The Treatment of Ulcers by Oxygen

D. F. Seance Thomson M.B. C.U.
Bishopsgards
Perth
Cumberland
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The question of the successful treatment of the various forms of chronic ulceration is one which has from all time occupied the attention, and tried the patience of the profession and it cannot, so far, be considered to have been solved in a manner which is invariably satisfactory. The numbers of people who go through life suffering from various forms of ulcers of the legs, whereby their usefulness is impaired, their comfort interfered with and their means lessened by the expense of treatment, renders any new form of treatment worthy of the most careful consideration, painstaking methods of application and accurate scheduling of results. The number of methods of treatment employed for such cases show that, so far, no one method yet has been eminently and invariably successful. The difficulty of healing
such ulcers as the callous, indolent ulcer of the lower limb, in itself and its several varieties and also the various other forms of ulcer both simple and specific has led me to lay before you for your consideration the treatment which was initiated by Mr. S. Stokes of London and which I have now for some considerable time been engaged in investigating, namely the application of oxygen gas.

Ulceration as spoken of in this paper applies to where the subcutaneous depth of the part has extended deeper than the cutis vera. The causes of this ulceration are of two kinds—local and constitutional. Local exciting causes are injury, burns or an inflamed varicose vein. The local predisposing causes are the varicose condition of the veins of the limb, and the swelling and passive congestion.

Ulcers are of many varieties and many treatments have been adopted. With those varieties of ulcer which
heal readily under ordinary treatment
I have nothing to do in this paper,
but it is with those such as the Callous
and other forms which are difficult
and sometimes apparently impossible
to heal, that the treatment which I
have to recommend, is to be pursued.

The modes of treating such ulcers
are none of them satisfactory and certain
the old-fashioned blister, strapping,
elastic pressure, Martini's bandage as
well as the local application of bichloride
of zinc, nitrate of silver, or bolus form
and the use of Volkman's spoon, and
the careful aseptic dressing all
share in the above category of being
nether satisfactory nor sure in their
results. Naturally added to all of these
is the postural treatment of the limb.

The question remains as to
what it is which prevents these
various methods of treatment being
always successful. Often we can
almost heal such an ulcer by any
of these methods but frequently
the healing breaks down again and the whole condition reverts to its previous state. It seems evident to me and I think scientific facts bear me out in saying that the cause of the difficulty in healing such an ulcer, is not so much one connected with the state of the edge, the solid oedema or the passive congestion of the limb though these all share in keeping up an unhealthy condition, as it is one of infection of the wound by organisms, which either by their actual presence or by the toxins which they produce set up such a condition of the wound as to absolutely prevent healing because it is difficult to render the wound perfectly clear of these noxious bacteria. I use the word noxious advisedly because I hope to show that all micro-organisms are not inimical to but that some such are essential to the healing of the ulcer.
In Stoker's box.

The rubber bag which I have employed is shown as a stocking because of the position of the ulcer, being near the ankle.
The method of treating wounds by pure oxygen was first recommended by Mr. Stoker and for the last year and a half I have been using it most successfully.

The treatment is simple in application scientific in theory and successful in result.

Mr. Stoker describes his method in the British Medical Journal for October 24, 1896. This method with alterations I have always carried out. The limb is enclosed in a box with glass sides and an india rubber funnel passes over the end of the box which is open over the limb so as to prevent the escape of the gas. By means of a tube with a stopcock, let into the side of the box a quantity of pure oxygen gas mixed with air in varying proportions is introduced into the box. The air is passed through two bottles one contained lime water and the other a solution of Potassium Permanganate before being passed into the box. This method
uses about one cubic foot of oxygen in
the 12 hours. The box is opened morning
and evening, the leg taken out and
washed with cold water & replaced in
the box which is again filled with
the mixture of oxygen and air.
This method may be applied to
wounds in any other part of the body
but these I do not intend to touch on.

I have tried Mr. Stoker's method but
have given up the box in favour of an
inside rubber bag made of very thin
rubber with tube & stopcock attached
to the side of the bag. At one or both
ends of the bag as required there is
a broad band of stouter rubber, 3
inches wide which encircles the
limb, keeps the gas from escaping
when the bag is distended. This is
used in the same way as the box
being filled with gas morning and
evening. The leg taken out and
washed in the manner before
described. I have however used no
admixture of air in my cases but
have used the Oxygen pure in all cases. My reasons for this will give in describing the Bacteriology of this subject. There tried various other materials for enclosing the limb such as celluloid, glass and hard rubber, but I consider the bags which I have mentioned as much the best. In my experience the box keeps the limb too dry and hot, causing desiccation of the discharge over the wound & preventing the action of the gas on the surface of the wound.

The treatment of wounds by oxygenating agents has been suggested and carried out long previous to Stoker's oxygen treatment being introduced. In 1870 Campbell Black of Glasgow advocated the use of such agents in putrid wounds in his pamphlet "Therapeutics & Disease" in which Hardy states that dissociated water has been used as a wound dressing in the Paris hospitals & both Ozone and Peroxide of Hydrogen have been tried in the same way. These however have
certainly not stood the test whereas I venture confidently to assert that the use of Oxygen pure principle will stand all tests and has only to be known, to remain always a steadfast method of treatment.

One of the greatest advantages of Oxygen is its action on the relief of pain. Within 24 to 48 hours of its application a patient, who has had broken sleep for years, states that the pain has gone & that unbroken sleep has been obtained. In some of my cases the patients have told me that for years they have had but little sleep at night on account of the pain but that after this treatment was begun the pain had all gone & it does not return.

Another advantage is the deodourising action of the gas. We all know how evil is the odour of a bad callous ulcer yet within from 2 to 4 days the Oxygen renders the ulcer perfectly sweet. These two factors in themselves the Analgesic & Deodourising properties
Of the gas are enough to render its application worthy of a trial. But when you combine with these factors the assurance that healing goes on rapidly and uninterrupted, then I think but little else is required to ensure oxygen being made a valuable auxiliary in the hands of the Surgeon and has already proved in the hands of the Physician.

In beginning the treatment of any ulcer no previous preparation is required. The patient is put to bed and remains there until the treatment is finished, the lamp, as it is, is enclosed in the bag which is then filled with oxygen direct from the cylinder. When the bag is distended the stopcock is turned off the cylinder removed. I do not use an intermediate gas bag as Stoker does, because it is unnecessary and adds to the expense. These bags as a rule hold half a cubic foot of gas. Twelve hours afterwards the stopcock is opened and fluid in
The bag is allowed to run out, this is partly discharge from the wound and partly water formed in the bag. The bag is then turned down over the foot. The leg washed with cold water. Usually at this dressing the whole skin cleans up, all the old ointment from previous dressings, dead epithelium and washed off under the stream of water. The limb is dried if the bag replaced...refilled. This is done regularly twice a day and no other treatment of any kind whatever is pursued, that is the same as under ordinary conditions only the bowels are regulated.

On the first dressing it is noticed that the surface of the ulcer is beginning to clean, in two days or sometimes less it will have cleaned up and by the end of four days the whole floor of the ulcer is seen to be studded with short, firm, bright red points. At each dressing the surface of the ulcer is covered with a greasy or red thin pellicle which is easily washed...
off. Steadily the granulations grow filling up the cavity as they progress until the whole wound is filled with a structure on which the short, red granulations stand and this is now level with the surrounding skin. The edges in the meantime have shed their old epithelium. Look pale and bleached. Then the granulations have attained the level of the surrounding skin and till then does the epithelium begin to grow in. It grows regularly from every side over the surface of the wound but is not attached to the subjacent structures for some time. It is only as the healing goes on that it becomes adherent. When the healing is complete the epithelium forms a superabundant mass over the last part to heal. This peels off later as a dry hard silvery scale. Which breaks to powder in the fingers. The resulting healed wound is covered for months with dry silvery scales which easily peel off and leave below a pinkish white skin
During the process, the nutrition of the skin improves, the oedema disappears, the colour alters and the hard, dense, elephantiasis-like skin becomes soft and pliant. The general condition of the leg reverts to the normal. The cicatrix, so-called, which results, is specially characteristic. There is no contraction or puckering, but loss of tissue that is not the hard, white, shiny appearance of an ordinary cicatrix, and I have seen, not a case of my own, black hair growing on the healed part. In one case (Mr. Moffat) there are small blue veins to be seen in the healed ulcer.

The time occupied in the healing process is much shortened, usually from 3 to 4 weeks will heal the worst of these ulcers but where the wound is directly over the front of the tibia, the time required is lengthened by several weeks in some cases.

The cost of the treatment is also to be considered. After the initial outlay for cylinders, bags, the actual cost
is very little indeed if it is the cheapest method of dressing that known of.

In the cases which I have to mention later on, each ball of them had been under the care of men who had tried every method of curing them with but meagre results. Two of them were cases which had been under my own care, I had previously failed to heal them although both the patient I had tried every known means.

In most of the cases to be brought to your notice, the bacteriology has been carefully gone into. Cultivations were taken both before and after the application of the oxygen from these cover glass preparations were made stained. The general results show that previous to treatment many forms of micro-organisms are present in the ulcers both Bacilli and cocci being demonstrated but that after the gas has been applied for a certain time the Bacilli disappear and the cocci remain to increase in number.
I should say one form ofoccus only remains that being a staphylococcus
Stoker says that when healing is
arrested it is due to the reappearance on
the wound of some of these unfavourable
bacilli the remedies this by increasing
the percentage of oxygen in the box. In
more of my cases has healing been
arrested and I attribute this to the use
of the oxygen without any admixture of air. I am led to believe that the
probability in Stoker's cases is that he
introduces the bacilli into the box by
means of the air with which he dilutes
his oxygen whereas by using the gas
pure this danger is done away with
and so the time required to heal the
wound is lessened. His objection to pure
oxygen is that, in some cases, it is too
stimulating but I have not found this
to be so I have had no trouble in
consequence. Stoker has inoculated wounds
which were slow of healing, with pure
cultivations of the staphylococcus Pyogenic
Albus and not only has had no bad
result but has found that healing is accelerated thereby. He has also grown
the unfavourable micro-organisms in oxygen + air mixtures and found that
they begin to die off in a mixture containing
50% oxygen and 50% pure air; that an
alcohol represented as O = 60 and N = 40.

Before beginning the treatment I have
photographed the cases and again after
the ulcers were healed and I have
attached the photos to the notes of each
case. Some of them were not photographed
and these I have mentioned last; they
were the first cases and are only
added as additional proofs of the fact
that ulcers can be healed in this way.

I will now describe the cases in
detail giving a short history of each
and then state the duration of
treatment and the appearances
noticed as the ulcer heals reserving
the notes of the bacteriological examin-
ation until later when this will be
described in each case and the various
micro-organisms noticed more fully.
The scar of the wound is seen as a white mark. This is due to the mass of silver scales which form on the healed surface. This photograph was taken 6 months after the leg had healed.
Robinson aged 43 yrs. has had an ulcer on her leg for 17 years. After some years it healed up but soon broke down again. This continued so in spite of treatment.

I attended this patient some four years ago but failed after many weeks in bed to heal her ulcer completely. She is a farmer's wife and is a stout healthy woman.

There is an ulcer on the left leg, 3 1/4 in. long by 1 1/8 in. wide. It extends from directly behind the internal malleolus upwards and forwards. It has a reddened, tense, hard margin for an inch from the edge of the ulcer, the floor of which is white and glazed with almost no trace of granulation. The discharge was small in quantity; semi-purulent and offensive in odour. Pain was severe.

The oxygen was applied on the 7th Oct. and in 24 hours, the white base of the ulcer seemed to vanish as if leaving a red surface. The pain disappeared in two days and all odour was gone by the end of the third day. After a week the granulations were sprouting up.
Smith
Before treatment
Inner side of
vance leg
Two large
ulcers and
same skin
condition seen

After treatment
The whole of
the leg is
covered with
white, silver
scales.
Smith

Outer side of right leg before treatment. Five ulcers to be seen. Also condition of surrounding skin noticeable.

After treatment, observe improvement in skin, practically no scars to be seen. The mark under the leg was due to a fold of the bandage.
all over the floor of the ulcers and in twelve days they were level with the surrounding skin edges. The epithelium now began to spread over the surface and gradually closed the wound which in five weeks was completely healed.

Smith, aged 64 years, a thin spare woman, scalded her leg 13 years ago. This scald extended from the middle of the leg on to the dorsum of the foot. It had healed up in part at the time. After 3 years the ulcers healed entirely but after a week broke down again. I have since remained so. All kinds of treatment have been adopted but without success. Her complaint is that she has never had a good night's sleep for years on account of the pain and that the smell of the leg makes her presence objectionable to her family.

From the middle of the right leg down to the ankle the skin is shiny, thin and dark purple in colour, almost blackish in character and sharply defined from
the healthy skin above. There are seven ulcers implicating both sides of the leg. These vary in size from that of a blister to that of a crown piece, one on the inner side of the leg measuring 3 inches long and 1 inch wide. They are irregularly shaped with fairly sharp edges as if punched out, base dark brown, smooth and glazed, discharging greenish coloured pus, no granulations the seen, odour abominable. The pain was intense. There were some varicose veins. The woman was unable to walk any distance or to stand on the leg for any time. There was no general oedema but a thickened hard mass over the front of the ankle.

Treatment was begun on the 13 Dec and on the night of the 14 she had an uninterrupted sleep. On the 16 the ulcers had cleaned & presented the appearance of sharply punched out wounds, the base being the deep fascia of the leg. Within a week they were filling up with granulations and in 10 days the small
Before treatment:

After treatment:
Mozaf. Right Leg. Before treatment

The photo is only shown to give some idea of the size of the ulcerated surface as the plate got spoiled, hence the unsatisfactory result.

After treatment

The white patch which is the healed ulcer shows the size of the original wound and neither this nor the photo of the left leg shows any sign of contraction in the scar.
ulcer seen below the external malleolus had healed. The wounds at each dressing were covered with a thin semi-transparent pellicle which easily washed off. The ulcers filled up to the skin level and the epithelium began to grow over the surface and in 4 weeks the whole of the seven were entirely healed. No pain was experienced after the first day and the swell was gone by the third day. The skin of the leg also improved in colour, apparently in texture, the purple colour fading to a healthy blush. The leg presents almost no appearance of the healing but is covered with silvery scales. The woman's general health improved. She can now go about easily.

Moffat, aged 57 years, a very short farmer's wife who suffers from oedema of her legs, has had an ulcer on her right leg for over 15 years. About 8 years ago she had "Erysipelas" in both legs and on recovering she had two ulcers on her right side on the
left leg. About 4 years ago I had her put to bed and treated her ulcers but the result was not a success. Since then they have remained in much the same condition.

Present condition of left leg: There is a large rectangular sore on the outer side and back of the leg about 2 inches above the ankle. This measures from below backward 3 1/2 inches and 2 1/4 inches from above downward it is 1 1/2 inches wide.

Condition of right leg: On this there are two irregularly shaped ulcers, one on the outer side about the middle of the leg extending from a point 1 1/2 inches above the malleolus up the side and measuring 4 inches with the long diameter by 3 1/2 inches across. The other is directly over the shin and higher up the leg and measures 2 1/4 by 1 1/4 inches. The edges of all these sores are eaten out, the margins hard and knotty, the base covered with dark unhealthy granulations and exuding a foul-smelling, serous discharge. The legs are much swollen tense that, dark purple in colour and the whole limbs are painful.
Sewell

The ulcer just over the tibia is shown here with the leg in the upright position, before the treatment was commenced.

After treatment.

The scar in this case is covered with white scales and shows up well. The apparent depression of the scar is due to the fact that the leg is oedematous.
Treatment was begun on 29th Dec, 1896, and the legs were both put in oxygen bags. In this case the paresis did not cease for three days when the dark granulation tissue came off in flakes leaving below the same conditions as previously noted. The smell disappeared, the discharge lessened, the lymph covering appeared over the wound, the cavity filled up and epithelium rapidly grew over the surface. In three weeks the left leg was healed, but the large ulcer on the right leg took 5 weeks before it was covered in. Then the ulcer over the skin had closed to the size of a pea but took some weeks longer to heal. The swelling of the limbs disappeared, the colour of the legs improved greatly, the skin lost its shiny appearance became soft and pliable.

Swell aged 62 years, a washerwoman very stout, with oedema of the legs due to failing heart received an injury to her shin in September 1896.
This was at once attended to and dressed. It got worse and she lay up and was seen by the district nurse who daily dressed the limbs. I saw her and advised the nurse as to treatment. It did not improve, and a large slough formed on the surface and in part separated. After six weeks treatment the ulcer was getting larger and the pain interfering with her rest so I resolved to use oxygen. The condition was then as follows: There was an ulcer over the shin bone, 2 in long by 1 in wide, edges sharply cut in places, ragged in other places, smooth in elevated, base red, inflamed slough adherent in the center, discharge small in amount, colour brown, pain very severe. In three days after the gas was applied the pain had gone in five days the slough separated, on the 6th day granulations were growing up from the base and then the same cycle of changes went on. When the epithelium had grown in for some
Before treatment.

After treatment. The mass of scales piled up over the healed ulcer is well seen in this photo.
distance, small effusions of blood under the new covering took place and the epithelium was opened to allow it to escape. This did not cause any health of the epithelium which fell down on the tissues beneath became adherent. It however seemed to delay the healing which took between 7 to 8 weeks. I may say that the treatment is continued with until the wound is absolutely healed even to the smallest piece, this ulcer was no bigger than a split pea for a week or two before the final healing took place.

Kellanwell, aged 33, has had a bad leg for 18 years with the exception that it once remained healed for nearly 3 years. About a year ago it healed for a short time, a few weeks, but it breaks down again. It has now been in this present condition for a year. She does not know what was the cause of it. The leg above the site of the ulcer shows some cicatrices of healed wounds.
There is a sore on the inner side of the left leg, just above the malleolus, it is 2 in long by 1 in wide, the edges are white, raised, hard and sharply defined, the base flat and glazed with some faint attempt at granulation, discharge small and amount and foul in odour, pain is what she complains of much of.

She has been treated by one of my colleague, thus been kept in bed for two months but without healing the sore. She looks thin and tired and complains very much of her condition. She has a large number of small varicose veins.

Treatment by oxygen began on March 5, 1921 the pain disappeared almost at once the ulcer was gone in 36 hours, in 4 days the granulations were growing, the edges softened and became pink in colour, the cavity filled up and in 20 days from beginning the oxygen the ulcer was firmly healed. The cicatrix hardness in the old wounds was lessened and the patient herself stated that the skin of the leg was altogether better than
The black line on the photos is intended to show approximately the size of the ulcer before treatment.

After treatment.
it had been for many years. Her general condition also was much improved.

In these cases I have shown photos of the legs before and after the treatment and have also examined the discharges that will state the result later. The following four cases have been treated in the same way but they were my earlier cases and unfortunately I did not make photos of them nor cultivate the discharge.

Davidson aged 60 years has had an ulcer on her right leg for over 25 years. This had improved from time to time until then got worse again but for the last 4 years no improvement had taken place.

The ulcer measured 4 inches by 2½ inches was on the outer side of the right leg just above the ankle. It was a typical Ulcer, with hard thickened edges, base smooth and hard, discharge great in quantity thick foul in colour, pain very great. The woman was entirely crippled by this sore and was practically unable...
to get about.

In two days after commencing treatment the pain was relieved, in four days the smell had gone and the ulcer cleaned and in a week granulations were forming. The edges softened, the thickened epithelium peeled off and the colour changed to the pink hue of a healing edge. As the healthy granulations grew the discharge lessened and the lymph follicle formed over them. The same cycle of change took place as in the other sores and the wound was healed in 3 weeks. This case has been healed for twelve months and I have photographs of the leg. The patient is a woman with a large family. She has gone about her work ever since the leg was healed and with no bad result.

Fothergill aged about 40 years, a housekeeper had three ulcers on her right leg, evidently specific in character, showing all the peculiarities of broken down granuloma. They were irregularly circular with a punched out appearance, the discharge
was a kind of debris and of unpleasant smell. The pain was very great. The edge of the sores were hard, persistent. The size of the ulcers was approximately that of a shilling, half-crown, and a crown piece respectively.

On treatment, the before mentioned changes took place, pain disappeared in two days, base cleaned, due change ceased, granulation occurred and in 3 weeks the two smaller ulcers had healed while the largest one was only the size of a threepenny piece. At this time the woman had to go to a situation and left before the third ulcer was healed.

Woolley aged 42 years had suffered for a long time with swellings round her knee joint. She states that she fell on her knee and it that it began to run in 1885. In my opinion she had a neglected Bursitis of much more recent origin. There were a number of putrid ulcers about the knee, which discharged
four fins and she had a great deal of pain. She had had no treatment of any kind.

Oxygen was applied in the same way and in 4 days the pain had gone and the discharge ceased, all odour had also gone. In 14 days the whole of the sores had healed & the knee was quite as good as before. I saw this woman six months after when the knee was well.

Lowthian, aged 65 years, had had a small ulcer on her right leg for 5 or 6 years. It was about the size of a shilling situated on the outer side of the leg just above the ankle, edges thin and red, base red & granular, discharge practically none, pain intense. There was great varicosity.

The pain disappeared almost at once on the application of the Oxygen, the inflamed appearance of the base and edge subsided, the granulations grew to the surface and she was healed in 10 days.
Bacteriological examination of the discharge from the ulcers.

Previous to commencing the treatment, cultivations were made of the discharge present on the surface of the ulcer. This was done by rubbing a sterilized platinum needle over the ulcer and making thrust cultivations in tubes of agar-agar and nutrient gelatine. When these had developed cultures were again made from these on obliquely solidified tubes of the same kind. During the healing process tubes of agar-gelatine were again inoculated in the same way from the ulcer. The agar-tubes were grown at a temperature of 37°C and the gelatine tubes at 20°C. From all of these tubes, specimens were taken at cover glasses preparations made and stained in the ordinary way. The general results show that there are present in the discharge many and various kinds of micro-organisms, previous to the application of oxygen. There are cocci of several varieties and very many kinds of Bacilli. In the tube cultivations
taken after the oxygen had been used for the time necessary to clear the wound it was found that the Bacilli had disappeared and that there was present only two forms of cocci the Staphylococcus Pyogenes and Staphylococcus Aureus in one or more of their varieties, viz. Albus, Ochraceous or Aureus. Some of the varieties of Bacilli I am able to name but others deflect some hesitation in attempting to name, that is however immaterial as they all share the same fate on the application of the gas.

I will now go over the cases I have examined and describe the appearance in each case.

Robinsen: (1) Primary culture on Agar tube 1.—After 24 hours there was a greyish white growth at site of puncture in thorough cultivation. After 2 days the needle tract showed a kind of featherly growth of same colour.

Sub-culture after 12 hours shows bluish white translucent growth in tract of needle the growth spreading out on obliquity of Agar.

(2) Primary culture on broth cultures:—
A greyish white growth at puncture and in
trace of needle after two days. Gelatine slowly liquefies. Patrid colour from all the tubes.
2) Subculture gives same appearances, but on pressure in jelly the growth is seen to spread out on surface like a common Pseudomonas ferea.

Microscopically: \(- \times 650\)

Cocci in numbers, as diplococci aggregated in masses. Individual cocci small about 2.5 \(\mu\) in diameter. Bacilli are small rods about 1.5 \(\mu\) in length, frequently in pairs or linked in 3 or 4, evidently Bacillus pyogenes foetidus.

Cultivations taken after oxygen had been applied for a week.

On agar agar: A yellowish white growth on surface and white growth in needle tract appeared after 24 to 36 hours.

On Gelatine the same appearance was seen only the growth was white flocced as if a drop of steam had been placed on the surface of the jelly. The jelly was not liquefied.

Microscopically: \(\times 1200\). Both tubes showed nothing but cocci aggregated in masses. These cocci were larger than those previously seen.
and answered to the description of the 
Staphylococcus aureus albus flavus which 
are associated with ward's name. These 
cocci do not differ morphologically or 
recently from the more common 
Staphylo. Pyog. Albus but are distinguished 
by the fact that they do not liquefy gelatine

Sewell: Primary culture: 

on agar. After two days there was a white 
growth in the needle tract composed of small 
white colonies with a white growth on 
surface of agar.

On cultivation after three days tiny white droplets 
were seen to be forming in the needle tract and 
not becoming aggregated.

On oblique gelatine the same formation of minute 
colones was not tending to spread much beyond the 
site of inoculation were seen. The have a faint 
fluorescent appearance like not liquefy the 
gelatine. The growth is very slow in both latices 
Microscopically x 1200. The preparations from both 
latices are seen to consist of small cocci in mass 
and in short chains of three or four elements 
This I take the Staphylococcus Pyogenes wardii
Cultures taken after oxygen
on agar gives a yellowish white growth,
after one day, extending down the thread
over the surface. As culture with nutrient
broth, takes the same appearance only after
a longer time, about 36 hours, and the culture
rapidly liquefies it becomes slightly turbid
depositing a powdery granular precipitate
forming the characteristic nail shaped
liquefaction.

Microscopically, x650. Cocci in clusters and
masses. These cocci are large. 2-3 in easily
There are staphylococci Pyogenes Albus
and Aureus.

Smith. Primary culture
on agar. Dirty white growth appeared after
20 hours, semi translucent on surface of
medium. White growth in needle broet
with air bubbles forming.

Subculture shows same kind of growth after
12 hours, irregular spreading colonies from
site of inoculation on oblique agar. After a
day or two the agar becomes green in
colours. The smell from the tubes is very foul.
In gelatine, white colonies appear in 24 hours and the medium is rapidly liquefied and becomes green in colour. There is a white flocculent deposit at the base of the liquefied part; the colour is foul. Microscopically \( \times 1200 \).

Preparations from culture tubes show cocci single or in clusters, some short, thickish bacilli about 1.5 \( \mu \) in length and numbers of slender rods.

The cocci are Staphylococci Pyogenes, the Bacilli are Bacillus Pyogenes Petrides and Bacillus Pyocyaneus. There are two described under the latter name one by Bresad and one by Errich, but their morphological characteristics are such that it is impossible for me to decide, without inoculation experiment in which this is.

Cultures taken after oxygen give the same appearances as in the last case only that the colonies were white and not yellowish and these show microscopically the same cocci as in the last case, namely the Staphylococci Pyogenes Albus.
Wellswell. Primary culture:—
On agar after 24 hours there was a grayish white growth along the margin over the surface forming later a thick round pellicle on the surface & smelling badly.
Sub-culture shows after 12 hours a gray nearly translucent growth spreading rapidly over the oblique surface.
Sub-culture shows yellowish white growth which rapidly liquefies the jelly and deposits a flocculent precipitate.
Sub-culture gives the same appearance. The liquefaction taking place very rapidly in the upper part & there is a fluorescent appearance of the jelly.
Microscope: x 1200

Number of small cocci, single in pairs and in small masses. Bacilli are short rods with rounded ends about 1 by in length and 3·4 by broad. There are also a few long slender bacilli from 2 to 3 by in length. These appear to be one of the forms of Bacillus fluorescens Aquifaciens along with Staphylococci and probably Bacillus flexides. Both tubes gave practically the same microscopic result.
Cultures taken after oxygen gave the same results as in the previous cases, that is, practically pure cultivations of Staphylococci, pyogenes albus, and are shown to be so microscopically.

Woffert: Primary culture on agar. After 8 to 12 hours a white streak appeared which rapidly became grayish, and in the preparation from the right leg spread like a thin film over the whole surface. That from the left leg formed a thicker semi-translucent film over the oblong and somewhat the same colour.

On gelatine, Right leg, gives a grayish white growth in the throat culture after 16 hours, rapidly liquefying the gelatine which is turbid. A white deposit settles to the bottom of the tube.

Left leg, there is a yellowish white growth rapidly liquefying and depositing a feebly yellow precipitate. These tubes have all a tickly offensive odour. The sub-culture from this leg deposited a flocculent precipitate in the liquefied
part and the gelatine was of a yellow golden colour.

Microscopically, × 1200.

Right Leg. Coci and Bacilli of various lengths, long thin filaments breaking up into short rods 1.5 y in length, some of the rods are as much as 10 y in length. On dividing they form chains of often several the rods are in groups and in bundles of three and four. The width is about 0.3 y.

There are also thicker rods sharply cut at the ends from 2 to 3 y in length at 0.5 y wide. They also appear to divide in the same fashion.

Left Leg (3½) Coci and long thin rods as in previous specimen, dividing into rods about 1 y to 1.5 y long. The specimen from the gelatine tube shows the same kind of division in the Bacilli there seen but they are thicker and not so filamentous as in previous specimen nor is their length so great, none of them being more than 5 y in length; I cannot name these Bacilli.

 Cultures taken after oxygen had been applied give the same result as in previous
cases, namely, practically pure cultivation of the Staphylococcus Pyogenes.

In remarking upon the bacterial conditions mentioned in the preceding observations, it is best noticed that whereas we have a number of micro-organisms present on the wounds when first seen, yet after the application of the Oxyjen there all disappear, with the exception of the Staphylococcus. This shows that these bacilli are unable to grow and reproduce themselves in the presence of Oxyjen, that is to say they are obligate anaerobes while the Oxyjen which remains viz the Staphylococcus Pyogenes is a facultative anaerobe. Now I think it is evident that the cause of the great cause of the non-healing of these ulcers is the presence of these Bacilli and the difficulty of getting rid of them completely and maintaining their absence is the chief factor in the non-healing of them. This however is a difficulty which is easily removed in the treatment.
advocated here. It is thus evident that oxygen is an efficient destroyer of these putrefactive organisms which by their presence and action interfere with the organisation of that blood clot, either coloured or colourless, by means of which all wounds are healed. All of the organisms which are found in such ulcers are those which are either pus bacilli or have been found in air or water and the readiness with which such ulcers become infected can easily be understood. It is worthy of note that the Staphylococci seen after the oxygen has been used are much larger and stain more readily and are much greater in number than before the treatment. There is in using oxygen in such cases applied to the surface and surroundings of the ulcers an efficient antiseptic (as oxygen is) which while absolutely fatal to the putrefactive organisms which prevent the healing, yet is eminently favourable to the growth of those organisms which aid in the healing.
It will be noticed that only about a week was required for these organisms to be destroyed and all of those which were noxious organisms fell victims to the oxygen. The Bacillus Tetrides, Fluorescens, Pyocyaneus and others were the most commonly found. I have mentioned the Staphylococcus Aureus which only found in one case. In all probability it would be more often found with a larger experience.

The oxygen also acts beneficially in other ways than as above mentioned. By its presence, it aids the healing process by nourishing the granulations while it have never seen any exuberant granulations form during its use. This may be due to the elastic presence caused by the distended rubber bag but even in using Stock's box no such condition has been seen. The nutrition of the skin is also improved by the oxygen as the color is apparently the texture also revert more to the normal and even in occlusive cases such as result from
burns, the old scar becomes softer and less blue & glazed than before. The micro-organisms mentioned, doubtless, only represent a few of the varieties which may be present in such cases but as Stoker has not had any failures in healing and as my cases have all been successful, it is probable that any unfavourable micro-organisms which infect such wounds are capable of being destroyed in the same manner as those already mentioned are. Thus oxygen exerts a selective faculty in destroying all unfavourable micro-organisms while it promotes the growth and well-being of those favourable to healing. The process of healing is worthy of notice. It seems as if the tissues were built up layer by layer from the bottom of the wound and this without lesioning in any way its superficial area. The fulcralia are never long and prominent. They are short red stumps just above the level of the subjacent layer, and as
the wound becomes filled up, they rise to the level of the surrounding skin & then become covered by the growing epithelium.

The cicatrix resulting from such healing is peculiar. There is almost no contraction, there is absolutely no loss of tissue and the scar does not assume the ordinary white, shiny, appearance of an ordinary cicatrix. It is level with the skin surface, pink in colour and sometimes shows small blue veins running through it. Its surface is covered with white scales like a case of Psoriasis and these are produced for a long period of time after healing. So far as I am able to judge, the healed wound does not tend to break down and as some of my cases have gone about their ordinary occupations for as long a time as 12 months with simply a bandage on (often ill applied), it is felt that a claim to permanent healing may be set up. I always advise the use of an elastic stocking.
for some time but many of the patients have used a bandage and some have not used anything special.

I feel satisfied, after the cases I have treated, that the method adopted achieves for us the end desired and that in the application of pure oxygen carefully and properly used we have a never failing means of rapidly curing all and every ulcer which cases have been for so long a trouble and source of disappointment to every practitioner who has had many to treat.

I started this experimental inquiry with some amount of doubt as to the efficacy of the treatment and with much incredulity as to its result, but I feel satisfied that the method is one which has stood the test and now I have neither doubt nor hesitation as to its efficacy. The late Prof. Spence, in his last opening lecture this class, quoted the Biblical axiom, "Prove all things, hold fast that which is good." This is one of the things I should feel...
because it has been proved to the good.

In conclusion I would wish to recapitulate shortly that in Oxygen as a means of treatment, used in this relation, we have it acting the part, locally, of a germicide, an antiseptic, an analgesic, a de-odourant, a stimulant to the part acted upon and a nutriment to the tissues concerned. Its use is easy and it requires no special skill in its ordinary application. It is cheaper than almost any other form of treatment.

It never fails to produce the result desired.

It produces a scar which does not tend to break down.

In short the treatment of ulcers by means of Oxygen gas as I have described, is as already stated:

Simple in application
Scientific in theory
Successful in result.
As the photo on the previous page shows, the general appearance of the Staphylocconi I have not added other photos of this species.

These photos of cover glass prep. from Sewell's leg.

From Smith's leg.
Micrographs of a sub-culture from Mutti's leg.

Micro-plots of a primary culture from Mozati's leg.
Micro-photographs of a culture from Hoggar's leg.

Micro-photographs of a culture from Hellawell's leg.

These do not show all the microbes described in the text, but the difficulty of manipulation must be my excuse for the deficiencies in the micro-photographs.