these are further discussed under the heading of "Secondary Deep Burns." Details of the progress of selected cases are as follows:

Case 1.—A woman aged 29 was admitted on December 27, 1940, having received superficial burns on the right side of the face and anterior aspects of both legs from the effects of an explosive incendiary bomb. The blistered area on the right leg extended from just below the knee to the dorsum of the foot and covered an area roughly twice that of the left. There were no signs of shock. The burnt areas were cleaned under an anaesthetic and the blistered skin removed. The face, which was denuded from the nose to the left pinna, including the forehead on that side, was dressed with sulphanilamide and tulle gras. The right leg was placed in an irrigation envelope and the left was treated with 15% tannic acid. During the next two days some pain was felt in the tanned leg and the skin was sore to the touch around the tanned area. No pain was felt in the face or right leg. When the tulle gras was removed from the face on the seventh day the underlying skin had completely healed. On the tenth day the irrigation envelope was removed and new epithelium was found to have covered the burnt area. The tan was still adherent to the left leg and could not be removed until January 29, 1941, nearly five weeks after its application. (Figs. 1 and 2.)

This case shows well how even when tannic acid is applied to a small superficial burn, and when no subsequent infection develops, the time taken before epitheliza-

FIG. 1.—Case 1. Showing complete healing of superficial burn on right leg after nine days' treatment in irrigation envelope. Tan is still adherent to smaller burnt area on left leg: this did not separate for nearly five weeks.

FIG. 2.—Case 1.

FIG. 3.—Case 5.

FIG. 4.—Case 8.

tion is complete under the tanned area is considerably longer than for a larger area on the opposite limb treated in the irrigation envelope. If, in addition, a surface overlying a joint is affected the immobility enforced by the tannic splint must greatly delay recovery of function.

Case 5.—A man aged 44 was admitted on December 8, 1940, with burns from an incendiary bomb involving the entire face and both hands and forearms (Fig. 3). There was complete "degloving" of the right hand, leaving a bleeding surface; the left hand was less extensively burnt. He was anaesthetized and the burnt area cleaned within five hours of admission; the face was treated with sulphaniilamide powder and tulle gras, the right arm with an irrigation envelope, and the left hand with strips of lint soaked in 2% sodium bicarbonate. He subsequently suffered from shock and required a litre of plasma, given intravenously. Four days later both hands were forming new epithelium, especially the palmar aspect of the hand enclosed in the bag, but this hand was more oedematous than the left. There was no pain in either hand. Cultures taken at this time showed a scanty infection of the left hand with Gram-positive cocci and bacilli, while exudate from the bag grew *Staph. aureus* and haemolytic streptococci. The face was still oedematous. Nine days after admission the face was healed except for one or two scabs round the hair margin; the left

hand had become sodden and was dressed with sulphaniilamide and tulle gras. After fourteen days the bag was removed from the right arm and the burnt area was found to be almost entirely covered with epithelium except for the flexor creases of the fingers and an area on the back of the hand. Movement was limited by oedema. A new bag was now applied. After sixteen days the left hand was healed except for small areas on the dorsum of the distal phalanges of the third and fourth fingers; movements were almost full. Three weeks after admission the bag was finally removed from the right arm, which had healed. Movements of both hands were good but not yet full. When seen three months later both hands had full movement and power and were covered with healthy skin except for a small area with early keloid changes on the ulnar border of the left hand and on the right wrist.

The rapid healing of the extensively burnt right hand in the irrigation envelope, in spite of moderate infection, is noteworthy.

Case 8.—A youth aged 19, admitted on March 8, 1941. This patient was burnt as the result of an explosion occurring in a gas oven. The skin over the face and of both hands and wrists was blistered (Fig. 4). The loose skin was removed under anaesthesia, the face was treated with sulphaniilamide and tulle gras, and both hands were fitted with irrigation envelopes. After nine days the bags were removed and the burnt areas on both hands were seen to be covered with a layer of mucopurulent exudate. On culture, *Staph. aureus* was grown. There was some oedema, preventing full flexion of the fingers, and in all respects no obvious difference between the two hands was observed. A fresh irrigation envelope was now applied to the left hand, while the right was dressed with sulphaniilamide and tulle gras, leaving the ends of the fingers and thumb exposed. From now on this hand was used for feeding and other minor activities. It was next dressed on March 20, twelve days after admission, and was then healed except for a small area on the dorsum. The left hand, in the irrigation envelope, was more oedematous and had not reached such an advanced stage of healing. On March 30, three weeks after the injury, the right hand was quite healed, and when the left was removed from the bag there was an extensive scab over the dorsum that did not separate until thirty-two days after the injury.

Although both hands were at first treated identically, after a week direct comparison was made between sulphaniilamide and tulle gras and the irrigation envelope. In this case there was no doubt that more rapid progress was made with the former method, although both were satisfactory. From the moment the right hand was dressed, leaving the finger-tips exposed, the patient began to use it, whereas, in spite of frequent encouragement, the hand enclosed in the irrigation envelope was left passive except during irrigations. To this rapid subsidence of the oedema of the right hand is attributed. Moreover, while only three dressings weekly were required for the hand treated with sulphaniilamide and tulle gras, thrice-daily irrigations were necessary for the hand enclosed in the irrigation envelope.

Deep Burns

Two of these 3 patients were burnt in coal fires—one following an epileptic fit, the other after the destruction of her house by a bomb. The third case was due to explosion in a gas oven. All 3 had severe burns of one upper limb, including the hand in 2 cases. They were treated in irrigation envelopes until necrotic tissue had separated sufficiently to allow grafting to be carried out. The time necessary for this was forty, fifty, and twenty-eight days respectively. The epileptic patient also had deep burns of the face and breast; these were treated with tannic acid 20% and triple dye. Infection of these areas developed, necessitating painful daily dressings, which were in marked contrast with the painless treatment of the equally burnt area in the irrigation envelope. The bomb victim had a circular burn around the forearm and involving the palm of the hand—the skin and subcutaneous tissues were destroyed, exposing muscle tissue and the radius. Case 9, in which there were superficial burns of the face and right hand (Fig. 5), was ready for grafting after twenty-five days,

but the development of a sore throat caused this to be delayed.

Case 9.—A man aged 23 was admitted on March 8, 1941. He was involved in the same accident as Case 8, but was nearer the oven and was more seriously burnt. He was considerably shocked and required plasma transfusions. His face was treated with sulphanilamide and tulle gras, and both arms were placed in irrigation envelopes. The left was much more extensively burnt than the right. After cleansing and removing burnt skin there was no apparent difference in the depth of the burns on the two hands, but in the course of the first week it became evident that the left hand and arm were burnt more deeply than the right. Whereas re-epithelization of the latter began

FIG. 5.—Case 9.

FIG. 6.—Case 16.

after four or five days, the epithelial tissues of the left forearm and hand then began to separate, leaving an area of granulation tissue. This extended round the forearm except for one area of unburnt skin beneath the wrist-watch and its strap, and involved the dorsum of the hand. Two weeks after admission the right hand was healing well, but necrotic skin was still separating from the left forearm. Twenty-three days after admission the right hand had healed except for an area the size of a sixpence over the fourth metacarpo-phalangeal joint. The left arm and hand showed some growth of new skin, especially on the palmar and ulnar edges of the hand and fingers, but most of the burnt area presented a raw granulating surface. Sulphanilamide and tulle gras were now applied to this limb, and twelve days later Thiersch grafting of both aspects of the forearm and the dorsum of the hand was successfully carried out (E. E. L.).

This case demonstrates the early difficulty in determining the depth of the tissue damaged by burning. The irrigation of the more deeply burnt limb in the envelope was valuable in assisting the separation of the necrotic skin and preparing a suitable surface for grafting.

Secondary Deep Burns

Two of these patients were burnt through the explosion of an oil bomb, one from a scald, and one in a manner unknown. Tan or triple dye had been used as the initial treatment in three of them. In one case the skin was blistered but not broken. This was removed and triple dye applied directly without further preliminary cleansing. The tanned area became infected, and was eventually grafted after thirty days (E. E. L.). The fourth case was admitted with superficial burns of the face, both forearms and hands, and the anterior aspects of the legs, due to the explosion of an oil bomb. These areas were cleaned with saline without an anaesthetic and dressed with foille and later with eusol and saline compresses. The legs were healed in seven weeks, and the face and arms in from eight to ten weeks, areas on the forehead and left elbow having been grafted a month after admission. The slow progress in this and the preceding case was almost certainly due in part to the inefficient initial cleansing. The history of Case 16, the most extensively burnt case in the series, is as follows:

Case 16.—A boy aged 14 was admitted on October 15, 1940, with extensive burns involving the back from neck to wrist, the left arm to the wrist, the right forearm and hand, and part of the left side of the face, as the result of the explosion of an oil bomb (Fig. 6). The skin of the back was severely blistered, but the burns nowhere appeared to be more than third degree. He was at first very little shocked, and cleansing under anaesthesia was carried out two and a half hours after the injury. 20% tannic acid was applied. Later in the day the blood pressure dropped to 85/65 and over two litres of plasma was given intravenously. In the course of the next week sepsis

developed under the tan on the back and on the left arm, and the tan itself began to strip off, being removed piecemeal. The temperature rose to 103° at night, and the pulse rate varied between 105 and 130. Eusol dressings were applied; but their removal was extremely painful, and more than two hours was spent over each dressing. Immersion in a saline bath was attempted, but this led to exhaustion and to an increase in temperature. Early in November liquid paraffin and brilliant green 1% were applied, and the burnt area of the back was left exposed to the air. This was followed by some improvement, and epithelization occurred over the centre of the back and the upper part of the shoulders. The rest of the back was covered with infected crusts, and the left arm and flank were painful and heavily infected. The temperature still rose to 100° at night, and the pulse rate varied between 120 and 130. The face and left arm where the tan had not been disturbed by sepsis were now healed except for the edge of the left pinna. At this stage (November 10) an irrigation envelope was applied and thrice-daily washings with dilutions of electrolytic hypochlorite solution (milton) were carried out. Considerable pain was experienced when the strength of this solution exceeded 1%, and it was therefore kept below this. During the first week the infected area became cleaner, epithelium spread in from the healthy skin edges, and numerous small islands of epithelium appeared in the middle of the raw areas. After a week the condition became stationary and then began to retrogress, the new skin becoming absorbed, the raw areas being bathed in pus an hour or two after each wash. The general condition was unaltered. On December 4 the bag was removed, the infected areas were washed for twenty minutes with 10% milton solution under gas-and-oxygen anaesthesia, and a fresh bag was applied. From this time healing continued favourably. A maximum final strength of from 2½ to 4% milton solution was reached in the bag at each wash. This was definitely painful, but seemed to cause no more pain than 1% had previously. Progress was accompanied by an improvement in general health, the temperature falling to a maximum of 99° and the pulse rate to the neighbourhood of 100. By January, 1941, the back had become largely epithelized, but there were fresh signs of reabsorption in some areas. The envelope was therefore removed and tulle gras and sulphanilamide powder were applied. The condition improved, epithelization continued, and on January 24 areas on the left arm and shoulder were grafted (Thiersch and pinch grafts—E. E. L.). On January 30 the grafts were found to have taken well, but there was some infection of the ungrafted granulation tissue of the left flank. Diphtheroids, *Staph. albus*, and *Staph. aureus* were grown on culture. In spite of repeated applications of sulphanilamide and tulle gras the infection spread, and large areas of newly formed skin broke down. Raw areas varying in size from a sixpence to a half-crown developed on both sides of the back. In spite of various antiseptic dressings it appeared as though the whole burnt area would shortly be involved and all the new skin reabsorbed. On February 17 the back was washed with 10% electrolytic hypochlorite solution (milton) in water under anaesthesia and a fresh irrigation envelope was applied. Within two days the temperature, which had risen again to 100° at night, fell, and the pulse rate dropped from 100 to 80. Rapid re-epithelization took place. This continued until March 11, when the bag was again removed, sulphanilamide and tulle gras were applied to the remaining raw area of the left arm and back, and new Thiersch skin grafts were made. These again took well, and by mid-April the back was healed except for a few small areas. Complete healing had occurred early in May.

This case reveals a number of important points. While it is possible that the original application of tannic acid to the extensive burnt area actually saved this boy's life by diminishing the absorption of toxic products, the subsequent infection beneath the tan reveals one of the disadvantages of this form of treatment. During this time what had originally been a superficial burn was converted into an infected area involving the entire depth of most of the epithelium. The use of the irrigation envelope was at first followed by striking improvement in the local condition, great relief of pain for the patient, and considerable time-saving for the nursing staff. The improvement was not maintained, probably owing to the great dilution of hypochlorite used in the wash-outs. Further cleaning with stronger antiseptic and the use of a higher concentration of hypochlorite for the irrigations led to the re-establishment of progress locally and marked improvement in the general condition. Even so, however, organisms (*B. pyocyaneus* and *B. coli*) which were apparently "fast" to hypochlorite

eventually gained ascendancy and reabsorption again occurred. A change over to sulphanilamide and tulle gras was at once followed by improvement, but again organisms (*Staph. aureus*, *Staph. albus*, and diphtheroids) "fast" to sulphanilamide became established after some weeks, leading once more to retrogression. This was halted by reverting to the use of the irrigation envelope and hypochlorite. After the first few days this patient always complained of pain, often severe, during and for some minutes after irrigation.

It is probable that in a case of this type with an extensive, deep, and infected burnt area inevitably requiring some months for recovery, no single method of treatment would have been effective. A change was essential from time to time, and the most rapid progress was noticed to take place always during the two weeks immediately after such a change, whether it was due to hypochlorite or sulphanilamide; this was followed by a period of slower improvement, and then by definite retrogression. The use of the irrigation envelope in this very difficult case contributed materially to ultimate recovery.

Bacteriology

Irrigation Envelope.—Infection of the burnt area was always present to a variable extent, and even prolonged contact with 5% electrolytic hypochlorite solution was not sufficient to abolish it. Thus in one case swabs taken from the burnt area after the initial cleansing were sterile. Three days later occasional Gram-positive cocci were seen in a smear, and scanty colonies of *Staph. aureus* and haemolytic streptococci were grown on culture. Four days afterwards coliform organisms were also present. Smears from the leg of Case 1, taken three days after admission, showed leucocytes but no organisms: on culture *Staph. albus*, diphtheroid organisms, and *B. subtilis* were grown. In another case purulent exudate always collected in the bag overnight, and haemolytic streptococci and *Staph. aureus* were found a week after its application; a fortnight later haemolytic streptococci and *B. pyocyaneus* were grown, and a culture taken when the bag was finally removed before skin grafting, six weeks after admission, showed a heavy growth of *Staph. aureus*, *B. pyocyaneus*, and *B. proteus*. The difficulty of abolishing an established infection was further shown in Case 16, in which absorption of newly formed skin was observed to be taking place two weeks after the bag was first applied: about half a pint of pus was then collecting in the bag overnight. Smears showed a moderate concentration of organisms, and on culture haemolytic streptococci, diphtheroids, and *B. proteus* were grown. The bag was removed on December 4 and the back and arms were washed with 10% hypochlorite solution for twenty minutes. At the end of this time they appeared clean, and there were numerous capillary haemorrhages on the granulating surfaces. During the next five days three washings daily with 2½ and 3½% hypochlorite solution were carried out. On December 9 there was no significant reduction in the number of organisms, and *B. proteus*, diphtheroids, and *Staph. aureus*, with occasional colonies of haemolytic streptococci, were cultured.

Sulphanilamide and Tulle Gras.—When sulphanilamide powder and tulle gras dressings have been applied to a well-cleaned surface, infection has been minimal but has not always been prevented. Thus in Case 5 a smear taken from the face five days after admission showed a moderate infection with organisms of the *B. coli* group, *Staph. albus*, and diphtheroids. Again, a swab from the back of Case 16 taken a week after the removal of the bag, during which sulphanilamide and tulle gras had been applied, showed a sparse growth of *B. coli*; after three weeks *Staph. aureus*, *Staph. albus*, and diphtheroids were cultured. In other

cases *Staph. aureus*, *Staph. albus*, and *M. tetragenus* have been cultured and proved resistant to further treatment with sulphanilamide. Both methods appear to limit infection, but with each of them, when infection becomes established, a change in the treatment is necessary to control it. Streptococci, diphtheroids, and *B. coli* were commonly grown from patients treated with hypochlorite solution, and staphylococci from those with sulphanilamide. Whichever method is employed the initial cleansing of the burn is of great importance.

Pain

Treatment with the irrigation envelope has been relatively painless. The majority of patients have had no pain throughout and have been able to tolerate irrigation with a mixture containing up to 1 oz. of electrolytic hypochlorite solution to the pint of water (5%) without more than a slight tingling. In some cases, however, pain has been complained of. This may occur during or after irrigation. In Case 16 a concentration of electrolytic hypochlorite solution of more than four ounces to twenty pints of water (1%) caused pain throughout treatment. Two other patients with burns on the hands also complained of pain during irrigation with 2½% solution; in one of these there was considerable oedema of the arm, probably due to too firm an application of the adhesive attachment, which was considered to be partly responsible. In the other no obvious cause was discovered, but it was subsequently found that half-strength eusol dressings were equally painful. In one case, although irrigation could be carried out painlessly with 5% solution, severe pain developed in the burnt area from half an hour to one hour after the irrigation was over. This ceased after three or four days of treatment. Treatment with sulphanilamide and tulle gras has been almost entirely painless.

Conclusion

Two new methods of treatment of burns have been investigated and both have been found to possess advantages over older methods. For superficial burns of the face or limbs the use of sulphanilamide and tulle gras has been especially successful, and rapid healing, with good function, has resulted. In some cases, however, infection, usually with staphylococci, has supervened, necessitating a change of antiseptic. This treatment is almost painless, and in many cases need only be carried out every few days. It is the most practical and efficient method for routine use in superficial burns of moderate extent. The irrigation envelope is useful for more extensive burns, and for deep burns in which separation of necrotic tissue must take place before grafting is possible. The burnt area can be readily inspected, and free and painless movement of limbs, fingers, etc., can be carried out during irrigation. The treatment is not always painless, and infection is controlled less well than with sulphanilamide. The application of the adhesive seal round the limb may increase the oedema of the burnt parts unless great care is taken. In some cases a change from one method to the other has been used with success. The irrigation envelope offers an alternative treatment of value in special cases. Both methods possess advantages over tan treatments: first, infection can always be limited and never develops to the same extent as often happens under an area of tan; secondly, the splinting effect of tan, with its harmful effects on the immobilized joints, is avoided. Nevertheless, in widespread burns of the trunk tanning methods may save life in the early stages.

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