Thesis

on

"Burns and their Treatment"

by

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I. Introductory.

As Senior House Surgeon for almost 2 years in a provincial hospital in one of the great iron centres of England I had excellent opportunity for observing burns of all degrees of severity: from the most trifling to the most extensive and severe, in patients of all ages.

Middlesbrough, the centre of the Cleveland district, is studded with many of the largest and most famous iron works in the Kingdom; and the hospitals of Middlesbrough are never altogether free from burning cases from these "works". Moreover, there is a large industrial population. The "unguarded five" of Mr. Herbert Samuel's recent "Children's Bill" is only too much in evidence from its results, and our children's wards were a fruitful field for the would-be studies of burns in children.

The loss of life in children, on the one hand, and the very serious deformity often following in non-fatal cases demand rather prophylactic treatment.
An attempt towards this end has been lately made by Mr. Herbert Samuel. In the latter, science is daily removing dangers which formerly seemed necessary evils. But the appalling results following bad treatment of serious burns, and the good results that follow proper lines of treatment in many serious cases, justify some consideration of the various means of grappling with these lesions.

Many of our worst burns in this district were caused by "slag" i.e. the mass remaining after the extraction of the iron from the iron-stone. I have always noticed that burns due to slag are much more severe and more troublesome to treat than those due to molten metal. We do not get the line of demarcation between the burnt and the unburnt areas marked off so sharply. The surrounding zone is much more inflamed and angry-looking even when the more involved area has already begun to clear up. In considering the analyses of various
Slags I have concluded that this is due chiefly to the lime which is present in greater or less amount, and, in a lesser degree, to the sulphur.

I append analyses of the 3 slags to which these burns are chiefly due.

**Blast-Furnace Slag (Cleveland).**

- Silica 28.24%
- Alumina 24.73%
- Prototioxide of Iron 1.28%
- Lime 33.15%
- Magnesia 8.01%
- Sulphide of Lime 3.31% (=1.47% Sulphur)
- Prototioxide of Manganese 0.98%

**Steel Slag (Basic).**

- Prototioxide of Iron 8.23%
- Peroxide of Iron 4.0%
- Prototioxide of Manganese 2.08%
- Alumina 3.12%
- Lime 49.68%
- Magnesia 5.48%
- Silica 17.28%
- Phosphoric Acid 8.45%
- Sulphur .25%
Spiegeld Slag
Silica 39.24%
Protocide of Iron 11.6%
Alumina 14.5%
Lime 17.8%
Oxide of Manganese 14.23%
Magnesis 1.08%
Phosphoric Acid 0.015%
Sulphur 1.375%

Of these 3 slags the majority of
the burns are caused by "Blastfurnace"
or "Basic" slag, and in these two the
lime is in large amount, and the
irritation around the burn very
marked.

In dealing with "Burns" I
have made no attempt to include
those caused by electricity in any of
manifestations or X rays as I
considered that these, in themselves,
would furnish sufficient material for
a thesis.
II Clinical Features.

1. Local

A. Early

It is now many years since Dupuytren described burns in six degrees. This division has become classical, and it will be convenient to commence by stating it.

Degrees of Burning.

(1) A scorch or mere superficial congestion of the skin without destruction of tissue. "Erythema ab igne".

(2) The cuticle is raised from the cutis vera and blisters are formed. When these burst the cutis vera, red and tender, is exposed.

(3) The cuticle and part of the cutis vera are destroyed and the delicate nerve fibrils in the papillary processes exposed but left intact. The deeper structures of the skin: sweat and sebaceous glands and hair follicles, are not destroyed.

(4) The whole thickness of the integument
and part of the subcutaneous tissues are destroyed.
(5) The muscles are encroached upon.
(6) The whole limb is charred and quite disorganised.

Severe burns when seen shortly after the accident are frequently very deceptive. "Slag" and hot metal burns often appear to be quite superficial; but when sloughing occurs muscles, tendons, and sometimes even bones become exposed. Nevertheless, the appearance of the affected area immediately after burning varies with the degree.

As a general rule burns exhibit different degrees in different parts of the burn. Thus one may find a burn exhibiting here the 3\textsuperscript{rd} or 4\textsuperscript{th} degree, and there only the 1\textsuperscript{st} or 2\textsuperscript{nd}.

A whitish appearance of the skin which may not be broken or the cuticle even raised, surrounded by a very hyperemic zone, generally means that the burn is going to be a deep one.
What are commonly called in iron districts "splash burns", due to blowing out of a shower of molten metal, and often occurring on the back and buttocks as the men are endeavouring to escape from what experience tells them is going to be a "spit", appear often as slight red spots, and on sloughing form little pits with steep edges and a yellowish base which heal remarkably slowly.

Many cases in which furnace flames have blown out on to the face, chest, and hands show little shortly after the occurrence, but subsequently manifest pretty extensive loss of tissue. In these cases the eyes are very often involved. The conjunctiva very shortly becomes congested and oedematous and discharges freely; the eyelids soon become very soft and boggy and completely close in the eye.

Burns of the eye itself may involve conjunctiva or cornea; sometimes even the sclerotic. In the first case one sees in the early stages whitish areas in a congested conjunctiva; and in the
Second a whitish mark on the cornea with loss of substance, and again conjunctival congestion. When the sclerotic is involved, in addition to conjunctival inflammation one will get other appearances such as the signs of iritis, varying with the depth of the burn. This class of case demands respect. The corneal lesion gives rise to a corneal ulcer which, unless properly handled, may spread all over the cornea resisting treatment most obstinately, the final result being loss of sight.

Extensive burning due to the clothes catching fire generally at first appears to a tyro trivial. The majority of fatal cases of this nature at the North Riding Infirmary during the last two years have shown only scorching of the surface with peeling of the upper layers of the epidermis. Of course in these the danger lies in the accompanying shock. In the early stages if the burn is of the first or second degree the pain caused is of a smacking nature.
But if the nerve terminals are exposed and the wound is extensive one finds exasperating suffering. Thus, of all burns, probably those of the third degree are the most painful. In the fourth degree, where the nerve endings are exposed and destroyed, the burn is comparatively painless.

B. Later.

The later local appearances are modified to some extent by the early treatment; but there are certain features that are common to all cases. The differences turn more or less on the amount of sepsis introduced.

We have, then, first of all, a condition of irritation of the tissues. There are, therefore, all the signs of inflammation: redness, burning heat, pain—which may be severe if the nerve terminals are exposed without being destroyed—and a certain amount of swelling.

In burns of Dupuytren's
first two degrees this may be the whole process; but if the destruction has gone deeper than the epidermal layer the true skin and subjacent tissues are devitalized or killed outright, and sloughing takes place.

Sloughing commences usually from two to three days from the time of the accident, and continues for varying periods. If the burn is deep and extensive the sloughs are often not separated for two or three weeks. I refer here to visible evidence of sloughing. Of course, theoretically, sloughing commences from the time of the application of the heat and commencement of the devitalizing process.

During the process of the separation of the sloughs the patient suffers considerable pain. There have been a protection to the delicate nerve fibres, and when they are removed the nerve endings are exposed. Hence dressing of the wounds at this stage is a process dreaded by the pluckiest
of patients unless some means are taken to deaden the sensibility.

During all this time there is a very free irritating discharge from the rawed surface, generally very offensive, when the dressing is changed though this varies with the septicity of the wound.

In parts such as the face where the surface cannot be completely covered by a dressing to deal with the discharge, this latter coagulates and forms hard crusts. These crusts are loaded with organisms; and, from the decomposition going on in them, give rise to a very foul odour.

It is almost impossible to render burns aseptic; and herein lies the difficulty in their satisfactory treatment. A priori one might imagine that if we can prevent a large lacerated wound or a compound fracture from suppurating as we can do, we should be able to deal in a similar manner with burns.
Unfortunately, this is not always the case, for attempts at rendering large superficial burns sterile by vigorous scrubbing etc. often end fatally, or they rate, do much more harm than good. We have, then, to face the fact that a larger or smaller wound has become contaminated by contact with dirty clothes or from the neighbouring surgically speaking "septic" skin. This fact modifies what we find as the general symptoms accompanying burns, and also our treatment.

As the sloughs separate off, the wound takes on the character of a healthy healing sore. Granulations spring up from the base. The skin grows from the sides. And in any burns where the structures developing from the skin (sweat glands, hair follicles, etc.) are not totally destroyed little islets of new skin develop from the dermal cells and extend widely over the surface.

We may consider the question of the scarring after burns from the
Standpoint of the degrees of burning. In burns of the first and second degrees there is none. In those of the third degree where the cutis vera is encroached upon, but where epidermal structures are left to give rise to islets of new skin, the cicatrix is elastic and contains all the elements of normal skin and contracts hardly at all. In the fourth degree the subcutaneous tissue is reached and no epidermal elements are left to give rise to new skin. Hence the cicatrix is pure fibrous tissue devoid of hair, glands, etc., and is at first thin and reddish or purplish and glazed and contracts much, often for months after the sore is covered. The resulting abnormal area is much smaller than the original area injured. Hence, unless precautions are taken against it, we have here the possibility of severe deformities as in webbing of the fingers, closure of the nostrils, flexion of elbow or knee, etc. In burns of the fifth degree the same remarks hold
good, but as the muscles ligaments etc.
are now encroached upon, the resulting
contraction is more serious, and, as
Erichsen says, "dense fibrous tissue
cicatrices often extend deeply between
and mat together the muscles, vessels,
and soft structures of a limb, of the face,
or of the neck" and most appalling
deformities result. In burns of
the sixth degree the whole thickness of
a limb is destroyed and the question
of scarring is hardly likely to come
into question.

2. General.

The Constitutional Effects following
burning vary with (1) The Situation
(2) The Extent of Surface involved (3) The
Age of the patient.

Burns are not serious so
much with regard to the degree of the
burn as with regard to their superfi-
cial area. Thus I have seen the
Case of a boy of 18 who had his leg entangled by a red hot revolving wire rope and the foot practically amputated above the ankle who suffered nothing like so much shock as cases with extensive burning of the chest and abdomen even of the first and second degree.

Extensive searing of the abdomen is always serious; so, to a less extent, is that of the chest. "Ceteris paribus" burns about the head are always more serious than burns of the limbs. Children always suffer severely from burns; and burns which, in the case of an adult, would be speedily recovered from, often prove fatal in a child. The younger the child the more serious the condition.

The causes of the constitutional phenomena are:-

(1) Shock to the Nervous System with an accompanying congestion of the internal organs.

(2) Reaction after extreme furnance depression.
(3). Retention in the blood of waste products that would be eliminated but for the interference with cutaneous secretion.

(4). Inflammation produced by the burning

(5). Absorption of chemical products of decomposition in the devitalized tissues.

With regard to (5) it is interesting to note that experiments have shown that the burnt surface absorbs just as readily as does a raw surface produced by section with a knife.

A. Early.

Under the early general phenomena we have to deal with that stage lasting some 36 to 48 hours which is marked by depression of the nervous system accompanied by congestion of the internal organs.

The most marked symptom of this period is Shock which is more marked in the case of the child than in that of the adult though accentuated though in the latter case; and, as has been previously remarked, more severe in an
Extensive superficial burn than in a more circumscribed deep one of whatever degree. The shock may be so severe as to cause death outright or before its effects have had time to abate. Thus of 9 deaths from extensive burning in children under 5 years in the North Riding Infirmary during 1907 all except one died without having recovered from the shock.

A child will scream with fright and pain, throw its arms and legs about, toss its body about the bed, and shout for water. The pulse, if obtainable, will be found to be very small and very rapid (160 to 180). The respirations are fast. The temperature is subnormal (say 96°F). There may be convulsions. This excited condition subsequently gives place to a more subdued restlessness and then perhaps to coma.

In the adult the pulse is slow at first but soon becomes fast and small; the temperature is depressed; the respirations quick and shallow;
the skin moist and clammy; the lips white and tremulous; and the pupils dilated. The blood pressure is considerably lowered. There is extreme mental depression and apprehension. The tongue and mouth are dry, and the thirst distressing. Delirium is not rare. Shivering and rigors may be marked, and have been said to be an index of the severity of the constitutional disturbance. They are more marked when a large superficial area is involved. The shock is accentuated if the pain is severe. With a serious burn a symptom of very bad prognostication is absence of pain when the patient remains perfectly conscious. This shows profound depression.

In this stage vomiting is often very troublesome and very severe. It is apparently due to congestion of the brain and its membranes following anemia. In this period the patient, especially if a child, may die. Convulsions occur more frequently.
In what may be looked upon as a transitional or quiescent period between the stage of depression and that of reaction.

B. Later.

Under this heading we have two stages to consider: (1) That of Reaction and Inflammation and (2) That of Prolonged Suppuration and Asthenia.

(1). Stage of Reaction and Inflammation.

The danger of death from shock has now practically disappeared. Nevertheless, fatal issues are more frequent in this stage than in the preceding, and the causes of death are more various. They may be directly traceable to the burns as exhaustion from pain, anxiety, want of sleep, and septic absorption; or only indirectly, as pneumonia, perforated duodenal ulcer (causing peritonitis or internal haemorrhage), gastroenteritis, meningitis (less frequently than in the early stage), etc.
The stage lasts from the 2nd day to about the 3rd week or longer. About the second day one finds the temperature rising, and this may go on increasing up to perhaps 105°F. Concomitantly, the pulse-rate increases and may touch say 115 to 120. Respiration between 20 and 25. The local phenomena supply the explanation. There is an area of redness round the burns, some swelling and oedema, heat, and tenderness showing inflammatory reaction to the actual burning, and to the presence of the dead and dying tissue now acting as a foreign body. Shortly, with the process of slough separation, there is abundant foul discharge and absorption of the chemical toxins produced. One finds the usual accompanying symptoms of toxæmia and fever: headache, nausea, loss of appetite, restlessness. There may be constipation and later diarrhoea. If the wounds are septic or have been neglected the discharge
becomes excessive and very foul; and this will add to the general misery of the unhappy patient.

As the local condition improves so concomitantly does the general. The temperature gradually drops to normal with perhaps, for a short time, a slight evening rise, the pulse steadies, and the patient gradually improves in appearance and well-being.

It is in this stage that one meets with the complication first drawn attention to by Curling in 1842 viz. duodenal ulcer. The 10th day is generally put down as about the average time for symptoms to appear. They seldom appear earlier. These are not generally very obstructive; but we may get the typical symptoms associated therewith: melaena, pain in the region of the duodenum (epi-gastric and right hypochondrium) coming on about an hour after food, perhaps gastric disturbance. The first indication may be the sudden
failure of the patient from perforation of the ulcer. This latter accident is not necessarily fatal. It may, however, give rise to peritonitis, internal haemorrhage from erosion of one of the branches of the hepatic artery, or open into the pancreas.

Duodenal ulcer is apparently an extremely rare complication. I think I have never seen a case in spite of having had to attend to a very great number of cases of burns. I have once made a post mortem examination on a man who came into hospital moribund with a perforated duodenal ulcer who had been discharged from the wards some twelve months previously, convalescent from very severe burning. But considering the great number of other cases of duodenal ulcer in which no such previous history was present one was hardly justified in looking upon the two conditions as cause and effect.

I find also, that the majority of observers agree on this point. Birkenshaw's figures, however, are 6 cases
of ulcer out of 22 cases of death from burns.

In King's College Hospital Reports a case is reported of duodenal ulcer found post-mortem in a child of 9 years who died from severe burns on the 4th day. The ulcer was about the size of a shilling with steep edges. This appears to be the only recorded case in which this condition has appeared so early.

An examination of the urine in this stage may show a temporary albuminuria or haemoglobinuria.

The blood changes are summed up by Bardeen shortly thus:

1. Slight increase in specific gravity.
2. The red blood corpuscles are morphologically injured when subjected to a temperature of 52°C. They show
   perikilocytosis. They break up into fragments which ultimately lose their haemoglobin giving rise to haemoglobin
   anaemia.
3. A leucocytosis especially of polymorphs.
4. Toxins are found in the plasma.

Locke studied the blood
in 10 cases of severe burns taking the blood in all cases from an uninjured part. He found that the blood flowed very sluggishly and was dark purple in colour. His findings are:

1. An immediate increase in red blood corpuscles amounting in non-fatal cases in a few hours to from 1,000,000 to 2,000,000 per cubic millimeter; and in fatal cases to from 2,000,000 to 4,000,000.

2. A rapidly increasing leucocytosis amounting in non-fatal cases to from 30,000 to 40,000 per cubic millimeter; and in fatal cases to 50,000.

3. Slight morphological changes in the leucocytes.

4. The percentage of neutrophils somewhat above normal but not so much as in ordinary inflammatory leucocytosis.

5. A considerable destruction of leucocytes especially in severe burns.

6. In severe cases myelocytes may be present in small numbers.

7. A marked increase in the number of blood platelets.
According to him the venous stasis is probably due to dilatation of the peripheral vessels and weakness of the heart.

(2). Stage of Prolonged Suppuration and Asthenia.

This stage cannot be clinically differentiated from the preceding. When the breezes are severe and septic and the sloughing extensive and prolonged the patient gradually passes from one stage to the other. In these cases he shows signs of hectic fever, the temperature swinging, the cheeks becoming flushed and the eyes bright. There is wasting degeneration with its accompanying symptoms. The patient may become emaciated to a degree.

Death in this stage may be due to exhaustion or even to pyaemia, but it is more frequently a consequence of intervening inflammation of lungs or pleura.
3. Complications.

In the early stages these are chiefly due to the internal congestion. Within the first 36 hours the cerebral complications are the most frequent. Thus we meet with Cerebral especially in children.

Cerebritis and Meningitis may occur, and do so more frequently in the first stage than in the later, but these complications are rare.

In the stage of reaction and inflammation Pneumonia is the most frequent complication. This may be either Lobar or, much more frequently, especially in children, Lobular. This is a very frequent cause of death. Pleurisy, with or without effusion, is not uncommon. And Gastrointestinal inflammation is very frequent. This latter complication will vie with Pneumonia in the fatal results it produces.

I have already referred to Duodenal Ulcer occurring towards
The 10th day. This may terminate causing internal haemorrhage or peritonitis. But peritonitis may supervene independently of duodenal ulcer. Septicaemia has occasionally followed severe burns. During the separation of the sloughs local haemorrhage may occur from ulceration into an artery or vein.

In the later stages we meet with Hectic and Waxy Disease; and, nowadays somewhat infrequently, Pyaemia.

In all extensive superficial burns Contractures are liable to be an extremely serious and deforming complication.

The scars of old burns are liable to give rise to Keloid or malignant disease; and instances of the latter complication are recorded from time to time.

It has for some time been asserted that Scarlet Fever is very apt to follow on burns. Rashes resembling
The scarlet rash are not infrequent, and often occur without any other evidence of Scarlet Fever. I have at present under my care a child who was scalded, not very severely, on one leg. For the next four days, as one would expect, she had marked Constitutional Symptoms: temperature up to 104°F, pulse 120, headache, dirty tongue, vomiting, slight sore throat. She had been perfectly well up to the time of the accident. In 4 or 5 days time when the local condition cleared up the general Symptoms completely disappeared. Nevertheless, in about 10 days time she commenced to feel, and has since desquamated from head to foot. In a lecture on Scarlet Fever MacCombie says—"A Scarlatenicform rash following burns without attendant throat and tongue Signs of Scarlet Fever may be, but probably is not, Scarlet Fever unless it be followed by the general Desquamation, which, if it be genuine is, in my opinion, Characteristic of
Scarlet Fever. I cannot find sufficient evidence in the literature to come to any decisive opinion on this point.

III. Pathology.

The pathological lesions produced by burns are of some interest. They are very marked and fairly extensive. Post-mortems made within a few hours after death have shown in the main the same lesions whether death has supervened in the early stage or in the second stage of reaction and inflammation by congestion and changes suggesting a toxic process.

Some good work has been done by Bardeen of Baltimore who studied the cases of 5 children between the ages of 16 months and 8 years who had died from extensive burns from 4 to 9½ hours after the accident.
His findings are briefly as follows:

1. Cloudy swelling of the liver and kidneys.
2. Enlargement and softening of the spleen.
3. Hyperaemia of the thoracic and abdominal organs which, contrary to the generally received teaching, he found to be only moderate.
4. Swelling of the lymphatic glands and gastro-intestinal lymph follicles.
5. Thrombosis of a few of the larger and deeper vessels of the skin and subcutaneous tissues.
7. Very slight thrombotic and embolic changes in the viscera.

Other observers have found in this early stage marked congestion of the brain and its membranes, with in many cases, serous effusion into the arachnoid and cerebral ventricles. They draw attention especially to the congestion of the mucous membrane of the stomach and intestines, and of
the pulmonary substance.

In the second stage (of reaction and inflammation) one finds in most cases congestion of the head with perhaps effusion; in practically all cases congestion of the lungs, and in about 25% pulmonary hepatization, bronchial congestion, and pleural effusion; in a very large percentage congestion of the abdominal organs most marked in the mucous membrane of the intestinal tract.

Petechial hemorrhages may occur in various places such as the pleura, peritoneum, stomach, cortex of the kidneys, or the meninges.

It is difficult to arrive at any conclusion as to the frequency of duodenal ulcers on account of the wide divergence in the experiences of various pathologists. Many with very extensive experience (e.g., Bowby, Fayrer, etc.) have seen no cases post mortem, whereas Erichsen claims to have found this condition present
in 6 cases out of 22 necropsies. When present the ulcer is, as a rule, indolent, non-ulcerated, and punched out.

In the Stage of Suppuration and asthenia the condition present will be that corresponding to a thoroughly septic process: cloudy changes and amyloid degeneration. In a certain percentage pyaemic lesions occur.

Very interesting researches have been made on the microscopic appearances in the lymphatic tissues and on the nerve cells in the Solar Plexus.

Bardeen has been the chief worker to call attention to these lymphatic changes. He found them very widespread throughout the body and very severe even though the lapse of time between burning and death had been very short. The nature of the changes suggests both mechanical and toxic causes and is very similar to that of lesions observed after fatal cases of certain fevers.
Lymph glands suffer most severely, but lymphatic vessels and sinuses are also found to be involved.

In the lymph glands a general oedema with venous and arterial congestion seems to initiate the process. This is most marked at the germinal centres of the follicles. Active cell division is the next step; and, at this stage if at any, karyokinesis is observed; it is seldom seen later. Very rapidly on this proliferative activity (within 2 or 3 hours) degenerative changes supervene.

The Maltzian Bodies of the Spleen exhibit the same morbid processes, so also do the swollen tonsils. Similar necrotic areas occur in the lymph follicles of the stomach. But the most severe changes in the lymphatic system are found in the intestines. Here the follicles, both solitary and aggregated, are so swollen that they extend above the surface of the mucosa and out into
the surrounding mucous membrane.

Korolenko studied the Solar Plexus in the case of a person dying from extensive superficial burns of the 2nd and 3rd degree 1½ days after the accident. He also experimentally produced scalds on the abdomens of rabbits by means of a jet of steam playing for various lengths of time in different cases, and then examined the nerve cells microscopically. The experimental findings agree with those of the clinical case. All the ganglion cells were shrivelled and retracted from their capsules. Their protoplasm was uniformly hyaline and stained deeply. The nuclei were invisible or else ellipsoid masses without a trace of chromogenic structure. Experimentally these changes occurred only with severe surface lesions. With slighter burns there was oedema of the cells with less retraction of the protoplasm, and these slighter pathological lesions tended to abate, so that on the 5th day the
oedema had quite disappeared, and even when coagulation had occurred the number of cells so affected had greatly diminished by the 6th day suggesting a "restitutio ad integrum".

It is interesting to note that Korolenko found that in slight scalds all the ganglia examined were very vascular; whereas, when the scald was severe, the ganglia were very anaemic. He suggests that the action on the ganglionic nerve cells is chiefly of a reflex nature acting either by a purely nervous stimulus or else through a disturbed or even completely arrested circulation. The fact that an electric shock to an afferent spinal nerve produces similar changes in the cells of the spinal cord lends some weight to the purely nervous hypothesis.

Korolenko draws the following conclusions:— The cutaneous burns cause a reflex stimulation of the solar plexus. This acts secondarily upon the abdominal circulation producing
arterial spasm affecting, along with other vessels, the nutrient arteries of the plexus itself whose cells, therefore, suffer in their nutrition. The arterial spasm is followed by relaxation and dilatation of the vessels which may last for some days and is one of the factors in producing the pathological changes found post mortem in the abdominal viscera. The question, too, of the influence of the Solar Plexus on the heart must not be overlooked.

Parsarcandolo has found retraction of the grey matter in the spinal cord and deformity of the posterior cornua. The cells showed chromatolysis. He found that degeneration of the Cord was the rule and always affected the posterior cornua.

Shock, as is generally held, plays the chief part in early death, and Korolenko's researches go some way in furnishing us with the neurosis corresponding to this psychosis. But Bardeen is probably correct, in view of his own and other workers' results,
in holding that in addition to embolism caused by the accumulation of blood platelets and red blood corpuscles altered in form and functional activity, and tocaemia are contributing factors.

Many attempts have been made to discover what actually is the toxin (or toxins) which shows its effect so widely in deaths after burns. But very little that is definite has been made out. Thus Ajello and Parascondolo assert that the toxin is an alkaloid not the same as that which is produced from the putrefaction of dead tissues—which means practically nothing.

Freund and Reiss have shown that the urine of badly burned patients contains pyridin which has been artificially produced by the action of \( H_2SO_4 \) on deuterio-albumone, and suggest that the body protein may break up in a similar manner under the influence of heat. In all of 4 fatal cases they found that the urine contained—
(1) A series of bases of the pyridine type.

(2) A body which is, or is allied to, cystine.

(3) A body which appears to belong to Darrow's group of carbohydrate derivatives of protein.

They state that the urine was free from albumin and nucleo-albumin. But albumin can be, and by many observers has frequently been demonstrated in the urine of such patients.

I introduce this merely to show that our knowledge on this point is practically nil.

The 'Pathology of Burns' would be incomplete without some reference to theories as to the causation of duodenal ulcer. The suggested explanations are many.

(1) Curling supposed that Brunner's glands, seeking by greater activity to make up for the deficient secretion from the skin, became irritated and inflamed, and finally broke down forming an ulcer. But if that were so one would expect to find this
Complication causally associated with other conditions in which the skin secretion is widely interfered with, such as Lupus and Acute Eczema. And yet it appears to be never associated therewith.

(2). Brown-Séguard's theory was that the lesion is a nervous one. This would seem to be merely a euphemism for ignorance. Sir James Paget favoured this theory. He says, "The duodenum is the nearest part of the intestinal canal to the great sympatheticplexuses. The first step towards ulceration may be an alteration or suppression of its secretion by the action of the Nervous System."

(3). Another ingenious explanation is that it is caused by the administration of ardent spirits immediately after the burn.

(4). A fourth explanation, and one that is favoured by other in the explanation of gastric ulcer, is that the cause of the complication is capillary embolism due to septic absorption allowing of
Self-digestion.

(5). The most probable explanation seems to be that it is due to the excretion of toxic substances in the bile. Hunter compares the most morbid appearances in the duodenum after burns to those produced experimentally by the injection into rabbits of toluyl-endiamine.

In the case of burns, says Hunter, congestion has been found in some cases to be confined in the duodenum to the neighbourhood of the bile ducts, in others to extend down to the lower ileum. So also he found in his experiments with toluyl-endiamine. In both cases the congestion may or may not go on to ulcer formation.

A further point of similarity is the occasional occurrence in both cases of haemoglobinuria.
IV. Prognosis.

As regards life the prognosis may be said to depend chiefly upon the superficial extent of the burn. The deeper degrees of burning affect more the prognosis for the involved area than the general prognosis. It is generally held that involvement of more than $\frac{1}{3}$ of the body surface is necessarily fatal.

One must always give a very guarded prognosis in children. Superficial burning here of any extent is almost invariably fatal especially if the abdomen be involved; and, even if the shock be recovered from, the complications that may arise very frequently carry off the patient. Most deaths from burns occur within the first week, and are chiefly due to shock, bronchopneumonia, lobar pneumonia, or gastrointestinal inflammation. In the case of gastroenteritis diarrhea generally appears as the ultimate
cause. Death has, however, occurred after 8 or 10 days without sepsis, duodenal ulcer, or any of the previously mentioned complications being present.

In the later stages death is more frequently due to exhaustion or pyaemia.

V. Causes of Death.

To discuss the causes of death 'in extent' would be simply to repeat what has already been said in various places so that I shall content myself with merely tabulating them.

1. Asphyxia. This hardly comes within the scope of my thesis but a good many deaths where fire is involved would appear to be consummated by the smoke and noxious fumes before any actual application of heat takes place. CO seems to be more responsible here than CO₂.

2. Shock.
(3). Cerebritis and Meningitis.
(4). Pneumonia (lobar or lobular).
(5). Gastro-intestinal Inflammation.
(6). Perforation of a Duodenal Ulcer.
  A. Haemorrhage.
  B. Peritonitis.
(7). Peritonitis apart from (6).
(8). Amyloid Disease with Exhaustion.
(9). Pyaemia.

VI. Treatment.

There are in England annually about 1400 deaths from burns of children under 5 years of age. Such an appalling figure calls for some prophylaxis. The two main causes of these fatalities are (1) unguarded grates and (2) the use of flannelette clothing. The Children's Bill 1908 in Clause 15 provides against the former of these causes; but until some substitute for flannelette equally cheap and equally warm is discovered which
Shall at the same time be much less inflammable, it would appear that coroners will continue to preach to a deaf-eared people. Flannelette of various qualities, all, after two or three washings, equally inflammable, varies in price from 2 3/4 to 10 3/4 per yard, and its cheapness along with its softness and warmth appeals to the short-sighted mother in the slum.

With regard to another fruitful source of burns: explosions in large "works," we are fortunate in having every year fewer and fewer of these. The advances of science have enabled us to take precautions against these much more successfully than formerly. So much for prophylaxis.

One wishes it could bulk much more largely in the treatment of burning accidents.

Coming now to the more directly medical aspect of the subject we must divide the treatment of burns into (1) general and (2) local.
Both are of paramount importance, and the administering or withholding of either may make all the difference in the saving or losing of life, or in the prevention of serious complications.

A. General.

As we have seen, directly after the accident the patient is profoundly shocked and this condition must be attended to before anything else. It is very important to keep the patient warm. Any unnecessary exposure is very harmful at first. Warm bottles wrapped in blankets are applied round the legs and feet. The patient lies between blankets. If the pain is severe considerable benefit is derived from an early dose of opium or morphia. If necessary, stimulants are administered e.g. a small dose of warm brandy or whisky and water, or a little hot milk with brandy or whisky. In some cases it is useful to give a coffee enema. If there is great delay in rallying,
Saline injections are of great use and may be given per rectum subcutaneously or, in desperate cases, intravenously. These salines may be composed of 35 of Sodic Bicarbonates to a pint of sterile water; or 35g each of Sodium Chloride and Sodium Bicarbonate to the pint of sterile water. One writer enters a warning that these should not be administered to elderly patients until vomiting sets in and delirium and drowsiness threaten. Nevertheless, one has repeatedly given such injections to this class of patient suffering from shock due to causes other than burns without any bad effects.

In order to be more precise I shall suppose the case to be that of a child of 2 or 3 years extensively burnt about the body from the clothes catching fire. The child is wrapped in a blanket just as it is, and kept warm by being nursed near the fire. It is hopeless to think of keeping such a patient warm in bed. A narcotic
is administered. I find one writer recommends 1/2 to 1 1/2 1/4 of Quiet Opium with about 3 1/4 of Brandy to be repeated at the end of an hour if the child is not asleep. Since 1/4 of Laudanum has been known to poison a child I think that the dose is excessive. At the North Riding Infirmary we used a Stock Mixture containing in every drachm Chloral Hydrate 9 gr. 5 rig. Morphiae 3 1/4. It was the custom to order 3 1/4 at once for a child about 2 years and 3 1/4 in an hour's time if necessary. One seldom found a 3 1/4 dose was called for but if it was another 3 1/4 was administered at the end of another hour. Along with this perhaps 3 1/4 of brandy or whisky in a little warm milk was given and repeated in 1/4 to 1/2 hour. When the little patient becomes quieter and less restless the burns are rapidly dressed in sections. The stimulants must be continued (say 3 1/4 every hour) and one or two coffee enemata given.
as long as the shock continues.

During the first and early second stages the diet must be very simple and should contain a fair amount of nourishment in little bulk. For this purpose such preparations as "Panopeptone" (a partially digested meat extract) 3/4 to 1 1/2 every 2 or 3 hours are very useful. Liquids should not be stinted as these will help to dilute the toxins in addition to supplying fluid to the tissues.

Complications are treated " Secundum anteum " as they arise.

B. Local Treatment.

On the local treatment for burns one might write a volume for the number of substances used as applications at one time or another by various physicians is legion. Thus we find in the list: Amyl Hydride with Oil, a mixture of Chloroform Olive Oil and Rizine Water, Olive Oil with Saccharated Rizine Water, Iodoform, Alkalies, a mixture of Chalk Oil and Vinegar, Whiting and Water,
Oil with Litharge, Carbolic Acid, Picric Acid, Boric acid, Boric Oil, Salicylic acid, Potassium Chlorate, Chlorinated Soda, Creaste, Peppermint Oil, Thymol, Silver Nitrate, Cocaine, Iodine, Pain, Cod Liver Oil, Bismuth with Gelatine, Charcoal, Opiates, Belladonna, Constituents of all conceivable composition etc etc apparently without end.

It is thus obvious that a thorough consideration of all suggested treatments would be as endless as it would be valueless; and in what follows I shall endeavour to deal only with the more recognised modern methods.

We may divide the local treatment of burns into (1) Greasy dressings (2) Non-greasy but primarily wet dressings (3) Dry dressings by which one means treatment with powders.

The objects aimed at in a first dressing are to:— (1) Relieve pain. (2) Prevent sepsis. (3) Allay inflammation. (4) Prevent the spread
of inflammation to devitalized tissue.

5. Promote rapid separation of sloughs by dry gangrene. 6. Encourage healthy granulations.

The clothes, then, are carefully removed, with scissors if need be. The burn area exposed, the next question is—how is this to be rendered surgically clean? One method advocated and, I find, as recorded by Sels-Bueden, at present practised in the Charité State Hospital in Berlin, is to anaesthetize the patient (a local anaesthetic for small burns, lumbar or general for extensive), open the vesicles and bullae, and thoroughly wash the damaged area for 10 minutes with hot water, sap, and a brush. Experience at the North Riding Infirmary and elsewhere has shown that this proceeding is warranted to considerably increase the shock, and I think has been responsible for a percentage of deaths. A much preferable plan is to flush well with a mild antisepticating lotion such as Boné, normal
Saline, or ordinary sterile water, picking off with forceps any foreign body that the lotion does not remove. Some prefer to use mercurial or carbolic lotions (Perchloride or Bichloride of Mercury 1 in 2 3 or 4000, Carbolic 1 in 40)
either aqueous or alcoholic, and many like to leave such lotions in contact with the burns for 2 or 3 minutes. A saturated solution of Picric Acid may be used for the washing, especially if a Picric dressing is to be subsequently applied.

Such is the ideal procedure; but with extensive superficial burns especially in children I venture to think that if one attempted to carry this out as a routine treatment the deaths from burns would be considerably increased. Here it is of the first importance to cover up the burns with the dressing as quickly as possible and trust to subsequent care that the wounds proceed satisfactorily.

In dealing with the blisters one
merely pricks them. To remove the raised epidermis would be to leave exposed a raw and tender 'cutis vera', and add considerably to the pain.

After the surface has been thoroughly disinfected the subsequent dressing put on at the Berlin Charité is sterilised gauge, a thick layer of absorbent cotton wool, and outside that a thick layer of non-absorbent wool. If the secretion from the wound is free the wool is changed from time to time as soon as necessary, but the gauge is not disturbed until from 10 to 14 days when it is said to be spontaneously thrown off leaving a satisfactory epidermis forming surface. The exclusion of air relieves the pain. If some time has elapsed between the accident and the first seeing of the wound alcohol poultices are used in place of the sterile gauge. My experience with alcohol for such wounds has been most satisfactory. It is a weak antiseptic but may be absorbed to any extent without detriment.
have frequently used fomentations of methylated spirits (1 in 3, 1 in 2, or even 1 in 1) with excellent results.

A treatment now very generally employed in this country, and very much used in France especially by Professor Thiery before it was introduced here, is that with a saturated watery solution of Pieric Acid.

Pieric Acid 3 or 5 or more accurately 5 grams
Absolute Alcohol 3
Dissolve and add
Distilled water to 340...1000 grams.

Strips of lint are soaked in this solution, covered by a thick layer of wool, and held in position by a many-tailed bandage. This dressing soon dries, and may be left "in situ" for from 3 or 4 days to a week. The date of the subsequent dressing is determined by the amount of discharge, the temperature, pulse, etc.

At the subsequent dressing it is advisable, especially in the case of children, to administer an anaesthetic. Sometimes
an opiate \( \frac{1}{2} \) hour before the dressing suffices. For an adult man 3 grains of Nupentol, or 90 to 120 grains of morphine hypodermically, or 125 of mixture of quinine give considerable ease. One must never tear away adherent lint. In some cases it may be well to dress twice a week.

Dakbyl points out that the injured part should be left alone so long as it is dry, but that no burnt surface should be left soaking in its own discharge especially if that discharge is purulent. He says that Peric Acid dissolved in ether or alcohol and applied on gauze gives better results than the watery solution because the rapid evaporation allows the Peric Acid to be precipitated as an insalvable powder all over the surface of the burn. He remarks, however, that dusting with Peric Acid is to be avoided because it has produced poisonous symptoms. But Dakbyl's warning re Peric Acid powder is sounded also by Williams of Gent with regard to
Strong solutions such as the alcoholic. He says that the saturated watery solution is a ½% solution, but that cases of Picric poisoning have been reported to the Surgical Society of Paris in which 5% or 10% solutions have been used, and it is unfair to place to the discredit of Picric acid what is really due to the use of excessively strong solutions.

The advantages claimed for this method are:— (1) Simplicity (2) Painlessness partly because of the anaesthetic action of the Picric and partly because of the infusent dressings. (3) Aspirin—Picric acid being a weak antiseptic. (4) Small amount of discharge. (5) Infusent dressings with consequent comfort to the patient and economy in dressings. (6) The astringent action of Picric Acid in preventing inflammation. (7) Its effect in promoting the growth of epithelium. (8) Rapid Separation of Sloughs. (9) Absence of poisoning symptoms (This claim cannot be allowed absolutely as will be seen later).
Its disadvantages are:- (1) Staining of the hands and clothes. This can be greatly, if not altogether, obviated by freely rubbing the hands with vaseline before dressing, and washing, after dressing, with alcohol. (2) Williams points out that this dressing is suitable only for burns of the first and Second degrees. But, granting that it is most useful when the skin is not deeply destroyed, nevertheless it has been found very valuable in burns even of the 3rd degree. When inflammation has subsided and a granulating Surface has been obtained other forms of treatment are more suitable. It is claimed that the granulating Surface is more quickly reached with Picric Acid than with any other form of treatment. (3) The occurrence of toxic symptoms. This is a drawback that is borne witness to by many who have had an extensive experience of the treatment.

The Symptoms of Picric Acid Poisoning are:- Severe Constitutional
disturbance, rapid pulse, rise of temperature, a rash resembling that of measles, icteric tint of the skin and conjunctiva, sometimes vomiting and diarrhoea, and in all cases urine dark red, dark green, or port wine in colour.

Elliot records a very interesting and instructive case of this complication. On the 7th day the patient complained of feeling unwell. The tongue was furred, the lips dry, the expression anxious. The patient vomited several times. The temperature rose from normal to 102.4°F and the pulse from 88 to 154. The respirations were 24. The conjunctivae especially towards the canthi, and the skin were icteric. There was a rash closely resembling that of measles over the greater part of the body but absent from the face, hands, and front of the legs. The rash was bright red, papular, non-haemorrhagic, partly discrete and partly confluent, and especially well marked and confluent in those parts of the body in contact
with one another or subjected to pressure. The urine was clear, bright red, and with a greenish tinge on the surface. It contained an abnormal pigment which could not be identified, but which was not one of the normal blood pigments or any of their simple derivatives. The blood showed considerable diminution in red blood corpuscles with a slight increase in eosinophiles. On the 9th day there were in parts slight haemorrhages into the papules. These symptoms gradually passed off with cessation of the medicated dressing, but on two or three occasions subsequently and without any definite exciting cause. The patient suffered from abdominal pain and vomiting. These symptoms were so severe that on the 37th day the patient was readmitted to hospital after having been 10 days discharged. The abdominal pain was then so acute as to call for morphia. The patient vomited blood, and blood was passed in the faeces and urine. There were a few petechiae on the
forarms. These symptoms gradually passed away and the patient was discharged about the 45th day well with the exception of a slight albuminous cloud in the urine.

This case, then, shows that symptoms of Picric Acid poisoning are not necessarily trivial, and demonstrates the necessity for a very close watch on the patient during treatment, with the immediate cessation of the dressing if the slightest toxic symptoms appear. The cicatrizes after the Picric treatment are smooth and supple, and contraction slight.

Lister in 1875 advocated the use of lint medicated with Boracic Acid in treating burns, and this has become a very useful and widely used method. This is the type of the fomentation treatment in general. The burn is to be covered by Boric Lint cut so as not to extend over healthy skin. The Lint is then covered over and kept moist by oiled silk or
gutta-percha tissue. Some prefer to cover the burn directly with perforated "green protective tissue" and then apply the fomentation. This sometimes gives less pain than the other method, but has always seemed to me to make the granulations weak and watery.

Maynard advises using Bone Dint worn out of 1 in 2000 Bichloride of Mercury, and states that this dressing may be left "in situ" after the first dressing for 3, 4, or more days depending upon the amount of discharge.

During Slough Separation the Bone fomentation is an excellent dressing, and the separation of the sloughs is hastened and the wound kept comparatively sweet by spraying it with Peroxide of Hydrogen or syringing it freely with Jodine Solution (3/7 of Inincta Jodi to a pint of sterile water). This treatment is eminently applicable in burns of the higher degrees where Peric Acid is less suitable.

One must be on the outlook here for
a Boracic Acid rash which closely resembles that of Scarlet Fever and is in part responsible for the belief that Scarlet Fever is especially liable to supervene on burns.

On the Continent Glycerin is a favourite first dressing. Bierne strongly recommends the use of lint soaked in pure glycerin laid on the burns. He asserts that this does not cause irritation nor smarting, but relieves pain and prevents blister formation. He finds this gives more relief than anything as a first dressing.

Capurroso prefers gauze soaked in a 50% solution of Tannin in Glycerin, and insists that the glycerin must be pure. The solution is applied several times a day without the removal of the gauze until the dressing falls off. The tannin is said to be slightly antiseptic which is doubtful. It coagulates the albumen and so forms a protective covering. The glycerin also is slightly antiseptic.
Others prefer Bismuth in glycerin.

On somewhat the same principle of astringency, Hazeline has been sometimes used in the same way. It is inexpensive especially if the *Extraction Hamamelidic* *Liquidum* distillation is employed, but is of little value in deep or extensive burns.

Plantier has for the past seven years employed Yeast. This is used either fresh or dried. Sterilised bandages impregnated with a paste of yeast in tepid water are applied and left unchanged, unless the discharge is abundant, for 3 or 4 days. He claims that with this treatment he has not seen any suppuration and the resulting cicatrices have been most satisfactory.

An attempt has been made to treat burns by protecting them with wire cages covered with lint soaked in a mild antiseptic and covered with macintoshing. Nothing is allowed to come in contact with
the sores. It is said that on account of the absence of irritation fibrous tissue formation is reduced to a minimum.

A great drawback to this method is that the burns are not protected from the air which, in itself, relieves the pain, and thus septic infection can hardly be prevented.

A treatment for burns now quite good many years standing and still with its advocates is that with Alkalies. Pepper corn and Jorizki are ardent recommenders and it seems to have been considerably used in America. Strips of lint soaked with a saturated solution of Bicarbonate of Soda (½ lb in a quart of sterile water) are made to completely cover the wound. M. Helland says that this dressing should never be allowed to dry, the solution should be freely and constantly used. According to him no other dressing is necessary and the lint first applied should not be disturbed for several days.

Jorizki gives 3 methods in which Bicarbonate of Soda may be used:
(1) The powdered salt may be freely sprinkled on the lesion. Said to be of most value in burns of the 1st and 2nd degree.

(2) Linen rags are soaked in a 1 in 50 solution especially for burns of the 3rd degree where there is considerable sloughing. The dressing is changed as soon as it is dry. The obvious drawback here is the frequent dressing.

(3) Linen rags are used as in (2) but the lotion is poured on without disturbing the rag.

The chief claim of Soda is that it quickly relieves the pain, and patients find it very soothing. It is an antiseptic and disinfectant as is claimed for it, it can be so only in the mildest degree. Any amount of absorption can go on without any bad effect.

Chlorinated Soda is recommended by Piddock. Other alkaline salts have been used, but for practical purposes none have any advantage over Soda Bicarbonatas.

Because of the great dif-
difficulty in keeping these lesions free from sepsis, and also from the soothing and pain relieving effect, continuous baths have been used. For a limb, this treatment is not difficult of application; and, in the case of a child with burns of the body, one can arrange a bath covered by a sheet or blanket through which the patient's head is passed. An excellent method of improvising a bath for a child is to fix the edges of a piece of macintoshing to the sides and ends of a cot, with bandages running across from side to side to prevent the child from slipping in and being drowned. One must carefully maintain the temperature of the bath, and be on one's guard against heart failure. To prevent maceration of the neighbouring skin, it should be freely ointoned with some fatty ointment. With these precautions, even children can be immersed in hot water (say at 100°F) continuously for many consecutive days and nights. The water excludes air, prevents sepsis, and
As to the composition of the bath, weak alkaline baths are probably the best. Some, however, prefer an antiseptic solution. Thus Horrocks used baths of weak Sanita at 90°F in severe cases with high temperature, and these he gradually cooled down to 70°F. In that case the bath was not continuous. Others use an alcohol bath of varying strengths, or one composed of a solution of Sulphate of Magnesium. In extensive burns in children a warm alkaline bath seems to give more comfort and ease than any other early local treatment. Watery dressings as they dry have a great liability to stick to wounds, and thus give rise to great discomfort and sometimes to actual pain. Greasy dressings are exempt from this drawback. The fatty globules, too, acting as a protective layer, soothe the irritated and injured tissues, and thus we find a great measure of
comfort. Various oils have been used as an early dressing: the virtue of all, without doubt, depending upon this protective action. Cod Liver Oil, Linseed Oil, Castor Oil, Olive Oil, Eucalyptus oil are only some from the list. The means of application is generally by using lint soaked in the oil.

The great drawback to the class of greasy dressings is the fact that, generally speaking, we may say they are septic. Theoretically, one may argue that they may be sterilised by boiling; practically, this is so troublesome and so dirty a process that it is seldom, if ever, carried out. Hence an attempt has been made by adding antiseptics to these oils to render them antiseptic. Thus Carbolic Oil, prepared by dissolving one part of the acid in 10 of oil has been employed. This is not only an inefficient antiseptic, but the Carbolic Acid, if applied to anything but a very small burn, is very rapidly absorbed and gives rise to toxic
Symptoms. These are:--Olive-green or, in the severer cases, dark green or almost black, urine; severe and uncontrollable vomiting; headache; collapse; rapid feeble pulse; subnormal temperature; twitching of muscles; and insensibility of the pupils. The coloured urine is the first danger signal; and, if the warning be not heeded, is soon followed by vomiting.

Wertheiner recommends Thymolised Carrot oil (1/5 - 1/10%) for the first two weeks. Fuller used a 1 in 1000 aqueous solution of Thymol for cleaning up and rendering the burn aseptic and then applied a 1% oily solution directly to the wound with a camel's hair pencil. Thymol is at the best a very weak antiseptic.

Boric oil has also been used.

Others recommend Oil of Peppermint to be painted on with a pencil either pure or diluted with an equal part of glycerin. Peppermint oil is slightly antiseptic and is also analgesic.
The same remarks apply to Eucalyptus Oil which is perhaps the most satisfactory of the oils. 10% Eucalyptus Oil in Carron Oil has been used to overcome the septicity of the Carron Oil; but this is far from being a satisfactory dressing.

Carron Oil is composed of equal parts of Linseed Oil and Lime Water, and so called because it was first used at the "Carron Iron Works". It should never be used as a dressing on account of its septicity.

As a general criticism against those medicated oils it may be said that, according to Lockwood and others, antiseptics mixed with oils become wholly or in part inert.

Naphthalene, a greenish black substance of the consistence of cottonseed, extracted from a variety of Naphthalene and consisting of 96% Hydrocarbon and 4% Soap, has been used for burns, but apparently with no very brilliant result. It appears to have
been first introduced for superficial skin affections such as eczema in which a sedative action was called for, and then the treatment was secondarily extended to burns.

The other form of greasy dressings is the ointment. There are many advocates of an early application of these in all cases; but I cannot help feeling that except in burns of the 1st and 2nd degree these are totally inapplicable except in the later stages. The composition of ointments recommended is very various. Thus Wertheimer follows up his Hypnotized Carron Oil treatment with an ointment containing Subnitate of Bismuth, Boric acid, Lanolin, and Olive oil. Others use a plain Bismuth or a plain Boric Ointment.


Euprophens 8 parts Olive oil 7 parts

Dissolve and add Vaseline 60 parts

and Lanolin 30 parts is recommended by Riebet. A 10% Dermatol Ointment has been used. Dermatol is
a Subgallate of Bismuth, is nontoxic and is slightly antiseptic.

Williams of ghent uses a 1% or 2% Pieric Acid Ointment, and certain in burns of low degree this acts very well. He says that even in children he has never seen any toxic effects with this. Oakhyl says that Pieric Acid in Vaseline is very liable to set up an erythema.

A special application of Pieric Ointment and one of considerable value is made by Fortunati of Rome. This is for burns of the conjunctiva or cornea especially those caused by chemical agents such as lime. Pieric Acid mixed in white vaseline (of neutral reaction) 50 parts is applied twice or thrice daily after the instillation of cocaine drops. Pain is considerably relieved. The results are good and Symblephonon as a sequel infrequent.

In the end stages of a severe burn or in the case of a very superficial
burn the ordinary zinc Ointment of the Pharmacopoeia or preferably, a zinc Oxide
Vaseline is very useful. A little Oleum
Methae hydriatis added to this ointment
makes it stimulating and soothing.

Thirdly one has to consider the Dry Treatment of burns.

The very old custom, and one un-
fortunately not yet extinct, of powdering
burns freely with flour or starch was the
first attempt at this means of treatment.

Setting aside the fact that these substances
are not free from depresis they are, as
are all organic bodies, liable to decompose
and are, on that account objectionable.

The favourite constituent of
powders used as a dry dressing for burns
appears to be Bismuth. Thus Barde-
leben's treatment, a treatment used
pretty extensively on the continent, is as
follows: -

The lesions are carefully washed
with 3% Carbolic or 3% Salicylic Acid
and blisters opened. The whole Surface is
then thickly covered with finely powdered
Subcutate of Bismuth, and this is over-
spread with a thick layer of cotton wool
kept in position by a light bandage. The
dressing is renewed when it gets moist.
Sometimes sterilized bandages have been
impregnated with the Bismuth Salt
and applied to the burn direct.

Renner prefers a powder com-
posed of 1 part of Subcutate of Bismuth
and 2 parts of Kaolin. As before the injured
area is thickly powdered with this.
Renner uses a layer of sterile gauze on
top of this, and then wool in thick layers.
This dressing is changed daily so long
as there is much discharge, the injured
part being submerged in a partial or
complete bath according to the extent
and situation of the burn. This powder
has very considerable absorbing qualities
and speedily takes up fluid from the
burnt tissues which are converted into
a black and dehydrated eschar. In
burns of a mild degree the area, after
the use of the powder, is covered by a
thick crust which serves as an
excellent protection during the growth of
the new epidermis.
This treatment is simple and
has the capacity of arresting free secretion.
It is claimed that pain is relieved. A
great drawback is that for extensive burns
it is very expensive for Bismuth Salts are
not cheap. Sometimes an urticarial
rash is set up with some itching round
the burn but this soon disappears after
a temporary cessation of the treatment.
Many other powders have been used
in exactly the same way. Eustand of Paris
employs Arizel 1 part with Dale 4 parts.
Riebet uses Europhen.
Iodoform has been a good deal
used in this way. But numerous cases
of poisoning have occurred. Of this the
chief symptoms are: elevation of
temperature even to 104°F, loss of appetite
with progressive emaciation the patient
complaining that everything tastes and
smells of Iodoform, infrequently vomiting,
very fast and weak pulse (up to 180),
serious cerebral effects e.g. violent maniacal
delirium or persistent drowsiness with great mental depression, in children symptoms resembling tuberculous meningitis, sometimes rapid collapse and death. Serious permanent eye symptoms may follow. Morson has, indeed, pointed out that optic neuritis, and Wagemann and Reitrih haemorrhages, may be amongst the sequelae of extensive burns themselves. On the other hand Välike and Gerson have both recorded the occurrence of double optic atrophy in similar cases after the use of Iodoform. In Gerson’s case after 3 weeks of Iodoform treatment without other signs of general poisoning a progressive amblyopia appeared accompanied by atrophy of the temporal halves of both discs. This still persisted several years after the occurrence of the burns. Hirschberg and Küster have had cases of a temporary toxic amblyopia which, however, readily yielded to appropriate treatment.

Sometimes 1 part of Iodoform with 2 of Boric Acid powder, or equal
parts of these have been used.

I have already referred to the use of Soda Bicarbonate as a powder. In the same way Magnesia Sulphate has been used by Stone.

Whatever has been the early treatment, the burns, after all dead tissue is removed, have gradually into a condition of healthy healing sores. These must be very carefully handled, as now is the time that any carelessness or neglect permits of those distressing contractures which are still only too familiar. Splints are now invaluable. For burns on the flexor aspect of a joint the limb must be kept in the fullest extension; on the extensor aspect in many cases in full flexion but sometimes in extension. The rule is that the limb must be so placed that the fullest amount of new tissue may be procured to allow of the contraction that always occurs for some months after complete healing.

It is unnecessary to consider
fully the treatment of the sore at this stage. Personally, I have always found that tinctures are most satisfactory here. The lint should be cut to exactly the size of the sore, and should not be overlapped by gutta-percha tissue more than ¼ inch. Astringent solutions such as zinc sulphate lotion (gr. j or ½ to 3), or lotion nigra of the B.P., or these alternately are valuable. Granulations must be prevented from becoming weak and watery, and to this end the silver nitrate stick should be freely used daily. In my experience copper sulphate sticks are useless. If the granulations become excessive they may be shaved down with scissors after which the caustic is applied.

C. Spence Smith suggests that a solution of Soda Bicarb (9ro ½v or ½ to 3) applied at this stage is very valuable acting not by any antiseptic virtue but by a local influence in raising the alkalinity of the blood, which has been found by Brucker and others
to be greatly reduced in cases of febrile reaction set up by bacteriological intoxications.

Skin grafting by both the method of Reverdin and that of Thielsch is now of the greatest possible value.

By Reverdin's method little snips of skin are removed from a healthy area, just so much being taken as to leave an oozing point, and soon directly on to the granulating area. Scimitar scissors and a pair of iris scissors curved on the flat are very useful for this purpose. This little operation should be carried out as soon as all the sloughs have separated and before the granulations become too high. If left too long the grafts become buried in the granulations and do not "take." To prevent them from being torn off with the dressing it is convenient to cover them with little squares of green protective tissue. They should be left undisturbed for 36 to 48 hours. At the end of that time
Those that are "taking" have become of a
pinkish hue and very soon give rise
to little islets of new skin. In some
cases grafts which have disappeared
and apparently died are seen in 3 or
4 days to have taken root and to be
growing vigorously.

Thiersch skin-grafting re-
quires an anesthetic. Long thin
strips of skin are then raised from
a previously prepared healthy area
by means of a "Skin-grafting knife".
These may be applied directly to the
damaged area or may be collected in
tepid saline solution (3.5 of NaCl to Oj
Sterile water) and then applied. The
area to be grafted may require pre-
vious preparation. If the granulations
are very young and very healthy
I have got the best results by grafting
directly on to these. If the granulations
are weak and flabby the whole area
should be scraped with a Volkmann
spoon and the grafts applied so as
to completely cover the wound after
all bleeding has stopped. It is useless to apply the grafts until this has occurred because they are otherwise simply washed off.

The method of dressing after Thiersch grafting is very important. Some apply perforated green protective directly and then a weak Boric or Saline solution. An excellent method is to build on the grafts by means of a few turns of sterile gauze out of saline solution cut and rolled as a 6 inch bandage. The gauze must be only one strand thick so as to allow of a free exit for the discharge which is always copious. Above this first layer of gauze a thick layer of folded gauze is applied. It is well to place a piece of gauze under this 2nd layer of gauze to keep it dry and to lessen the risk of dragging off the grafts at the first dressing. The wound is left for 3 days. On the 3rd day the outer dressing is replaced.
by Bovic fermentations and these are changed daily. The 1st layer of gauge is removed on the 10th day by which time the grafts should be firmly adherent.

These Sores are extremely liable to break down after healing and, if the lower extremity is involved the patient should on no account be allowed to set foot out of bed until the wound has been completely healed for a week. Even then he may be driven back by small areas breaking down from time to time for months. Burns too extensive to heal may leave chronic ulcers which may finally call for amputation. Or amputation may be necessary in the first instance for very severe burns of the extremities.

To obviate contractures, extensive fibrous tissue, early injections of Thrombinine and Fibroligan have been recommended. But there is, as yet, insufficient
evidence to estimate the value of these compounds.

Various plastic operations may be called for.

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