THE EARLY MANAGEMENT OF THE SEVERELY BURNED PATIENT*

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I am honored to give the John Chalmers DaCosta Oration this year. First, because of the high position Doctor DaCosta held in American surgery and medicine during his lifetime, and for the profound influence he has had on the Philadelphia schools of medicine and surgery. Not the least of my pleasure in giving this oration is to follow in the line of the distinguished surgeons who have preceded me. It has been an extraordinary delight to have known many of the surgeons who have given this oration, some of whom I count among my dearest friends.

I entered the Philadelphia scene as an intern at the Pennsylvania hospital in 1937, too late to have known Doctor DaCosta. Among my fellow interns were several who used to recount the marvels of his lectures and demonstrations. I gathered from them he was a most remarkable teacher and demonstrator of surgery, up to the time of his death.

It would be deceit for me to claim to have read most of DaCosta's writings, but those I have read impressed me deeply. That he could

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charm with words as well as manner is evident. The greatest pleasure in reading some of his works came from his address on "The Surgeon, the Patient, and the Clinical Diagnosis." I am intrigued by his discussion of the importance of observation in the development of the competent surgeon. It has been my conviction for years that the chief attribute of a good surgeon or scientist is the magnitude and depth of his observational powers. One of the distrubing things of modern life is to note the remarkable powers of observation of young children and how often these become dulled in the educational processes inflicted on them later. Doctor DaCosta wrote wisely on this matter; students of surgery should read his remarks and follow his advice in this respect. (1)

Doctor DaCsota appears to have possessed the emotional qualities that mark the great teacher. His writings recall Werner Jaeger's eulogy of Hesiod, "He was a great poet because he was a teacher." In Doctor DaCosta's case I would reverse the statement and remember he was a great teacher because he was a poet.

The duty of every lecturer and writer is not to expound his wisdom but to teach. I believe you want to hear not what I know about burns from a review of the enormous literature, but rather what I know from my own experience. This lecture, therefore, will outline what I believe to be the objectives and principles for the best early care of the burn patient; these largely gained from personal experience of handling burn patients for the past 10 years.

THE CLINICAL EVALUATION OF SEVERE BURNS

Age, extent of burn, respiratory involvement, and the general state of the patient on admission are the chief factors influencing the recovery of the burn patient.

A. Influence of Age.

With more efficient burn care and enough burn patients carefully studied, it is possible now to evaluate clearly the influence of age on mortality of the burned patient. Although modern methods of shock therapy have greatly reduced the incidence of death in severe burns, many patients in the older age group, (about 60 years) still die following relatively small burns. The statistical studies of Bull and Squire (2) and those from our own burn wards (3) show that a patient over 60 years with a relatively minor burn may die after a short or long hospital stay from causes apparently not immediately related to the burn. Generalized arteriosclerosis, and pre-existent cardio-vascular renal disease seem to be the chief factors responsible. The single factor of immobilisation in bed may lead to an early general disability in this age group. Pre-existent cardio-vascular renal disease makes it exceedingly difficult to plan efficient and adequate fluid and electrolyte therapy for older burn patients. Many of the older age group certainly suffer from malnutrition. Intensive study of the general stress reaction to injury in the older age group may indicate this response to be faulty or lacking in older people after burn injury.(4)

The physician confronted with a minor or serious burn in an older patient must regard the general state of the patient as more important than the burn and "treat the patient as well as the burn." He must appraise the situation carefully and give a very guarded prognosis even though the burn injury is small in area. Perhaps many of these older patients would do better treated at home or at least ambulatory.

In contrast, babies and children stand burn injury quite well if proper treatment is carried out. There are special problems of fluid and electrolyte requirements in very young children but the formulas to be described later seem to provide adequate therapy if they are followed. I am opposed to much of the modern trend of specialization in medicine and think it very important that the physician learn early in his training the proper methods for feeding of infants and children so that he can employ these if confronted with burned children. This does not mean he should not invite the aid of the pediatrician when the problem taxes his competency.

The feeding and nursing care of the burned child is especially important in the earliest hours so the physician must learn from the mother any idiosyncracies in the child's schedule. Nothing is more important for the burned child than proper nursing care; nothing takes the place of a good mother. A burned child may only do well when it is held in the arms in the manner to which it is accustomed.

B. Extent of Burn.

It is now possible to evaluate clearly the relation of the extent of surface burned with the early or eventual outcome of the

patient because in several well conducted burn clinics admitting large numbers of seriously burned patients annually, the management of burn shock is so well conducted along quantitative lines that almost hourly observations are made on hemoconcentration, urinary output, response to intravenous salt and colloid, etc. From the studies of Bull and Squire(2) and those from our own clinic (3), as well as the earlier observations of Cope and Moore(5), it is apparent that from a small burn up to one involving approximately 40 per cent of the body surface, there is an increase in a linear manner in the body's need for fluid and electrolytes.

The alert clinician handling a severely burned patient must remove the clothing of the burn victim so that the extent of the burn can be charted and the patient's weight estimated. After this examination he can calculate rather accurately the fluid and electrolyte needs for the patient. These will be described later. In the event a lone doctor must treat several badly burned patients at the same time, an estimation of each burn injury will indicate which patient deserves the earliest and most vigorous treatment. Also, this examination will help him to decide which patients are hopelessly burned and would probably not recover despite all efforts. Studies by Bull and Squire(2) and our own group (3) indicate that if a deep burn is more extensive than 50 per cent, the likelihood of recovery, even with heroic therapy, is small.

C. Respiratory Involvement.

Of particular interest to the clinician first seeing a burned patient is examination to rule out respiratory tract burn. In our clinic during the past year, respiration tract burn involvement was responsible for fully half of the deaths. Death occurred in several of our patients who had only a small percentage body surface burned but who either early or late developed signs of respiratory tract burn. Respiratory tract burn is usually associated with burns of the face; it is rarely seen in a true flash burn and is most likely caused by inhalation of hot irritating gases. One should examine the nose and pharynx of all patients with burns to discover respiratory tract involvement, especially noting the singeing of nasal hairs and redness of the nasal, buccal and pharyngeal membranes. These patients may early suffer from an intractable cough and their sputum may contain carbon particles. Sometimes the only sign of respiratory burn is difficulty in speaking, or hoarseness.

Respiratory burn involvement must be recognized early so that fluid and electrolytes are given only in the minimal effective amounts, else pulmonary edema ensues. There is really no effective treatment at present for respiratory tract burns. Oxygen inhalations for anoxia, suction removal of excessive phlegm and exudate, occasional by tracheotomy, vigorous antibiotic therapy are all used, often with very little effect.

D. General State of the Patient.

The physician must learn at once the extent of time that has elapsed since the onset of burn injury. In burns above 20 per cent, if no resuscitation measures have been taken and the elapsed time is above

an hour, shock will likely be present, at least to a minor degree. The physician should acquaint himself with the clinical signs of burn shock because in several aspects they differ from ordinary traumatic shock. Burn shock appears much earlier in the burned child than in an adult showing a corresponding extent of burn.

The outstanding sign of burn shock is thirst. This thirst is more pronounced in burn patients than in most patients in shock from other trauma. Burn shock patients complain most bitterly of cold and usually ask to be covered by a blanket. The extremities are, in the main, cool to cold but sweating is a variable feature. The color of the skin and lips may be gray to bluish.

The pulse rate is generally fairly rapid in incipient burn shock, and becomes very rapid in profound burn shock, especially in children. The pulse volume is usually fairly normal in early burn shock but as shock progresses it becomes very thready.

Most burn patients in incipient burn shock are quite apprehensive; however, if shock has gone untreated for some hours they may be first seen in an apathetic, sleepy state; they may be semicomatose. The respiratory rate may be somewhat elevated in moderate burn shock, to become slightly lowered as shock deepens.

Early in burn shock one may experience difficulty in securing blood samples from an available vein without the use of a tourniquet and as shock deepens it may become impossible to collect even a small amount of venous blood with a tourniquet. In my experience, this stagnation of blood is more pronounced in burn shock than in shock from other forms of trauma. It is for this reason that we tend not to rely very much on peripheral venous hematocrit values.

THE MANAGEMENT OF BURN SHOCK

Shock should be suspected in those patients with burns more extensive than 15 per cent and is more likely to occur in babies and children with small burns than in young adults. The clinical signs of burn shock have been presented above. I place little importance on the level of systolic blood pressure as a sign of burn shock except when it is below 100; unfortunately, in the early stages of burn shock the systolic blood pressure may be normal or elevated.

Immediately after admission the extent of burn is mapped out on an appropriate chart so that the extent of burn injury can be estimated. Berkow's (6) or the simplet "rule of 9" chart (7), is used. The tendency to over-estimate the extent of burn injury must be remembered.

I believe the hourly urine output to be one of the most important guides to proper fluid and salt therapy in the severely burned patient, so an indwelling Foley type catheter is inserted in the urinary bladder and the bladder emptied. This initial urine sample is examined for the presence of hemoglobin breakdown products; if grossly bloody, it indicates a severe, extensive, deep burn. Next, a small polyethylene tube is inserted into an accesible ankle vein and an infusion of 0.9 per cent sodium chloride begun at one. A sample of blood is secured from a vein which allows free flow of blood for the initial hemoglobin or hematocrit estimation. This sample of blood when centrifugalised is examined for any evidence of "pink plasma", which, if seen, denotes a deep, extensive burn.

If the burn is extensive, and/or burn shock already established, a suitable colloid solution for shock therapy (plasma, plasma substitutes or whole blood,) is given at once. This is administered rapidly enough to secure a urine output of 25 to 50 cc during the first hour. The first hours' urine should be examined for red blood cells or break-down products.

Extensive trials with gelatine and dextran solutions for burn shock made by us (8) (9) indicate they are as effective and as safe as pooled plasma. If the burn is deep and more extensive than 25 per cent of the body surface, we routinely give whole blood in equal quantities with plasma or a plasma substitute for initial burn shock therapy.

If the initial hemoglobin is above 19 grams and the urine output below 25 cc for the first hour, intravenous therapy is speeded up. In general, we tend to use colloid or whole blood to influence hemoconcentration when the hemoglobin is above 19 grams and use saline or similar solutions to secure and maintain an adequate urine output of 50 to 60 cc per hour. Only when the shock situation is well in hand should attention be diverted to the burn wound, except when the burn wound is extremely painful and it is thought that this pain is a factor in influencing the severity of burn shock.

No mention is made here of oral salt therapy for burn shock. In our clinic we make every effort to secure an adequate oral intake of water or other solutions but we have had little success in using oral salt preparations in the prevention of burn shock in the extensively burned patient. Perhaps in the light of experience of others we have not persevered enough in this regard.(10) Some years ago when I first began treating burn patients,

I used rather routinely oral tea (hot or cold) for fluid therapy. Recently, in looking over these older records I was impressed again with the possible beneficial effect of orally ingested tea.

For the past 2 years we have employed the following formula for the estimation of colloid, salt and water requirements of the severely burned patient. The amounts vary according to the weight of the patient and the extent of the burn. Table 1 illustrates the use of this formula for these estimations. It is emphasized here that even in very extensive burns (more than 40 per cent) we rarely administer more than 4000 cc of chloride or 4000 cc of 0.9 per cent sodium chloride in the first 24 hours, and only half these amounts during the second 24 hours. Our extensive clinical observations and experimental data in the burned animal support the contention of Cope and Moore (5) that there is a definite limit about which, even in extensive burns, the extracellular fluid space cannot be expanded safely.

If the burn patient is in moderately severe shock on admission and 3 or 4 hours have elapsed since the burn injury was received, we have given the complete 24 hour estimated amounts of chloride and salt within the first 6 to 12 hours after admission. This has meant the use of the second day's requirements during the final hours of the first day. This we do not hesitate to do but even then we have rarely had to give more than the estimated 48 hour requirement for colloid and salt.

In general, after the first 48 hours, if fluid and salt therapy secures a good urine output and keeps the hemoglobin level below 19 grams, it is no longer necessary to administer intravenous colloid and salt. By this

time most burn patients take adequate amounts of fluid and food by mouth. Because the adrenal cortical response to burn injury is so profound in its effect upon prevention of renal excretion of sodium, after the first 48 hours we rarely give daily more than 2 to 4 grams of sodium chloride and this only by mouth. An occasional burn patient has shown chemical and clinical signs of potassium deficiency (muscular weakness, aphonia, etc.); this has been treated with 4 to 6 grams of sodium chloride, given intravenously.

I emphasize here the necessity for close clinical observation so that gastric or intestinal distention in the extensively burned patients may be recognized early. It has been characterized by a peculiar type of peripheral circulatory collapse, abdominal distention, and the vomiting of small amounts of blood-stained gastric contents. Roentgenograms have demonstrated the gaseous distention of the stomach. When a tube is passed and gastric lavage carried out in certain of these patients large quantities of air have issued forth under considerable pressure. With the relief of distention the patient's general condition quickly improved.

This gastric dilation may be accompanied by gaseous distention of the small and large bowel, (especially the latter), so measures should be taken to relieve this, (prostigmine, Levine tube, rectal tube,) making certain sodium or potassium deficiency do not exist.

THE BURN WOUND

Only after shock treatment for the severely burned patient is well underway, is attention turned to the burn wound. Of course, in well organized Burns Units with adequate personnel, it is often possible to care for burn

shock and the burn wound at the same time. During the time necessary for adequate shock therapy, the patient's burn wound should be covered with a sterile sheet or sterile towels and the attendants and doctors gloved and masked. If a hospital admits many burn patients, a special room should be set aside for dressing burns under relatively aseptic conditions.

A. Characteristics of the Burn Wound.

Burn wounds do not differ radically from any traumatic wound, except they may not be seeded with as many microorganisms. If the skin destruction is superficial, the necrosis may be so limited as not to support bacterial growth, but if destruction is deep, the burn wound may early show all the evidence of infection invading adjacent dead or living tissue. The point to be remembered is that all burn wounds are potentially the seat of infection because skin is never sterile and cannot be sterilized by local mild antiseptics.

The physician is naturally interested in estimating the depth of skin destruction when he first sees the burn patient, but experience, with developing wisdom, will soon teach him the fallacy of any dogmatic statement of the burn depth from the appearance of the burn wound on first examination. More helpful in my experience in estimating depth of burn is information as to what caused the burn: Was it hot water, steam, actual flame from clothing, or electric contact?

Burns from hot water are generally superficial and supply the uncritical physician the clinical material which forms the basis of the claims for the extraordinary healing properties of the most advertised burn remedies.

These burns heal under almost any treatment so long as the treatment does not damage growing epithelium. On first examination these hot water burns are usually covered with distended blebs, which, if broken, leave a pinkish, weeping surface. Because they involve only the most superficial necrosis and the skin nerve endings are still intact, these burns generally are painful.

Burns caused by actual flame, (burning clothing) are generally serious because the skin destruction is deep, extensive, circumferential and generally not confined to one portion of the body. The skin color is usually grayish-white to a brownish-yellow. The skin is leathery to the touch, and the burn is less painful than in superficial burns because the nerve endings have been destroyed. It is the deep, full-thickness burn that defeats all magic burn remedies; it is this burn that defeats most of the arguments over the relative merit of one burn treatment over another; it is this burn which taxes the ability and ingenuity of the able surgeon; the treatment of this burn requires skill in all the disciplines of the true surgeon: physiology, bacteriology, pathology and the use of the scalpel.

B. Objectives of Burn Wound Care.

Before describing the currently accepted methods for burn wound care, it will be advantageous in judging their merits to set down the objectives and principles that should underly this care. These objectives can be stated simply:

(1) To minimize the severity of unavoidable early contamination or infection.

(2) To prevent or minimize reinfection

(3) To provide and promote drainage of the burn wound, especially if it should become infected; this to ensure a dry wound.

(4) To secure immobilisation of the burned part; this to minimise lymphatic drainage.

(5) To secure healing in the minimum period of time and with minimum loss of function.

C. The Closed Treatment for Burns.

In 1942 Allen and Koch (11) described their closed treatment method for the severely burned patients. This was based on earlier observations on the pressure dressing of serious wounds of the hands and other portions of the body. The main tenet of their procedure was the conversion of the open contaminated wound into a clean wound by patient, gentle washing of the wound with sterile water and soap. The wound was then covered with sterile strips of fine mesh gauze, impregnated with petrolatum, after which an occlusive dressing of dry sterile gauze and mechanics waste was held in place over the burn wound by elastic bandages so that a moderate pressure resulted. In superficial burn wounds the dressing is left in place for 7 to 14 days and when removed the burn wound is practically always healed. In deep full thickness burns the dressing is removed after 7 to 8 days and the full thickness burn slough excised and immediate skin grafting carried out.

This method has come to be known as the "occlusive pressure dressing" of Allen and Koch and has been widely employed with success when properly used. It's value was supported admirably by the observations of Cope (12)

at the Coconut Grove fire. We have used it extensively with a single modification of employing sulfanilamide ointment in a fatty base at the primary dressing.

Several years ago we noted several disadvantages of the closed method, especially if the petrolatum or sulfanilamide gauze was too heavily impregnated with over abundant amounts of ointment. In such instances it was noted the burn wound early became macerated and the burn dressings became sodden with exudate. For this reason, and that such methods of burn care require a trained staff and a considerable amount of costly sterile dressings and time for their application, we attempted to devise a simpler method of burn wound care which would still adhere faithfully to the closed dressing principle.

Accordingly, we now have had considerable experience with a single one piece dry burn dressing.(13) It was primarily developed for use after atomic disaster when a locality could be confronted with mass burns, but it's use is of equal advantage in peace time. The requirements of this burn protective dressing specifically are:

(1) The dressing is of one piece, constructed in such a manner that it can be quickly applied.

(2) To ensure a dry wound, it has adequate absorptive capacity so as to contain any burn exudate that may form, for as long as fourteen days.

(3) It has a non-adhering inner surface of dry gauze.

(4) It does not interfere with normal healing if left in place for as long as fourteen days and is easily removed.

The inner surface of the dressing we use is a dry fine mesh gauze applied directly as such to the burn wound. No grease or ointment is used at the initial dressing. The intermediate layer is first, a one inch layer of absorbent cotton and then many layers of absorbent cellulose. The last six layers of the cellulose are chemically treated so as to be water repellent; this treatment tends to spread any exudate into other dry portions of the absorbent burn dressing. The outer layer is a simple non-woven cotton fabric treated to be water repellent. This treatment still allows the passage of water vapor from the burn wound to the exterior.

Eighteen months of experience with this new dry absorbent burn dressing allow us to make the following comments:

(1) When properly applied this dressing does minimize reinfection from the environment or from other parts of the patient's body.

(2) The dressing provides and enhances drainage of the burn wound so that almost always when we remove the dressing on the 12 to 14 day, the burn wound is dry.

(3) It securely immobilizes the burn part, acting almost as a splinted cast when properly placed on the burned extremity.

(4) In superficial burns, excellent healing is evident at the time of the first removal of the burn dressings, (12 to 14 days.)

(5) In only one instance in the past year when the dry absorptive dressing was placed on the burn wound on admission has the dry dressing become stuck to the burn; in this instance the adherent portion of the dressing was stuck to an area of full thickness slough.

The chief advantage of this new absorptive dressing in my opinion is that it does promote a dry wound by the excellent absorption of all burn exudate. When made in large quantities, is is quite cheap and simple enough that it can be applied rapidly and effectively by relatively untrained persons.

D. The Exposure Treatment of the Burn Wound

The exposure treatment of the burn wound has the same objectives as the closed wound care method. As the term implies, no dressing is put on the burn wound. On admission the burn patient is placed on sterile or clean sheets. No heat cradle is employed. Wallace and his co-workers (7) have up until recently dusted the burn wound with penicillin lactose powder for local antibiotic and drying effect; Pulaski (14) and Blocker (15), American advocates of this method, use no local antibiotic or drying powder. An attempt is made to immobilise the extremities. The patient is protected from drafts. In circumferential burns every effort is made to move the patient frequently to promote drying of the burn wound.

The success of the exposure method is dependent on the rate and effectiveness of drying of the burn wound. In general, superficial burn wounds have a dry surface in 24 to 48 hours and are covered with a thin crust which at first is light brown but gradually become darker. In full thickness burns the surface takes longer to dry, usually about 72 hours. The dry crust tends to be thicker and darker.

Insofar as the objectives referred to above are concerned, the advocates of the exposure method for burn wound care claim that:

(1) If the wound early becomes dry there is an absence of or minimal infection of the burn wound.

(2) The dry burn wound does not become reinfected from exposure to the environment because bacteria will not grow on a dry wound surface.

(3) When the dry eschar cracks, the burn wound drains through these cracks, even when these are filled with sterile gauze.

(4) Superficial burn wounds heal rapidly (7 to 14 days.) If the dry eschar has not separated by the end of the third week, it may be surgically excised and the wound grafted.

(5) Because the wound has been kept dry, there is more rapid healing of deep, second degree burn areas which, therefore, do not require later grafting.

A COMPARISON OF THE OPEN AND CLOSED METHODS OF BURN WOUND CARE

In the past 2 years our clinic has treated approximately 40 patients by the open method and 200 by the closed method described above. It is thus possible to give a tentative statement on the relative merits of each method as I see it.

This comparison of the two methods implies that we have made conscientious efforts to apply both correctly. In addition, I have had the opportunity to see both methods in practice in leading Burn Clinics in this country and abroad. Our tentative conclusions are as follows:

(1) Despite the objections of many, I believe the best results with either method are gained when the burn wound is initially gently washed with soap and water or other detergent in an attempt to convert it from a contaminated wound into a clean wound.

(2) There seems to be no quantitative difference in pain suffered by burn patients treated by either method. As soon as the absorptive dry dressing is properly applied, pain is relieved and even children go to sleep. When either method is properly used very little opiates are needed.

(3) When either method is properly used there is no gross infection and the characteristic odor of infected burns is lacking as long as the dressing remains dry.

(4) Superficial burn wounds, even the deep second degree type, heal rapidly with either method. No more skin grafting seems to be required with one than the other method.

(5) All deep, full thickness burns eventually become infected and remain infected until the burn slough is removed and the area grafted. This infection is less obvious when the exposure method is employed.

(6) In deep burns, separation of burn slough is much more rapid when the closed method is used.

(7) The chief advantage with the closed method is for encircling burns of the limbs or trunk. With these it is exceedingly difficult to get a dry wound with the exposure method. Recently, however, we have noted rather good drying of the circular burns when the burned

member was laid, (not enclosed), on our absorptive dry dressing.

(8) In my experience, it is difficult to immobilise the burned part properly when the exposure method is used. In deep, extensive burns immobilisation is important. Lympathetic drainage from the burn part must be minimised lest overwhelming blood stream infection results.

(9) The exposure method appears to be more useful for burns of the face and perineum.

(10) Hyperpyrexia which is fatal unless effective cooling measures are rigorously employed is more often encountered when the closed method is used, especially if the burns are extensive, (50 per cent) and involve the limbs and trunk.

(11) A high relative humidity and a low environmental temperature are probably limiting factors for the successful use of the exposure method. This is now under serious study in our clinic by Doctor Alastair Batchelor.

Finally, there is probably no single "ideal" method for burn wound care. The two methods (closed and exposure), are not mutually exclusive. I still have a marked preference for the closed method. The thoughtful surgeon can often employ either alone or both in conjunction to the patient's advantage. The effort, so far as I can determine now, should be focused on the production of a <u>dry</u> wound, free from infection and early grafting of the full thickness burn.

CHEMOTHERAPY IN SEVERE BURNS

It is distressing that even today few surgeons properly assess the influence of infection in the healing of the burn wound. So much confidence has been placed in the miracle drugs, the antibiotics, that too little attention is devoted now to prevention of infection and reinfection in deep burns.* Fortunately, it is now possible to remove most of the streptococci, (penicillin), and staphylococci, (aureomycin and terramycin), from the burn should it become infected, but these antibiotics are often administered in a haphazard, illogical manner.

Intelligent surgical chemotherapy results from effective cooperation between the surgeon and the bacteriologist. With the best management, a culture is made from the burn wound on admission and the results reported to the surgeon when they become available in 24 to 36 hours. Sensitivity tests against the several antibiotics are run on all pyogenic organisms and the choice of antibiotic controlled by these test.

In general, penicillin therapy, 300,000 units q 6 hours is started on admission. It is continued at that dosage (rate) until the initial dressing is removed if the patient's course is satisfactory. Should the patient show clinical evidence of serious infection, (temperature, pulse, respiration, and blood count), the penicillin dosage may be increased to around 800,000 units q 6 hours. If the sensitivity tests

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* The figure of Leonard Colebrook looms large in the fight against wound infection in burns. No one in modern medical science seems to have grasped better the significance of Lord Lister's teachings. (16)

show the offending organism not to be affected by penicillin, the most effective antibiotic is selected from the sensitivity tests. We have used chloromycetin, aureomycin and terramycin when indicated.

We now recognize as do others that the burn wound may be contaminated from the outset by Proteous and Pyocaneous organisms which, in our experience, are not effected by any of the antibiotics currently available. These organisms generally are not considered pathogenic in the ordinary burn wound but they may be important pathogens in the severe extensive burn. The recent report of Jackson, Lowberry, and Topley (17) appears to justify the local or even systemic use of polymyxin against B.pyocaneous but so far we have had no experience with this therapy.

It is very important that the doctor early recognize severe invasive infection in the extensively burned patient. We have seen in the past 2 years 5 patients develop this type of infection after deep, circumferential burns, especially of the upper limbs. Any unusual complaint of pain under a burn dressing is indication for its removal and careful inspection of the burn wound. The clinical picture has been dominated by a peculiar mania, high temperature and pulse rate, and pain in the burned member. In some the mania has become so severe as to be almost uncontrollable. It has appeared as early as the fourth or fifth day after burning. When the dressings were taken down there was evidence of deep invasive infection involving necrotic muscle. In certain patients radical debridement and excision of necrotic tissue down almost to bone has been necessary to save the limb. The offending

organisms have been both aenerobic and aerobic in nature. Obviously, the success of any treatment with this type of infection is more dependent on proper surgical excision than on any antibiotic.

I have omitted a discussion of the local use of antibiotics in the prevention and treatment of burn wound infection, not because I consider the topic unimportant, but rather because space does not allow a full presentation of all aspects of this controversial surgical subject.

Tetanus antitoxin or a booster dose of tetanus toxoid is given to each burn patient on admission. In extensive burns, I choose to give an initial dose of at least 3,000 units tetanus antitoxin.

THE STRESS RESPONSE IN SEVERE BURNS

The stress response or alarm reaction is a natural sequel to any traumatizing injury and is believed by most investigators to be evoked by the release from the adrenal of a hormone, presumably Compound F. Profound metabolic alterations occur in relation to this response. Burning injury is one of the more important forms of trauma in which the stress response has been studied.

With the introduction of ACTH and Cortisone into clinical practice, the surgeon caring for burn patients naturally has asked the question: Will ACTH or Cortisone so alter the stress response after burns as to be beneficial to the patient?

Investigation in our laboratories have provided certain answers to these questions.(4) We have learned that the stress response to burning

injury is surprisingly large as measured by eosinophil depression and corticoid excretion in the urine. The eosinophil depression appeared to be closely related to the extent of burning injury and is almost complete with 40 to 60 per cent burns. There was little evidence in the burn patients studied by us that therapeutic doses of ACTH or Cortisone could be expected to alter greatly the already intense stress response after extensive burn injury. Doctor Butterfield and I have not seen any dramatic or unexpected recoveries on a small number of burn patients in whom the natural stress response was augmented by ACTH.

One of the most important contributions of this study has been the discovery of a pseudodiabetic state that occurred quite commonly after severe burning injury, presumably as a result of an intense natural stress response but augmented by forced feeding of a high caloric, high carbohydrate diet which was started soon after the burn patient was admitted. These observations will be reported in detail soon (18); they have lead us to question seriously the merit of ACTH therapy in the acute phase after burning. Indeed, at this time we do not consider ACTH therapy for the acute burn to have a truly rational basis and do not use it in our treatment of the severely burned patient.

If a burn patient is not doing well, (persistent shock state after adequate therapy), it is always wise to have a quantitative eosinophil count made on the blood and, if the eosinophil count is elevated above 100 a tentative diagnosis of an ineffective stress

response to the burning injury can be made. In such an event, it might be rational to expect that Cortisone, adrenal cortical extract or Compound F therapy might be indicated. In our experience, however, we have not yet seen a patient with a severe, extensive burn who has not shown the expected stress response to burning injury.

NUTRITIONAL THERAPY IN SEVERE BURNS

Of great advantage to the severely burned patients is a proper feeding schedule which is started soon after the patient has been admitted. Some nutrition enthusiasts attempt to force-feed large amounts of food during the first few days after burning injury. This is done to lessen the negative nitrogen balance regularly seen after injury. Recent observations by Doctor Butterfield and myself indicate this may be quite hazardous, especially if the carbohydrate content of the diet is too large. (18) Our old experience, (19) of feeding no more than 3,000 calories per day in the early days after burning injury seems to have resulted in good nutrition of our burn patients and I am rather inclined to believe that oral feedings should not be pushed much beyond this level during the first week. We have seen pseudodiabetes, fatal in 2 cases, occur so commonly after forced feeding in the early days after burning injury that we consider it unwise to go beyond these limits.

In conclusion, an effort has been made in this lecture to outline the objectives of good surgical management of the burned patient for

the first week or ten days after injury. Emphasis has been placed on the general physiologic needs of the patient, rather than on specific details of this care. The methods outlined may appear complicated, but, frankly, they are not.

I have tried to follow Doctor DaCosta's admonition (20) and steer a middle course between conservative and radical views of burn care. Some critics certainly will say I have been beguiled by the "Good Fairy" in even presenting the exposure method. Fortunately, time will settle that issue.

To those beginning a career in surgery, a word of advice: Don't shun the care of burn patients. Accept them. Your elders generally relinquish this responsibility with considerable relief and no hard feelings. And, if you can treat many burn patients, from the beginning to the end, you will have schooled yourself in all the disciplines of the true surgeon. These benefits and lessons will carry over into your treatment of all surgical conditions. And not the least from all this experience, you will develop those prime attributes of the Master Surgeon, Compassion and Charity for the unfortunate, the down-trodden, and the ill.

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TABLE I

As a clinical example, a 70 Kg. man with a 35 per cent body surface burn wound require the following during the first 24 hours:

plasma, plasma substitute or whole blood	= 70x35x1 cc.	= 2,450 cc.
electrolyte solutions (0.9% NaCL)	= 70x35x1 cc.	= 2,450 cc.
5% glucose in water	=	= 2,000 cc.
		6,900 cc.

Half this amount of plasma and/or whole blood and electrolyte and the sa amount (2,000 cc.) of 5 per cent dextrose in water is given the second 2 hours. Calculation will show that should the burn involve 60 to 75 per cent of body surface, large amounts of colloid and saline would be requi if this formula were employed. Nevertheless, we rarely give more than 4,000 cc. of colloid or 4,000 cc. of saline solution in 24 hours, no mat how extensive the burn.