

5-1-1942

## Therapy of thermal burns

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THE THERAPY OF THERMAL BURNS

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Senior Thesis

Presented to the College of Medicine,  
University of Nebraska, Omaha, 1942

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## INTRODUCTION

The study of the methods of treatment of burns is a difficult one since, as Glover (28) states, "The surface area and amount of tissue involved in each is different." Therefore, it is difficult to evaluate the results obtained by each type.

The etiology in a burn case is already established. Throughout history reference is made to fire. It would seem that fire has helped develop our civilization, and at present it is a great aid in destroying that same civilization.

Dupuytren's classification of burns is used as it is given by Bancroft (4):

First degree - Erythema

Second degree - The formation of blisters.

Third degree - A considerable amount of epithelium is destroyed so the papillary layer of the derma is exposed. Some interpapillary epithelium, hair follicles and glands are unaffected.

Fourth, fifth, and sixth degrees, as described by Dupuytren merge one into the other, and are based largely on the depth of the burn.

An attempt is made here to cover the various types of treatment with particular reference to local treatment. The techniques used are discussed so that the

advantages and disadvantages of each may be better understood. Since shock is common to several conditions and is a subject in controversy in itself, shock is mentioned only where the various men believed that their form of local treatment had some influence on it.

Reference is also made to the thesis's of Dilworth (21) and Hawkins (34) for information regarding the theories of toxemia considered in themselves. The theories are considered here as they affect the type of treatment under discussion.

### OBJECTS AND RATIONALE OF TREATMENT

Each author has at one time believed that his method of treatment has certain advantages over others, but as usual when there are many methods of treatment, each leaves something to be desired. The ideal local treatment would be a dressing that would be analgesic, antiseptic, non-toxic, of a stable nature, easy to apply, stimulating to the healing of tissue, cleansing, and non-irritating. It should also stop the breakdown of tissues, aid in the prevention of shock, present an easy nursing problem, and prevent the formation of scar tissue and contractives. If all the above are present, the patient will be a grateful one and the attending surgeon would be satisfied that he did a good job. Some men include among their objects of treatment the exclusion of air from the damaged area as it is their belief that exposure to air causes the patient much discomfort.

## COAGULATION IN TREATMENT OF BURNS

Ehrenfried (24) in referring to picric acid describes what is attempted in coagulation treatment as follows: "Forms a protective, aseptic scab . . . which heals up ruptured lymph spaces, protects exposed nerve-endings, and splints the wound in such a fashion that epithelial proliferation may proceed rapidly beneath, simulating Nature's method. This artificial scab protects against infection from external sources and promotes rapid and painless epidermatization." The above quotation seems to pretty well fit the idea of the coagulation treatment.

The earliest use of the tannic acid eschar is believed to have been among the Chinese in the sixth century, B. C. The strong tea they used has a tannic acid concentration of about seven per cent; however, this method of treatment became lost for some time.

Mitchner (59) reports that an attempt was made to coagulate surface proteins by Petit and Lister in the nineteenth century. These men used perchloride of mercury as a precipitating agent; however, the patients so treated either died or suffered severely from mercurial poisoning.

Also, late in the nineteenth century, Horwitz (42) mentions the use of silver nitrate for the local treatment; however, this is just one among many methods used at this time.

About the turn of the century picric acid enjoyed a certain popularity. Other men such as Levings (47), Foote (26), Kern (44), Colquhoun (16), and Maingot (51) wrote about the use of picric acid. A ten per cent aqueous solution as usually used; however, sometimes it was quite painful. A six per cent alcoholic solution was also available. The last article noted in the literature on its use was written by Colquhoun who believed it to be often responsible for a dermatitis venenata picture with edema, erythema, and vesiculation. He also comments on the toxicity in general and goes on to say that he doubts its antiseptic value. Maingot believes that the mortality of treated burns is cut in half when tannic acid is used instead of picric acid.

Davidson reintroduced the tannic acid treatment of burns in 1925 and his treatment soon met with many favorable comments. As soon as others tried it there was disagreement as to concentration of the solution to be used so that it may vary from 2.5 per cent up to 20 per cent. The technique is to spray the burned areas where a third



degree burn is present after thoroughly cleansing the affected area. The area is usually sprayed each hour until an eschar is formed. The eschar may form anywhere from twelve to twenty-four hours.

The above mentioned method may be found in many places in the literature as in the writings of Wilson (85), Howard and Allan (43), Homans (40), Cohen (14 and 15) and Milford (58).

In considering the value of a tannic acid eschar it is obvious that air is excluded from the injured surface. The eschar is believed to aid in the prevention of toxemia as the protein is fixed in the burned tissue and cannot be lysed. The eschar prevents a new infection. The outpouring of fluid from the burned surface is stopped.

Tannic acid does not seem to be antiseptic to any degree. Another disadvantage is that the solution should be made up fresh. The time interval before the eschar is formed is also considered a disadvantage. This substance is also hard on the linen used around the patient. The use of tannic acid does not seem to stimulate tissue healing. Despite the advantages and disadvantages the method's advocates believe that the mortality from burns was reduced to two-thirds of that when previous methods of treatment were used.

Shillito (72) in 1929 initiated a variation in the silver nitrate treatment by utilizing light with a one to five per cent solution of silver nitrate. A mercury vapour or tungsten arc lamp is placed six to twenty inches from the sprayed lesion. A black, dry shiny coagulum is the result. Another application is made within twenty-four to thirty-six hours. The coagulum has the ability to prevent over-irradiation and seems to have about the same properties as that formed by tannic acid; however, the author explained he used this treatment on second degree burns only. His rationale is that the silver nitrate is ionized by the light, and the light has a bacteriocidal effect along with a sedative effect on the peripheral nerve ends.

The next coagulative treatment was the use of ferric chloride introduced by Coan (12) in 1935. As is the case in many discoveries, this one was entirely accidental. It was found when a man fell into a vat of boiling ferric chloride. The technique used is to paint or spray over denuded surfaces a mixture of:

Tincture ferri chloride	15.0
Sodii hydroxidi	0.3
Aq. dest. q. s. ad.	30.0

Tincturae ferri chloridi may be painted over first and second degree burns.

All the advantages claimed for the tannic acid treatment are claimed here with the addition of having a stable solution and a more flexible coagulum. The men innovating the treatment believe it is easier to detect neurosis and infection beneath this eschar. The disadvantages are the same as tannic acid; however, if the tincture is used, faster action is obtained, but the dressing is more painful to the patient.

Due to the length of time it takes to form an eschar with tannic acid, silver nitrate was added to the treatment. Bettman (6) is given credit as the originator of the technique where five per cent tannic acid is followed by spraying on ten per cent silver nitrate. The technique was also described in 1935. This method eliminates the objection of the slow formation of an eschar and conserves the body fluids sooner. Some experimental work was done on animals and it was found that seventy per cent of the body fluids may be lost in twenty-four hours if the burn covers one sixth of the body surface; however, by saving fluid the kidneys and other organs are saved from fluid concentration. The silver nitrate is believed to penetrate far enough to have some antiseptic value. The claim is made that a thinner, more flexible eschar is formed which is not so apt to cause constriction. A constriction such as around

a limb, may result in a contracture which is a serious disadvantage. The nursing problem is somewhat simplified here.

The authors who agree as to the use of tannic acid or the Bettman modification agree that skin grafts are often necessary, but they disagree on the use of stimulating dressings and the handling of infection beneath the coagulum.

Wilson and Cohen believe if pus floats up the eschar, the eschar should be stripped off and wet dressings and antiseptic lotions are of no value. Cogswell and Shirley (13) use one-fourth per cent chloragene solution packs to clean up the infected region through the opened eschar. Hartman and Schelling (33), utilizing the standards prescribed by the Federal Food and Drug Act for testing, found that any tricresol 1:28,000 was effective against *E. typhi* and *S. aureus* when combined with tannic acid and hence would eliminate infection. Their idea was successful, but the dressing was so irritating it had to be abandoned. McCorkle (54) after getting a coagulum from silver nitrate and tannic acid uses one per cent gentian violet over the surface for several days to keep down infection, or if he finds it necessary to split the coagulum, as when the burn en-

circles an extremity, to prevent a contracture, he sprays the defect with gentian violet. Morhardt (61) uses one per cent aqueous gentian violet before utilizing the silver nitrate tannic acid treatment. Another recent article by Cohen mentions the use of one per cent brilliant green in thirty per cent alcohol to paint the coagulum daily to keep down infection; however, a more recent article by the same author expresses the belief that the infection can usually be handled by the body, although he used sulfanilamide orally on the burned soldiers evacuated from Dunkirk. When using sulfanilamide he tries to build up a blood level rapidly. Heuschen (36) also makes use of sulphaniilamide. Glover utilizes dressings of Dakin's solution over the eschar when it begins to curl at the edges to reduce the danger of infection.

As in other fields of medicine there is a tendency for methods to change like the swing of a pendulum. Skin grafts were recommended by such men as Holmes (39), Roberts (67), Levings, Lexer and Bavan (48), Dorrance, Wilson and others. Poyner (66) dakinizes the granulating surface before using pinch grafts. A more common type graft seems to have been the Ollier-Thiersch graft. Heuschen uses a graft between the thickness of the Thiersch and

Wolfe grafts which he perforates with multiple incisions to allow discharge from the granulating surface to escape.

The rubber sponge bandage was recommended by Luxenberg (50) in 1933. A piece of vaseline gauze is placed next to the granulating area and is followed by fluffs of gauze to aid with drainage. Sheet wadding is placed on next to protect the surrounding skin from irritation by the sponge. A rubber sponge is then applied to cover the entire granulating area and is bandaged on with gauze or an ACE bandage, the advantage being that the part so bandaged may still be used. By 1937 Cookely (11) was using an early skin graft following an eschar to prevent contracture at the flexor surfaces of joints.

Cogswell and Shirley utilized ultra-violet light, scarlet red ointment, cod-liver oil ointment, or oxyquinoline sulfate scarlet R gauze before grafting; however, they make no recommendation of which to use on the granulating surface left after the coagulum has been removed. These men recommend the use of homografts to prevent septic absorption if autograft cannot be obtained.

The use of the oxyquinoline sulfate scarlet R dressing is recommended by Bettman while Branch (7) recommends the use of scarlet red t. Scarlet red

ointment was started by Fischer in 1906 and reference to it are found mainly in the German literature according to Herz (37) who uses scarlet red ointment eight per cent. An area ten by three inches was filled with solid skin in eleven days by changing the dressings three times per day. This ointment was used at the periphery, and boric acid ointment was used in the center.

The more recent developments in the uses of tannic acid seem to be the use of sulfanilamide internally and the care taken when a coagulum is placed over the fingers and hands. Cohen places a sterile dressing over the region and movements started within one week of the injury. Tannic acid jelly has also been developed which was believed to be of value in the first aid care of the men evacuated from Dunkirk. The men injured seemed to do well although some of them had developed a septic condition with this type first aid.

One recent product contains tannic acid ten per cent, metaphen 1:5000, benzyl alcohol four per cent and a combination of potassium, sodium and calcium chlorides to make the solution isotonic when the product is diluted with four parts of water. The product has been developed with the idea of getting an antiseptic effect from the metaphen and an anesthetic effect from the benzyl alcohol.

## ARTIFICIAL CRUSTS

In keeping with the idea that air must be excluded from the burned surface many devices to form an artificial crust have been used.

In 1842 Robert Liston (49) recommended the use of an artificial crust of tar, pitch, flour, starch, or hair powder. Then he went on to recommend the separation of injured parts to prevent cohesion. It does not seem proper to give Liston credit for the kinds of treatment as he was merely reporting the ideas of his time. No recommendation was made regarding the various treatments as to classification of burns.

Goldbeater's skin, a tough membrane of ox's cecum or from the intestines of other animals, was placed over burns of the second degree, but Attlee (2) in 1858 has a different treatment for third degree burns.

The first mention of collodion found was made by Helmuth (35) in 1879. Another method mentioned is the uses of molasses and honey to cover the lesion.

About the time of World War I the "Ambrine treatment" was introduced in the United States by Sherman (71) who reported three thousand cases with what he believed were good results. A Frenchman, Barthe de Land-



forte, introduced the treatment in 1914. The dressing consists of paraffin ninety-two per cent and a combination of oil of eucalyptus, olive oil and beta naphthol to make eight per cent. The affected area is dressed after it has been thoroughly cleaned and dried. Melted paraffin is now sprayed over the burned area until a thick coat has been applied.

Keen mentioned the use of paraffin dressing after irrigating with acriflavine 1:1000 and having a reasonable degree of assurance the wound was clean. He used a combination which was made up in the following percentages: scarlet red, 0.2; eucalyptus oil, 2.0; olive oil, 5.0; adeps lanae hydrosus, 4.0; paraffinum molle, 21.0; and paraffinum durum, 67.8. Other combinations contained betanaphthol, eucalyptus oil and olive oil or resorcinol and sudan or eosin and beeswax, or olive oil and asphalt. By the additions to the paraffin it was believed the additional advantages of stimulation of healing and some antiseptic value might be gained.

Main ot, who was still using the method in 1937, applied a thin layer of cotton over the paraffin, more paraffin, and so on alternating the layers. A fresh dressing was applied each day and sometimes irrigations of acriflavine of 1:1000 were used instead of sterile water. When gross contamination was found, sodium

sulfate or sodium chloride ten per cent was used. Skin grafts were used when necessary.

Industrial medicine still finds use for this type of dressing according to Zeiss (86) who in 1940 reports his method of treatment. It is believed advisable to change the dressing daily each time finishing with a layer of cotton bandaged into place last. His method allows inspection of the injured area each day. When the dressing has been removed, a solution of 0.5 per cent sodium hypochlorite is used to remove drainage, the lesion is irrigated with Dakin's solution for two or three days. Early grafts are used. If the wound is contaminated with tar, the first time the paraffin is removed, the tar will come with it.

By using an artificial crust air is excluded from the burn which has an analgesic effect according to some, and it also prevents additional infection by bacteria. The dressing is a non-toxic one and does not cause irritation. Whether or not this type dressing helps stop the break down of tissue, aids in the prevention of shock, and prevents the formation of scar tissue and contractures is a debatable point. The nursing problem is simplified in that there is no damage to the bed linen and the lesions require attention but once a day.

Paraffin does not seem to have any antiseptic value or seem to be cleansing except where tar has caused the burn. Although paraffin is a stable mixture of hydrocarbons, it must be kept warm in order to spray it on the wound. Zeiss claims it is an advantage to change the dressing daily so that the burn may be examined; however, a transparent crust would remove this objection as one could see the burn through the crust.

## OILY DRESSINGS

Surgery books after the Civil War mention the use of Carron oil, which is composed of half linseed oil and half lime water, for second degree burns. Holmes mentions this type dressing and also the use of carbolized oil when the wound begins to have a putred odor. The wound was also swathed in wool. An interesting sidelight is the use of carbolic acid, cas<sup>s</sup>arilla bark or iodine to sweeten the odor of the room as a foul odor would destroy the appetite and cause diarrhea.

Foote mentions the use of an oil dressing in second degree burns to protect the lesion from changes in temperature and also from the air.

Ointments are recommended for first degree burns by Lexer and Bevan.

Following World War I Horan (41) advocated the use of dichloramine T which he used in an undisclosed number of cases. The solution used was two per cent dichloramine T dissolved in chlorocosane, which is chlorinated paraffin wax. The solution is sprayed on the burned surface and followed by wet compresses of the same which are changed daily. This method was used as the oily base prevents ease of changing dressings, has some

antiseptic value, and retains its properties for twenty-four hours. At the appearance of granulations aseptic vaseline compresses (ninety-one parts vaseline, six parts paraffin, and three parts resin) were used. When necessary the Dan's pin prick graft was employed.

Although carron oil maintained quite a popularity before the World War I, little was heard of oily treatment following the war. Some work was done by Steel (74) in 1922 using a hot air mineral oil treatment. The locally burned areas are sprayed three times a day with mineral oil, and the patient is placed under a light cradle. The patient lies on a gauze pad which is changed daily and is allowed to assume any position desired. The physical chemistry of oils in the treatment of burns was not investigated until later, but clinically it was believed that suppuration was reduced and adherent material separates and falls off in about a week. The exuded serum forms small, lumpy crusts which fall off or are picked off every second day. There was little handling of the patient, and the method was cheap. Some analgesic effect was obtained. Since no debridement was used the clothes were removed with warm saline solution. The treatment was not used on areas where there was much charred tissue.

Antiseptics such as eucalyptus oil and carbolic acid have been added to linimentum calcis, while Tomb (78) used chlorinated lime in the liniment as it had the properties of the original liniment plus the antiseptic values of the hypochlorites; however, the new type of liniment must be made weekly because of deterioration. No cases where this treatment was instituted were reported, but it was used in iron foundrys where the burns were said to have healed rapidly without pain, suppuration, or rise of temperature and with sloughing of dead and decomposing tissue taking place at a rapid rate.

At times proprietary treatments come out such as Anticests which was not accepted by the N. N. R. but for which extravagant claims were made.

Provitamin A ointment was used by Baker and Vonachen (3) in 1937. The carotene or provitamin A is derived from a plant source as fish liver oils become rancid as they contain free fatty acids which also give off an odor. Preservatives might also have an effect on the wound. Carotene equivalent to 2000 units of Vitamin A per gram is used in the ointment. A cacao butter base is used with petrolatum to get the desired consistency as the cacao butter is said

to penetrate tissue better. The base is sterilized and carotene is placed in the base at 65°C then the ointment is filtered and parked.

No controlled experimentation was done, but nineteen burns of all three degrees were treated by applying the ointment once a day. Cod-liver oil had been used in the past by such men as Seiffert, Fueller, Loehr, Drummond, Green and Mellanby, Proto, and Steel; however, Proto found that by applying A and D directly to the wound it was stimulating. Baker and Vonachen believed Vitamin A was the effective part of cod-liver oil and they say their treatment was successful in some instances where others failed.

Berlien and Davis (5) and Hardin (31) have used cod-liver oil and vaseline and believe the chief values are the relief of pain and stimulation to epidermal growth.

One reference was found on the use of aloes in an ointment. Crews (17) cleaned up the injured area and sometimes used a preliminary wet dressing of a teaspoonful of each borax and sodium chloride in a quart of water. Vesicles were collapsed and mercurichrome injected. With the area ready to be dressed the ointment, consisting of two drachms of mineral oil and one ounce of white vaseline was spread one-eighth inch deep on several layers of

sterile gauze. The dressings are laid ointment side down on the wound and bandaged into place. Dressings are changed every two days and only four to six dressings are usually required. This regime is followed by zinc stearate or some other bland dressing. The aloes are claimed to be analgesic, and to promote healing. The drug is an astringent and is claimed by some to be an abortifacient, but the author had no trouble in the two cases where abortion could have occurred. No cases were presented where the patient's life had been endangered. Collins and Wright have used aloes in roentgenologic injuries.

Some recent experimental work has been done by Thompson, Clayton and Howard (77) which tends to uphold the former use of carron oil. Work was done on guinea pigs and rabbits, and they found that uncontaminated wounds healed quickest when treated with an oil such as cod-liver oil or carron oil. Neurotic tissue is liquefied as the oil penetrates. Two other advantages are a comfortable dressing is used and new growth is stimulated.

The oils were studied from the view of interfacial films. When tannic acid and protein are combined, a mutual coagulation occurs which is hydrophilic in makeup. Oil/protein membranes are both hydrophobic and hydrophilic, and as cell membranes must let both water



and fat soluble materials pass through; an attempt at analogy is made here. These men believe that the film has an ability to absorb toxic materials better than the tannic acid type. It also seems that better drainage is obtained when oil is used. Reference was made to some work by Löhr who found that streptococci, staphylococci and Bacillus coli perish in cod-liver oil. These authors also refer to Haas who did some work with lipoid material and water by making subcutaneous injections of cod-liver oil into a guinea pig. It was found that distinct membranes similar to elastic tissue are formed. The article suggested that further work be done along the lines that they had laid down. If the results obtained are true, they fulfill the desirable qualities necessary in the ideal therapy with the possible exception of aiding in the prevention of shock.

## WET DRESSINGS AND BATHS

The older surgical texts such as Liston and Horwitz mention the use of cold applications as burn therapy while Foote specifically mentions the use of gauze strips, soaked in normal saline for second degree burns or moist dressings of alumium or boric acetate which have been kept warm. Sloughs were cut away as they loosened. Lexter and Bevan, after the removal of gross dirt, recommended boric acid or soda solution warmed for use on second and third degree burns. They also recommend the use of grafts following warm water grafts. Lord Lister is said to have used a saturated solution of boric acid which was later condemned by some on the same basis that normal saline was condemned. Such solutions are believed to hydrate the eschar and liberate any toxic products which had been trapped there. These recommendations were all made previous to 1908.

Acetic acid one-half per cent on a sterile dressing of turkish toweling to hold the heat was used by Dorrance and Bransfield (22) in 1922. As soon as the initial shock was over, the patients were placed in a saline bath at 110° F., and the clothing was cut away. The acetic acid dressings were kept saturated and baths

were given twice daily. On the second or third day criss cross cuts are made to form two centimeter squares to let the acid get to all parts which aids in forming the slough. The object is to cut completely through the charred material so there will be little reabsorption. The dressing is used until a char surface is present so the surface may be Dakinized. Then a graft follows. One-half per cent wet acetic acid sterile dressings are said to alleviate pain in first degree burns. The rationale here was that damage is done by toxalbumin immediately after the injury as in the case of a crushing injury of a limb where the patient may die when the tourniquet is loosened on arrival at the hospital.

Reasoning that since the histopathology of burns and frostbite was similar, Rose (69) in 1936 had a rationale of treatment which was based on the limitation of edema and the lessening of tissue damage by stopping vasodilatation which would cause some capillary walls to rupture. The procedure was to remove as much clothing as possible before submerging the injured parts in cold tap water. When the face is burned, cold dressings are applied to it. Pain is relieved which the author states helps relieve primary shock. Harkins (32) mentions the work of Blalock and Underhill who showed

that in burned animals the edema fluid at and around the site of the burn may equal over fifty per cent of the blood plasma volume. Fluids are given orally and intravenous medication may be started when the patient is still in the tub. At first the temperature is 60° to 70° F. and by the beginning of the third hour it is raised to 98° F. Sedation is then given, clothing removed, and any scrubbing to be done takes place. Rose follows with the tannic acid and silver nitrate coagulum.

Meyer and Wilkey (57) attempted to evaluate the methods used at the Cook County Hospital up to 1938. Although mildly contaminated wounds were treated with five per cent tannic acid, the patient was first placed in a tub containing a solution of sodium bicarbonate to cleanse the surface. Next fat solvents were used. Then the burned area was washed with white soap which was believed less irritating than green soap and later irrigated with boric acid solution. Where the wound was severely contaminated moist saline or boric acid dressings were used. The dressings were changed three to four times daily, each time washing the area with soap and water. Xeroform, tribromphenol, plus bismuth, strips which are sterile gauze with sterile vaseline containing three per cent xeroform are used later. The strips are changed daily, each time cleansing the area with boric

acid and white soap. The strips are covered with sea sponge and handled in the manner recommended by Luxenberg. These men admit hospitalization is longer, but they believe the mortality is lower.

Special reference is made to the bath procedure by Lavender (46) in 1939. He mentions the belief that burns are usually deeper than scalds. The cases treated were first hospitalized and given supportive therapy. After an initial rest period, the patients are given some form of mild sedation and placed in a hammock in a large tub of water at 100° F. The water contains one pint of aqueous green soap which is the same as the U. S. P. tincture except the oil of lavender is omitted and water replaces the alcohol then. The soap is filtered as usual. The patient remains in the tub five to ten minutes and is removed to a sterile sheet where debridement takes place with sterile gauze. The latter process should not take over four to five minutes. Dressings of old linen or cotton, not gauze, are placed on the injured areas after they have been soaked in Burrow's solution (alum, five parts, and lead acetate, twenty-five parts, dissolved in 500 parts of water), two ounces to a quart of water. The dressings are kept constantly wet. The following day the patient is tubbed with the dressings on as they will float off. Dressings

are applied immediately after each bath. By the third day of treatment the patient can usually tolerate an hour in the tub. Each day the time in the tub is extended finally using the tub twice a day. All the fluids desired are given while the patient is in the tub and mild exercise is encouraged to prevent contractures. After a time the patients begin to look forward to tubbing. Grafting can be done without any further preparation; however, if pyocyanus infection is present use dressings containing ~~one~~ per cent acetic acid or two or three percent ammoniated mercury if Barrow's solution is not sufficient.

Rats were used in an experimental work by Smith, Risk, and Beck (73) in 1939. These men built a wooden cabinet with glass windows into which could be forced air and atomized water that had been heated to 250° C. to sterilize and then cooled to 90° F. Two hundred cubic feet of the mixture per minute were sent into the cabinet. By branding the animals with a brass rod some equality in the size and depth of the burns could be obtained. After branding the rats were placed in the cabinet. The animals treated in this manner healed more completely and faster in four weeks. The percentages of healing was at least nineteen per cent more

than where no humidity was used. Twelve animals were used for each test. Tests were also made using surgical excision or tannic acid with and without moisture. The poorest results were obtained where tannic acid alone or butesin picrate alone were used.

A more portable method of bath procedure was devised by Bunyan (9) in 1940. The burnt area is washed with a five per cent solution of electrolytic hypochlorite at 100° F. as a superficial method of cleansing. Next an appropriately coated and shaped silk envelope, which is made watertight by resins, is slipped over the affected area. A watertight seal of some sort is made with the body. Two openings are necessary in the envelope so that liquids may be put in and taken out. The author uses two solutions: A. sterile water at 100° F. and B. normal saline with sufficient electrolytic hypochlorite (containing one per cent sodium hypochlorite) to make a five per cent solution. The two solutions are connected to the envelope by a Y tube so that the solutions are connected and on reaching the burned surface will contain equal parts of each. The envelope is agitated, and in twenty minutes the fluid is run off. More hypochlorite may be run in to take off that which combined with the dead organic matter. The procedure is done three times per day when infection is present,

and twice when not. The envelope is left on until the wound is healed or a graft is attempted. Some advantages for this method in particular are it can be used with compound fractures and can move affected limbs. The author believes less mental trauma is experienced.

The War Wounds Committee of the Medical Research Council of England also makes use of wet dressing which will be discussed with the sulphonamides.

Edmunds (23) recently wrote an article on treating superficial granulating surfaces where he uses a wet dressing of one-half per cent chloramine. Tubes are perforated in many places and placed between two layers of cloth. The solution may be injected each six hours and it is only necessary to change dressings every three days.

The men who advocate wet dressings believe their method is the best as epithelial proliferation and new granulations are not disturbed but instead the moisture is believed to stimulate epithelialization. A moist surface is said to retain some carbon dioxide normally released which keeps the pH low thus reducing the amount of infection. The burned area is kept cleaner and there is no coagulum to trap pyogenic invaders. Separation and sloughing are said to occur earlier. This method helps prevent contractures and adhesions. Grafts can



be started earlier. It is said to be a soothing and comfortable procedure. Bunyan claims his method minimizes the loss of body fluid and protein which is hard to believe when it is compared to the tannic acid method. If his method is as soothing as claimed, it should be a factor in combating a nerve type toxemia as well as keeping the bacterial factor low.

One great disadvantage seems to be the difficulty in having the proper equipment for the more elaborate set ups when working under wartime conditions.

## DYES IN THE TREATMENT OF BURNS

Acriflavine has been used for some years as an anti-septic. Work was done by Browning (8) in 1934 on animals which proved to his satisfaction that acriflavine was the best anti-septic. His articles also site cases where it has been of great value in the practice of medicine.

Cruikshank (19) made numerous cultures of infected burns and found the most common infecting agent to be *Streptococcus hemolyticus* so he agrees with the work of Graham and Browning who used flavines and also the work of Aldrich who used gentian violet.

Attempts have been made to combine the use of tannic acid with gentian violet as did Coakely who used tannic acid five per cent and gentian violet one per cent.

Extensive burns were treated by Branch in 1937 with silver nitrate and methyl rosaniline (gentian violet). A ten per cent solution of silver nitrate was sprayed on to lay down an immediate white coagulum which is followed by the application of a one per cent solution of gentian violet staining the coagulum violet. The patient is then placed under a heat cradle. At fifteen minute intervals the patient is sprayed five times. If necessary, he may be sprayed at intervals of one or two times daily. If the coagulum is present after two weeks, it is soaked off with sodium bicarbonate solution and some means of stimulating epithelial growth is used.

Aldrich (1) in 1937 found on culturing burns older than 72 hours beta hemolytic and gamma streptococci were the usual infecting agents. This author regards a burn as an infected surgical wound and believes death is usually caused by infection rather than toxic split proteins. The work of Underhill is used to prove his point. Underhill used strychnine, methylene blue, and trypan to determine the amount of absorption from a burnt surface. Blood cultures were also made and found to be positive with the same organisms as found on the surface. Mention of the theory that gentian violet kills all gram positive streptococci which cause the toximia; however, he believes a combination of acriviolet and brilliant green do the job better. The technique involves a superficial clean up unless oil has been used previously; then it becomes necessary to remove oil. The areas are sprayed each hour until an eschar is formed.

Gentian violet is recommended on first and second degree burns by Cogswell and Shirley.

It would seem that a uniform treatment for burns was not adopted by the British Armed Forces as Wakely (81) prefers a one per cent gentian violet and merthiolate 1:5000 jelly on gauze as a first aid dressing. While he recommends cod liver oil for burns of the face, and castor oil and one per cent cocaine for burns of the eyes, he uses dyes for other burns. After shock is treated, the area is cleaned and covered with a warm saline pack. After five

minutes warm two per cent gentian violet or the triple aniline dye is applied. When the surface is dry, another coat is applied. When five days have elapsed, no more dye is applied. The triple dye consists of gentian violet 1:400, and flavine 1:1000. If the burned area is quite large, saline baths are used as long as can be tolerated then dye or tannic acid are applied. Whenever there is a moist area, the dye is reapplied. Saline dressings are used before grafts are made. He also mentions the use of two per cent copper sulfate as first aid for phosphorus burns.

Attempts have been made to combine tannic acid, silver nitrate and gentian violet such as that recently used by Ross and Hulbert (70). They use tannic acid ten per cent, silver nitrate ten per cent and gentian violet one percent aqueous.

The dyes seem to have the advantage of being accepted by more men as an antiseptic where tannic acid alone is not; however, Crile states that both tannic acid and gentian violet are antiseptic. It takes longer to form an eschar with dyes than it does with tannic acid-silver nitrate method. One additional disadvantage is the difficulty of keeping the dye on the patient alone. Another advantage is that the solution is stable. With the exception of the items above mentioned, the treatment seems to have the same advantages and disadvantages of tannic acid.

## SULFONAMIDES

Various work has been done from time to time on the absorptive power of a burned surface with much discussion for each side. Underhill, Kapsinow, and Fisk (80) did experimental work by injecting phenolsulfonephthalein and strychnine into burned areas and found that compared to controls absorption was inhibited. From this these men inferred that it is unlikely any toxic substance would be taken up by the blood stream; however, since this is another debatable question which is as yet unsettled, reference is made to the writings of Pack and Davis (62) which gives many arguments both for and against absorption and in the end admission is made that the toxin of burns is unknown. It may be stated that some substances are known to be absorbed from burned surfaces as is stated when the various mercurial dressings are discussed. Mason, Paxton, and Shoemaker (52) found potassium iodide to be readily absorbed from burned surfaces. Hocker and Lam (38) in some recent work found sulfanilamide to be a readily absorbed substance. Sulfanilamide was sprinkled on burned surfaces and the blood level of the drug was measured and in from two to six days; it was found to range in concentration of from one to thirty-three mgm. per cent. The blood level varying directly with the size of the burned area.

From the above it would seem that sulfanilamide applied locally may have a twofold action by acting locally and also on any organism in the blood stream; however, the first record found of using sulfanilamide was by Cohen who administered the drug orally. Here the drug was used on a series of war burns.

In England recommendation was made by the War Wounds Committee of the Medical Research Council (83) first aid is to consist of covering the burnt surface with a sterile dressing of vaseline gauze or lint. When the patient reaches the hospital soap and water are used to cleanse the area. If oil has been used on the surface, ether soap is used. Irrigation is done with saline, and debris is removed aseptically. The skin and the burn are dried and dusted with sulfanilamide. If coagulants are used, sulfanilamide powder is dusted into any cracks. When there is no coagulant applied, a tulle gras dressing may be applied. The dressing consists of curtain net impregnated with soft paraffin 48 gm. to balsam of Peru, 1 gm. After this first dressing six or eight layers of gauze soaked in warm normal saline are applied. The gauze is always kept moist. The first few days the gauze is changed every three or four hours. The tulle gras is changed twice daily at first and later once. If it is possible, the whole part should be immersed in a bath so the dressing will float off. It may take half an hour to do this. The area is powdered with

sulfanilamide and dressed as before. This type dressing is especially recommended where the lesion is a circumferential lesion of a limb.

Euglamide, a glycerin sulfonamide paste, is reported by Robson and Wallace (68). Five grams of abricide (a sulfonamide powder soluble in water which forms a neutral solution) is mixed with 100 cc. of glycerin. The mixture is heated until the solid is dissolved which usually takes thirty minutes. Ten cc. of cod liver oil are added while the mixture is still warm. Fine kaolin, usually about 60 gms., is added to yield a smooth paste about the consistency of thick cream. The paste is a permanent one. The burned area is covered by first making a thick spread on a dressing and then applying the dressing to the area. Daily application is especially necessary over the face, flexure regions, and when infection is present to keep the concentration of sulfonamide high. The authors believe kaolin helps produce a flow of lymph and antibodies to the areas. Glycerin is said to absorb water and keep down the amount of edema. Twenty cases were reported which were mostly second degree burns. Blisters and loose epidermis are removed before the application of the paste. Occasionally the paste causes slight pain on initial application, but later is said to be non-irritating and healing, and a clean surface suitable for grafting was soon obtained in the one case where it was needed.

Milford (58) also mentions euglamide which he says was introduced by the Edinburgh school.

Gower (29) utilized Metacaine two per cent topically when cleansing the burned area. The wound is cleaned up pretty well and then the burned area is first overlaid with a strip of sterile gauze impregnated with scarlet red ointment so that the meshes are not occluded. The first dressing is overlaid with a pad of gauze and cotton moistened with a freshly boiled one and one-half per cent solution of sulfanilamide in water. This is a supersaturated solution. The area is covered with waxed paper and bandaged into place with stockinet. The scarlet red bandage is left in place if the surface is dry until area is healed. If not, replace the sulfanilamide dressing. When frankly purulent, sulfanilamide is applied directly and pressure is made by a sponge. Dressings are then changed daily. Early grafting is advised in third degree burns. Several cases are reported.

Sulfadiazine has been used recently at Johns Hopkins Hospital according to an article by Pickrell (65). After the initial shock treatment has been instituted, the burned areas are sprayed with sulfadiazine in triethanolamine eight per cent. When the initial spraying is over, debridement of all blebs and loose tissue is done aseptically. Spraying is done each hour the first day, every two hours the second, every three the third, and every



four the fourth. At this time a thin transparent eschar should be present. In ten days the edges of the eschar begin to separate from the epithelium beneath. If so desired, compresses of the sulfadiazine may be applied. Where a third degree burn is present, the eschar is left on for two weeks. In treating second degree burns the same debridement is used, and the areas are sprayed several times. If the patient is not hospitalized, the areas are covered with sterile vaseline gauze or ointment containing five per cent sulfadiazine and eight per cent triethanolamine in a stearin base. Here no eschar forms unless the area is exposed. The eschar allows the attending surgeon to watch the progress of the wound which cannot be done with tannic acid. This eschar is strong yet pliable and elastic so that active exercise and some weight bearing may be done.

Of the sulfonamides this sulfadiazine method seems to be the best as the solution has a pH of about 8.7. The mixture does not stain, is almost odorless, does not injure the skin, mucous membrane or granulating surfaces, and can be used in and around the eyes with impunity. Although the sulfadiazine is detected in the blood a few hours after the area is sprayed, the level falls promptly when the eschar is formed. The results of 115 cases have been tabulated and the Johns Hopkins staff believes more

rapid healing took place than was the case with previous methods. The relief of pain present made it possible in many cases to dispense with a narcotic. The principle disadvantage seems to be the attention required when giving the repeated sprayings.

### MISCELLANEOUS DRESSING

One of the earlier dressings was that used by Hippocrates in 430 B. C. He used old swine seam mixed with resin and bitumen warmed by fire and bandaged to the area according to Zeiss.

Liston mentions that he recommended holding the burned part in a fire or plunging it in a hot liquid; however, he does not recommend the method. He does recommend separation of the parts involved to avoid cohesion.

Mention of the open air treatment is made by Attlee who merely places the burned area so the cicatrix will form as large as possible so the retraction won't be injurious. Foote states one form of treatment is to expose the burned area to the air so the surface of a second degree burn will dry. Dusting powders may be used such as bismuth subgallate, bismuth subnitrate, or nosophen. Lexer and Bevan use dressings containing powdered bismuth and starch on both second and third degree burns. For final separation of the eschar warm water baths are used. In 1913 Moorhead (60) mentioned the use of the open air treatment again.

On the theory that air should be excluded from first degree burns a warm lotion was used on a rag by Holmes. Laudinum was sometimes used in the lotion. Sometimes the areas were painted with ink, with whitewash or flour. The same author recommends that burned areas not be dressed too often.

Helmuth described the Henriques' method which is the application of a solution composed ten drops of either arnica, cantharides, or urtica areus to one half pint of pale brandy. Another prescription calls for one ounce of creasote to one pint of water. Dry earth is said to have had its advocates; however, if suppuration is present calendula is used both externally and internally.

In 1890 it was recognized by Roberts that sublimate cotton will poison the patient if used over large areas. Another author, Horwitz, writing during the same period recommended the use of bichloride gauze spread with vaseline and dusted with iodoform. Another mercurial has been used more recently. After giving opiates and doing a complete debridement Turner (79) swabs the area with normal saline. Then a swab containing two per cent aqueous mercurichrome is applied to the area, and the area is dried. The procedure is repeated four times the first day, three times the second and twice the third. If any collection of pus is present, the crust is removed, the area swabbed with saline, and mercurichrome reapplied. The patient must be turned freely, or the crust is apt to disintegrate. Although the writer claims many local advantages for his method of treatment, it seems he did not look far enough because Graham (30) cites the work of Arnaud who treated nine cases with mercurichrome dressings. In this series either nephritis or other symptoms of mercurial poisoning

or mercury was detected in the urine in twenty-four hours.

One mention of lead lotion was made by Horwitz. He also mentioned lint soaked in Goulard's water (a liquid containing lead subacetate) or iodoform as a local antiseptic, or mucilage of gum acacia. Sodium bicarbonate was also used as it makes an alkaline medium in which autolytic enzymes do not work.

The use of a weak carbolic acid solution has also been recommended by Horwitz, but Pack and Davis believe that its antiseptic and analgetic properties are counterbalanced by its neurotizing power and penetrative power so its use is contraindicated.

Turpentine was applied in saturated compresses by practitioners in the late nineteenth century to cause relief of pain and early healing; however, oil of turpentine is known to pharmacologists as a rubefacient which may penetrate quite deeply causing vesiculation which is painful and slow to heal.

The surgery books of Gallaudet (27), Pick (64), Walsham (82), and Careless and Wakely (10) contributed nothing new to treatment.

Levings mentions the use of acetozone 1:2000 for first and second degree burns, and hot acetozone solution was to be used on the surface until granulation tissue is formed. When granulations appeared an ointment consisting of a zinc oxide ounces I, powdered cinchona ounces I, and extract of opium grains II was applied.

Mention is made of four per cent aluminum acetate dressings by Foote, but this type of dressing did not obtain much popularity.

Two other dressings mentioned by Pack and Davis are potassium permanganate which they believe inhibits the growth of new epithelium and slightly irritates the burned area. Chloretone in the strength of one dram to a quart of water has been used for the relief of pain, but on large areas chloretone poisoning may result.

Harkins mentions that Robinson introduced the use of horse serum.

Following World War I Mercier (56) advocated the use of ten per cent iodine in alcohol of ninety degrees for burns of the first and second degree. No bullae were ruptured, and the tincture was applied daily. Pain was experienced for a few seconds at the time of application and then relief was noted. Application was made rapidly with a saturated cotton swab. No debridement was done, Where a patient was encountered with a skin very sensitive to pain or if they complained a great deal after one application of the tincture, vapors of nascent iodine were used daily. Crusts were left on till they fell off. For nervous patients he gave morphine or inhalation anesthesia. When a third degree burn was encountered, iodine was applied to the surrounding surface and after the slough of dead parts, ordinary antiseptic means were used.

Willis (84) did a complete debridement by excising all traumatized tissue which might form toxins. Some animal experimentation was done after one case. The method was initiated following some work done by Cannon on experimental traumatic shock. It was believed by excision relief of toxemia, reduction or elimination of pain and hastening of local healing were accomplished. In a large burn this would be quite an extensive procedure.

Actinotherapy was described in a paper by Kessler (45) in 1926. It was believed that light therapy is close to what nature would have. No solutions, ointments or dressings were used. Delafield and Pruddens are quoted as having said that with burns there is apt to be a congestion of brain, and thoracic and abdominal viscera plus a blood and lymph stasis. The deep therapy lamp or electric bath cabinet does away with the above, and it also causes a cutaneous hyperemia where the blood can absorb actinic rays. To carry the reasoning farther he stated that in this manner increased amounts of toxin are carried away, tissue vitality is increased, body resistance is increased, and metabolism is balanced. The burn is sterile at the start and actinic rays keep it sterile. Only three cases are presented, but good results were obtained for each. Light penetration was used for one to two hours daily followed by air or water cooled ultraviolet light. The following advantages were claimed: relieves pain, keeps

down infection, stimulates epithelial growth, eliminates scars and contractures, normalizes red and white blood counts, accelerates elimination, normalizes body metabolism, a wonderful tonic, and makes for a grateful patient. At the time the paper was read Fouts, Moor, Gibson, Patterson and Kessler endorsed it but not much more was found in the literature.

Injuries where there is no danger of acute toxemia were treated using salicylic esters. Stewart (75) first experimented with acetyl-salicylate which was found to be definitely analgesic and slightly irritating. In one-third of the cases the results were bad as there was infection. One-half per cent dichloramine T was added and ninety per cent of the results were good. The solution was unstable and still irritating. Five per cent abra-cide solution 1:1000, an isomeric substituted phenol, was used to replace dichloramine T. Itching and scaling was present even after the lesion had healed. Benzyl and methyl salicylate were used but they had no advantage over amylsalicylate. The final preparation was amylsalicylate containing abra-cide 1:10,000. The technique was to cleanse the area with normal saline and remove all the raised epithelium. Swabs made of two or three layers of gauze are soaked in the mixture and applied directly to the area. The gauze is covered with a wool piece and bandaged. The swabs are undisturbed, and in three or



four days new swabs are placed on top after the serious discharge has been wiped away. The swabs are left on until they separate off. The report speaks of five third degree and thirty-seven second degree burns. Two cases compelled the use of a stronger antiseptic. Treatment varied from seventeen to thirty-seven days. The longest time was due to third degree burns with infection. All types of burns were considered.

DeWhalley (19) used a mixture of dextrose, levulose, and sucrose on burns of the second degree. The high osmotic pressure causes the blisters to collapse.

Burned areas have been cleansed with hydrogen peroxide according to Flynn (25) who follows with a spray insulin to the burned surface. Insulin is sprayed on with an atomizer twice daily. The insulin was believed to increase the metabolism of new cell growth and form healthy granulation tissue. If a graft's growth became sluggish, hydrogen peroxide is applied locally followed insulin to stimulate growth.

Last year Matthews (53) used an anesthetic dressing when using the tulle gras dressing on burns. One per cent powdered Decicain base was used. 0.1 per cent percain may be used, but it may cause irritation and tingling. This dressing is said to bring the patient much relief. Sterilization above 150° C. is impossible because the tulle gras dressing may decompose.

The technique of Stopford-Taylor (76) utilizes perforated oiled silk. A simple zinc ointment paste is spread to a breadth of one-half inch from the edge of the burnt area. A sheet of sterile oiled silk with one-eighth inch holes one-half inch apart cut in the shape of the burn with one-half inch overlap is placed directly over the raw surface. Dry gauze made into saline compresses is put on top of the silk and bandaged into place. The dressing is changed twice a week although the gauze may be changed daily. When the margins are cleaned, the oiled silk is sterilized and replaced, and as the part heals, the edges of the silk are trimmed. The report states that one case had burned areas eleven by five inches on the back of each thigh, some thickened scar tissue was present, but it was believed the amount compares favorably with that present when other methods are used. Stopford-Taylor reasoned that the epithelium should proliferate in its own serous fluid. Drainage was believed to be sufficient and the wound has its own bacteriocidal action.

Foile, a water in oil emulsion of benzocaine, oxyquinoline, and calcium soaps, was not accepted by New and Non-official Remedies.

One of the most recent treatments is that of Mellon (46) who started experimenting because he noticed sulfur water had a benign effect on sunburn. Since most methods of treatment make use of one drug which has a property

that is highlighted or is a combination to get the best effect, hydrosulfosol, a sulfhydryl solution, was developed. The solution contains calcium from calcium oxide 0.549 per cent, total sulfur 1.46 per cent, sulfur as sulfide ion 0.3 per cent, sulfur as thiosulfate ion 0.22 per cent, sulfur from polysulfide 1.256 per cent, and sulfhydryl ion 0.237 per cent by analysis. The solution contains 10.56 grams of solid. The SH group is in fifty times greater concentration here than in the blood. The pH of the solution is 10.2, but the carbon dioxide in the air causes a drop in pH so that a colloidal precipitate of sulfur is formed and hydrogen sulfide is given off. The precipitate forms a flexible eschar. The present belief is that absorption takes place. Tissue cultures in which the solution is diluted to 1:500 and 1:1000 show stimulation of fibroblasts. The bacteriostatic action in vitro has not been fully explored. 0.25 to 0.3 c.c. given intravenously to a rabbit is fatal but when 5 cc. or more diluted in water and injected there is no evidence of toxicity. One hundred and fifty cases were treated of which two thirds required hospitalization. Debridement was done under anesthesia although it is not necessary for good results. The solution is diluted half and half with water and sprayed on the burned surfaces every twenty to thirty minutes. In the eye a three to five per cent solution is used. No evidence of a toxic

condition from bacteria was found in any case. During the first twenty-four hours a sharp temperature rise to 104° to 106° F. was noted. After the peak is reached there is a rapid fall until the end of the twenty-four hours and then the fall is by lysis. The urine shows a high output<sup>of sulfur</sup> when determined as sulfur dioxide. The output is highest the first day.

Animal experimentation was used to develop a technique in which animals would die in shock in six to eighteen hours. When hydrosulfosol was used a number of cases lived several days to one week. The solution is a reducing agent so that anaerobes will live in an open test tube; however, in vivo there is a paradoxical bacteriostatic action. Wonder is created about the initial temperature rise which may alter the metabolism and the system to make the tissue more resistant. Evidence is incomplete that hydrosulphosol tends to counteract shock; however, Mellon believes the mitigation of pain reduces shock and the exclusion of air relieves pain. Sulfhydryl compounds are formed with the precipitate and glutathione, a normal component of the skin depends on reducing sulfur to SH (sulfhydryl) for nutritional value.

## SUMMARY

The general concensus of opinion seems to be that before any local treatment can be attempted the patient's general condition should be taken care of.

Since the basic cause of toxemia has not been definitely established, it is difficult to treat the cause so any treatment must be empirical to some degree. Most treatments recommend the cleansing of the burned area in some manner. Methods of cleansing vary from complete surgical excision to irrigation. Preliminary cleansing of some sort is an essential part of most types of local treatment.

Of the modern developments or rediscoveries the tannic acid method seems to be the first step in a large reduction of mortality rates; therefore, this treatment became quite popular. Bettman offered the greatest improvement in the treatment by introducing silver nitrate into the technique. If a coagulum is desired, it would seem advisable to create one as soon as possible to conserve body fluids. Bettman conveys the idea the fluid is lost from the body while Harkins seems to believe most of the fluid is lost into the tissues around the burn. An outstanding principle is the precipitation of any protein which may be toxic. A major disadvantage is the constriction of the blood supply by this dressing when the

injured area surrounds a limb. Various men find it advantageous to use some sort of bacteriocidal solution with the tannic acid. Since the tannic acid does not stimulate the growth of epithelium, stimulants such as the scarlet red ointment have not been used.

The use of some sort of a protective covering has long been advocated to exclude air and act as a covering to replace the natural one lost. The most recent type has been the paraffin dressing which can be said to be non-toxic and easy to remove in case there is a desire to inspect the wound. Paraffin stops the loss of fluid and the entrance of any new infecting agent. In general there seems to be little advantage over the tannic acid method except the ease with which the covering can be removed from the wound.

Oily dressings were at one time quite popular and still seem to be popular as first aid when used by the general public. If the physician does not intend to use an oily dressing, much difficulty is encountered when an attempt is made to clean up the wound. Carron oil was the most popular oily dressing. The most recent innovation is the use of an oily base containing some form of Vitamin A which seems to be stimulating to tissue growth. The research done on the interfacial films seems to be one which can stand further investigation; however, the clinical results formerly obtained by the utilizing of

oily dressings do not seem to compare favorably with the results obtained using more modern methods. Claims have been made that codliver oil has some bacteriocidal effect. It seems the oily dressings do not remove proteins and their products from the burned area so that no absorption will take place.

It would seem that every period has its advocates of wet dressings. The outstanding value seems to be the irrigation of an infected area. As contrasted to the coagulative form of treatment, an attempt is made to wash away any toxic protein or protein products rather than trap it. The use of a wet dressing does not stop fluid from leaving through the wounded surface. Perhaps one reason for the popularity of this type of treatment is that many burns are grossly contaminated by the time it is possible to begin treatment. Men with mechanical ability seem to enjoy putting their ability to use in devising some method of wet dressings. The use of the envelope method seems to be an ideal one where a compound fracture accompanies the burn. Wet dressings are said to aid in the proliferation of epithelium which is an advantage over coagulative treatments. Here one need not worry about the dressing constricting a limb, but exercises may be started earlier than in other forms of treatment. The wet dressing seems to make a suitable one for grafting available at an earlier date.

When one thinks of an antiseptic dressing, one often thinks of dyes. The dyes have been used alone as it is possible to form an eschar, and they have been used in combination with both tannic acid and silver nitrate for their antiseptic value. The dyes seem to find favor with those who agree with the bacterial theory of toxemia. Some men believe a thinner eschar is formed which tends to decrease the danger of a contracture when the dressing is used around a limb. The eschar here is formed much more slowly than with the tannic acid-silver nitrate method so fluids are not as well conserved. At present the dyes find some favor as a first aid dressing when used in an ointment base.

Since the sulfonamides have been clinically used for many things, they have also been tried on burns. The development of the glycerin sulfonamide paste is a handy dressing which is finding some popularity. The most valuable of this group would appear to be the sulfadiazine dressing which was reported from Johns Hopkins Hospital. The sulfonamides aid in combating any bacterial infection from both a local action and from the blood stream. From the material available it would seem that of the sulfonamides, sulfanilamide is absorbed to a higher degree than any other. The true value of the sulfonamides does little to conserve body fluids which may leave from the site of the burn.

Under the heading of miscellaneous dressings are included the various types which have received little popu-



larity. Many of these methods have not been investigated except by clinical observation. The use of an anesthetic dressing such as described seems to be of particular value in allaying the pain in a first degree burn. The most recent development seems to be the hydrosulfosol which makes use of the sulfhydryl group. Incomplete experimental work has been done but that done seems favorable. The method of action is as yet unknown.

The various authors mention many methods to stimulate epithelial growth. One of the newer ones is the use of insulin. The recent trend seems to be toward early skin grafts. Throughout the literature from the Civil War on mention is made of grafts, but the development of the dermatome by Padgett (63) has made grafts more popular along with enabling the surgeon to obtain better results.

The first aid treatment recommended at the present seems to be an attempt to give the people something to do and yet keep them from interfering with the treatment to be given later on.

Most of the literature refers to third degree burns which present the greatest problem. It seems probable that the present conflict may make more changes in the treatment. The type of treatment seems to depend on the facilities available and on the time interval between the injury and the receipt of treatment. The development of the Padgett dermatome and the conditions created by the present conflict favor the treatment of burns of the

various regions of the body will in time necessitate different forms of treatment.

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