A YEAR'S EXPERIENCE OF THE USE OF SULPHUR IN SURGERY.

BY

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As more than a year has elapsed since I commenced to use sulphur in surgery, I venture to lay before this Society some record of the experience of its action which I have gained during that time, together with such conclusions as I have arrived at as to the best methods of its application.

It was my misfortune to lose a patient by iodoform poisoning. He had suffered from spinal caries in the lower part of the dorsal region, and a large superficial abscess had formed beneath the skin in the vicinity. The abscess was laid freely open and its walls scraped. A cavity in the chest near the carious vertebral bodies, which communicated with the superficial abscess by an opening between the ribs, was also cleared of its contents as thoroughly as possible. Then glycerine and iodoform emulsion was introduced into the cavity, and most of the incisions were closed by means of sutures, a drainage-tube being left in. I had adopted similar treatment on a great many occasions with considerable success, and in no instance had it been followed, as far as I knew, by any ill consequence attributable to the drug. On the day after the operation the patient's pulse became rapid, and during the night his mental condition attracted

some attention. Dr. Thomas Stevenson saw him, in consultation with me, and confirmed my suspicions that the patient was suffering from iodoform poisoning. Like all patients into whom iodoform has been introduced, his urine contained iodine in readily recognisable quantities. The wounds were at once opened up and freely irrigated, every remaining particle of iodoform being removed. In spite of this, and in spite of the introduction of a large quantity of normal saline solution into his circulation with the view of enabling him to excrete the poisonous material through his kidneys, the rate of his pulse, the mental depression and the delirium increased, and he died within four days of the operation.

It seems likely that this patient possessed a peculiar idiosyncrasy in regard to iodoform, as there was no variation from the modes of operation previously adopted to account in any way for the drug producing such dangerous symptoms. Though I felt I was free from blame for the unfortunate termination of the case, yet it caused me much distress and a feeling of distrust and uneasiness in the use of the drug. I could not help fearing that it soon might be my misfortune to experience another such disaster; and I spent much time in thinking of some material that would take the place of iodoform without possessing its poisonous properties. It would appear that iodoform produces but little if any effect upon organisms unless it is placed in contact with a raw living surface, when the living tissues break it up into its components, one at least of which is powerfully germicidal. It occurred to me that sulphur, which is able to check the growth of the *acarus* of scabies, *Tricophyton tonsurans*, *Microsporon furfur*, and other animalcula and micro-organisms, might, under the influence of raw living tissue, produce sulphurous acid in a quantity sufficient to diminish or even stop the growth of any organisms with which it might come in contact.

On consulting my friends as to the possibility of its being of service in this manner I received but little sup-

port. I was, however, comforted by the general assurance that at least the drug could do no harm, as, if sterilised, it would probably remain inert when introduced into an aseptic wound.

The first case for which I used it was that of a girl aged ten years, who was admitted under my care into the Hospital for Sick Children, suffering from very advanced and rapidly progressive hip-joint disease. I operated on September 19th, 1893, and found very extensive disease involving the head of the femur, the acetabulum, and the adjacent portions of the innominate bone, and associated with this, abscesses extending into the true pelvis, into the buttock, and down the thigh. There was no pocket or cavity in the neck of the femur in which I could pack a quantity of iodoform; and though pieces of necrosed bone were removed from the pelvis, no opportunity for such treatment offered itself there.¹ After clearing away the necrosed and caseous structures as well as I could, and after removing the contents and scraping the walls of the abscess cavities as thoroughly as their position would allow me, which in the case of the large collection in the true pelvis was of necessity done very imperfectly, I felt convinced that, if the case were left in this condition, the disease would return in a very short time as acutely as before, and that the patient would have derived very little benefit from the operation. I therefore introduced a quantity of sterilised precipitated sulphur into the wound, in the hope of its being of service in staying the development of the tubercle bacillus, and closed the incision, leaving in a drainage-tube. The limb was then put up in its position of rest, the inner margin of the foot forming with the vertical an angle of about 50°. At

¹ I may say in passing that this is the only use I now make of iodoform, namely, to plug cavities in bone with the solid drug. This very insoluble material is slowly removed, its place being taken by new bone. This method I described in the 'Lancet,' July 15th, 1893, in a paper entitled "One of the Best Applications of Iodoform in Surgery."

the end of forty-eight hours the tube was removed, when the odour of sulphuretted hydrogen was perceived.

The case followed the ordinary course of an aseptic wound till the 25th of October, when the temperature rose to $100\cdot5^{\circ}$. The wound was dressed on the 26th, when the smell of sulphuretted hydrogen was more obvious. By the 30th, the edges of the incision, which had previously united, had broken down, became black and sloughy, and gas escaped freely. The patient was put under an anæsthetic, and the parts beneath the skin were freely exposed. It was then found that not only the skin, but also the fat, fascia, muscles, and bone were most extensively destroyed. Indeed, it was with the greatest satisfaction that I found the femoral artery pulsating in the depths of what seemed like one extensive slough. The soft broken-down tissues and the necrosed surfaces of bone were removed very carefully, and the wound was freed of any perceptible relic of unchanged sulphur.

It was again covered by an inhibitory dressing, and was irrigated daily with a dilute perchloride of mercury lotion. The remaining sloughs separated rapidly, and union took place in a most satisfactory manner, leaving a very useful firm limb.¹

I gathered from this experience that sulphur, under the influence of recently incised living tissues, produced sulphurous acid, which rapidly changed to sulphuric acid by oxidisation, and that this acid was formed in quantities sufficient to destroy not only any organisms with which it came into contact, but every living structure as well, whether muscle, bone, fat, fascia, or skin. It also was apparent that I had used this powerful drug in an excessive quantity, that I had left it in the wound too long, and that I was dealing with an agent which, if used properly, must be of the greatest service to the surgeon in dealing with many conditions which had

¹ This patient was readmitted under my care in 1894 with extensive tubercular disease of the ankle, which I erased successfully.

hitherto successfully resisted all his efforts. I soon learned to use the drug properly, and have arrived at the following conclusions :

1. Neither sulphur nor the products generated by its decomposition act prejudicially upon the life or health of the individual into whose body it is introduced.

2. If placed in contact with recently incised healthy structures, twenty-four hours is a sufficiently long period for it to render the part sterile. After using it in this manner it is necessary to leave the wound open, so that the sloughs which have formed may escape. In my earlier cases I used to irrigate the wounds at intervals with a dilute perchloride of mercury lotion, but now I prefer to pack with sterilised gauze.

3. If the recently incised or scraped surface be but poorly supplied with blood—as, for example, is the brawny edge of a carbuncle or that of a spreading gangrene of a limb—the sulphur may with advantage be left in contact with the tissues for a considerably longer period.

4. If the surface be a granulating one—such, for instance, as the wall of a chronic tubercular abscess—sulphur may be introduced daily, preferably as an emulsion with glycerine, without causing any considerable destruction of parts.

5. In such joints as are reached with difficulty—as, for instance, those of the tarsus, the sacro-iliac synchondrosis, &c.—the tubercular growth may be reached by diffusing sulphur and glycerine between the articular surfaces as often as may be necessary.

6. The presence of other organisms in a tubercular cavity, whether due to the surgeon or admitted by a spontaneous rupture of its walls, influences in no way the action of the drug, since it destroys all organisms, whether free in the cavity or intruding into the surrounding living structures forming its walls.

7. The action of the sulphur is painless.

8. The formation of new compounds caused by the action of living tissues upon such drugs as iodoform or sulphur, which, without such influence, are practically harmless to organisms, illustrates forcibly the fallacies that may arise from the attempts of bacteriologists to demonstrate the capacity of drugs as inhibitory or germicidal agents by means of experiments on dead cultivation media alone.

I cannot do better than relate briefly the histories of some of the cases in which I have used it.

A. B—, æt. 7 years, was admitted under my care into the Hospital for Sick Children, suffering from very advanced disease of the elbow-joint. I operated on September 22nd, 1893, and found the several bones most extensively diseased. This condition, with the very largely distributed boggy infiltration of the soft parts about the joint, rendered it extremely unlikely that a good result would follow an excision. Consequently, after removing the diseased bone and tissues as freely as I could, I introduced a quantity of sulphur. Much swelling ensued, and the part was again exposed on the seventh day after the operation. The changes found were similar to those described in the first case, though not so extensive, while the treatment adopted was the same. From this date the patient made an uninterrupted recovery, and has now a strong useful joint with moderate movement. I believe that a primary excision of the articulation would very probably have been followed by an amputation, but on this point it is obvious that I cannot speak with any certainty. As in the case first mentioned, the sulphur was left in for an unnecessarily long period.

A man æt. 30 was admitted into Guy's Hospital under my care on July 11th, 1894. He had been cleaning a window, when he fell forty feet, transfixing his forearm upon an iron spike of the area railings, from which he was suspended. The skin and muscles of the forearm were extensively lacerated along the whole of its length,

and portions of his coat-sleeve and shirt, which were both very dirty, were driven in among the pulped and lacerated muscles. Such portions of the muscles as were much mashed and fouled were removed. The ulnar artery was uninjured. The damage to the soft parts was so extensive and the fouling so considerable that I was convinced that, however thoroughly the parts might be washed with germicidal lotions, amputation would become necessary at no distant date.

Therefore, after cutting away some parts, cleaning up others, and removing all foreign materials present, gauze saturated with an emulsion of sulphur and glycerine was introduced everywhere in and between the lacerated tissues. This was removed at the end of twenty-four hours, when the wound was found to smell strongly of sulphuretted hydrogen, and the tissues to be covered by a soft black slough. Irrigation with dilute perchloride of mercury lotion was used daily, and the intervals in and between the lacerated muscles were packed with cyanide gauze. The slough soon separated, leaving a healthy granulating surface. The highest temperature recorded was 100.6° on the evening following the operation. I would repeat that, as far as my experience goes, this arm would have become foul very soon after being treated with the germicidal solutions we use for such purposes, and amputation would have been rendered imperative in consequence. He recovered with a very useful arm.

L. J—, æt. 12 years, was admitted into Guy's Hospital under my care on November 8th, 1893, suffering from tubercular disease of the base of the third metacarpal bone, and from extensive lupoid ulceration which covered the back of the hand and wrist. This had obviously resulted from an infection of the skin where the tubercular abscess about the base of the metacarpal bone opened externally.

The cavity in the bone was scraped clean and plugged

firmly with iodoform. The extensive patch of lupus was scraped and covered with lint soaked in glycerine and sulphur emulsion. When this was removed at the end of twenty-four hours the surface was seen to be covered with a soft black slough which smelt strongly of sulphuretted hydrogen. This separated under the influence of hot boracic compresses, and on the clean surface a large single graft was placed. The patient was discharged with the sinus in the bone and the skin surface firmly healed. She experienced no pain from the action of the sulphur.

E. T—, æt. 17, was admitted into Guy's Hospital under my care on October 30th, 1893, suffering from tubercular disease of the tarsus, which was much swollen in the vicinity of the medio-tarsal joint, and of the articulations between the cuboid and cuneiform bones. Externally there was an opening as large as a sixpence, through which a probe could be passed deeply into soft caseous bone and granulation tissue.

The cavity in the cuboid was scraped out thoroughly, and much caseous material was removed from it and from adjacent bones. Glycerine and sulphur emulsion was introduced into the cavity and made to percolate into the several affected articulations, and on subsequent occasions small quantities were dropped into the sinus. The swelling of the foot rapidly subsided, and the patient was sent to a convalescent home with a depressed cicatrix occupying the position of the sinus. She had no pain or discomfort in the foot.

The amount of swelling and the very extensive evidence of disease of the joints and bones of the tarsus would have led me to perform a Syme's or Pirogoff's amputation if I had not been aware of the action of sulphur.

W. C—, æt. 11 years, was admitted into Guy's Hospital under my care on November 24th, 1893, suffering from extensive tubercular disease of the lumbar and sacral spine, discharging externally by several sinuses. An

attempt was made to get at the disease by extensive incisions, but without much success; gauze saturated with sulphur and glycerine was introduced, and the cavities were plugged as firmly as possible. This was removed on the following day, and sterilised iodoform gauze was substituted. A strong odour of sulphuretted hydrogen was given off from the wound, and this continued for a long time, owing to the fact that much of the sulphur must have been left in the irregular branching abscess cavities.

Before this operation the boy had been losing ground steadily, but almost immediately after the operation the improvement both locally and in the general condition was most remarkable. The cavities and sinuses soon closed, and the boy recovered perfectly. He was seen a fortnight ago, when he was leading a very active life and enjoying very good health, his cicatrices being white and firm.

As far as my experience goes such a result could not have been obtained in the time, if at all, by means of any other method with which I am familiar. But for the sulphur treatment I believe the boy would have died within six months.

F. G—, æt. 47 years, employed in the brewing trade, was admitted into Guy's Hospital under my care on August 20th, 1893, suffering from a lacerated wound of the front of the dorsum of the foot. It was fouled by dirt. He acknowledged that he had been a very free drinker for many years. The patient was put under an anæsthetic and the wound was thoroughly cleared of foreign material, all ragged tissue was cut away, and the wound as well as the rest of the foot was rendered as clean as possible by means of liquor potassæ, soap, and strong carbolic lotion. Cyanide gauze moistened with one in twenty carbolic lotion was applied.

When the dressing was removed at the end of forty-eight hours the edge of the wound and the tissues in its immediate vicinity were found to be gangrenous, while

the foot and leg were œdematous. The wound was again cleaned with strong carbolic lotion and repacked with cyanide gauze, as on the previous occasion, and over this dressing a large hot carbolic compress was applied and the limb was raised. Twenty-four hours later the gangrene had spread considerably, while the skin and subcutaneous tissues of the foot were very thick, livid, and brawny. This was most marked in the immediate vicinity of the gangrenous area. The œdematous condition had also extended higher up the leg. The gangrenous tissues were cut away and sulphur was applied in considerable quantity to the brawny œdematous adjacent tissues. An abundant hot boracic compress was applied all over the foot, and kept constantly hot and moist. A change rapidly took place in the character of the œdema, and within a few days all danger of the gangrene spreading had come to an end. Sulphur was applied frequently and any dead tissue was cut away. When the wound was quite clean a graft was applied.

You will readily gather from the character of the conditions which I have described that nothing short of amputation would have stayed the rapidly spreading septic gangrene in this man, whose vitality was enormously lowered by alcohol, if sulphur had not been used. The ordinary germicidal agents in common use were tried most thoroughly, and apparently without benefit.

A. L.—, æt. 12, was admitted into Guy's Hospital under my care on July 8th, 1894, suffering from a large tubercular cavity which involved and had destroyed a portion of the wall of the rectum and internal sphincter, so that besides an abundant discharge of pus the child was quite unable to control its motions. The disease had begun twelve months before, apparently as an ischio-rectal abscess. The inner surface of the ischium was bared by the tubercular process, and was carious. Besides the large opening into the rectum there were several fistulous openings externally. The child was very feeble

and emaciated, and was rapidly losing flesh. The cavity was exposed as freely as possible, and was found to be very extensive, reaching high up into the pelvis. A large quantity of tubercular matter was removed, and the space was plugged with gauze saturated with sulphur, glycerine and sulphur being introduced at intervals subsequently. The improvement in the child's general and local condition was rapid and unmistakable. The cavity filled up quickly, and at the present moment the child is practically well, being able to control her motions and enjoying good health. This case showed quite as well as the others the rapid change in the general condition which is brought about by the removal of the bacillus of tubercle from the body, and the abrupt cessation of the absorption of any of its products.¹

E. A—, æt. 20, had suffered from very destructive tubercular disease of the knee for more than six years, the joint having been disorganised and dislocated for a long time.

The joint was excised on October 13th, 1894, when, besides a very extensive tubercular infection of the synovial membrane and of the soft parts, the bones were found to be diseased through a considerable length. A very large sequestrum was removed from the femur. The sawn surfaces were retained in accurate apposition by means of silver wire, as, in spite of a very prolonged operation, owing to the very boggy condition of the surrounding soft parts, I feared that I had not completely removed the diseased structures. Gauze saturated with sterilised sulphur was packed into the space from which the tubercular material was removed, and left there for twenty-four hours.

A slough formed which gradually separated, the part being kept thoroughly dry and aseptic by the use of

¹ Some time after leaving the hospital a portion of the wound broke down again. This, in all probability, would not have happened could we have kept her long enough.

sterilised dressings. The inflammatory thickening subsided almost at once, and after seven days had elapsed the temperature never rose above 99°.

As far as I can speak from experience, I am certain that this case would not have progressed in the same satisfactory way if I had not made use of sulphur in the manner described.

E. W—, æt. 34, had suffered fourteen years ago from tubercular disease of both testes, which subsided after prolonged suppuration, and for nearly thirteen years from tubercular abscess in the perinæum, ischio-rectal fossa, and prostate.

These had for the last nine months communicated with the rectum on a level with the prostate, the mucous membrane of the rectum being deeply ulcerated about the aperture, through which urine escaped involuntarily.

In April, 1894, I had laid the cavities open as freely as possible, and had plugged with iodoform and gauze, with the result of rendering his condition decidedly worse, since my incisions rapidly became involved by the tubercular process.

The injection of sulphur and glycerine was commenced on September 4th, 1894, when the patient weighed 8 st. 10 lbs. He was shown at the Clinical Society on November 9th, when he weighed over 10 st. The rectal fistula had closed, and except for the escape of a few drops of urine occasionally from a minute perinæal fistula the patient was practically well.

Although only a fortnight has elapsed since he was last weighed, he now turns the scale at 10 st. 6 lbs., a gain of 1 st. 10 lbs. in two months and a half. No urine now discharges through the very minute orifice in the perinæum, and I expect this to close within a few days. The result obtained in this case was quite beyond my most sanguine expectation.

E. P—, æt. 50, was admitted into Guy's Hospital under my care on September 27th, 1894, suffering from a large

carbuncle on the left shoulder. It had begun to discharge externally, and was surrounded by an extensive area of thick brawny tissue.

The slough was removed the same day, when the cavity left measured at least an inch and a half in depth. It was plugged firmly with gauze and sulphur, and a hot compress was applied. The plug was removed at the end of thirty-six hours, after which the hot compresses were continued. Five days after the operation the edges of the surrounding skin were nearly level with the floor of the ulcer, from which the soft slough left by the action of the sulphur had almost completely separated. A graft was applied a few days later. Though I have scraped out a good many carbuncles, and have plugged the cavities left with iodoform and gauze, I have never before seen the same rapid subsidence of the thickened infiltrated edge and the early recovery of the healthy appearance of the floor that took place in this case.

I think I have related the details of a sufficient number of cases to indicate to you pretty clearly the action of sulphur and the various modes in which it may be used. From a consideration of them you will see that its range of application is a very wide and important one. I have availed myself of it largely for every infective process in which it could be applied locally. For instance, in tubercular disease of the bladder it is introduced as a tragacanth emulsion through a catheter; in the various conditions included under the very vague term "whitlow" I have derived immense advantage from its action, whether I have employed it in the form of a powder to fill a sloughy cavity in the subcutaneous tissue, a suppurating tendon sheath or joint, or an infective process running up beneath the annular ligament into the forearm. In these latter circumstances an emulsion distributes itself more rapidly and acts more effectively than the powder.

In lupus of the nasal cavities or of the mouth sulphur produces the same result as it does when applied in lupus

of the skin, though in the case of the mouth and throat it is obviously difficult to keep the sulphur in contact with the ulcerated surface. This difficulty can, however, be met by perseverance and ingenuity on the part of the surgeon.

For foul offensive ulcers, for some varieties of eczema, for the infective sores which occur about the head and buttocks of badly fed children, &c., it is equally valuable. When possible, a hot moist compress should be used as it stimulates the affected parts, and so produces more active chemical change.

As far as I know, sulphur has not been used in this manner before. On talking it over with an old friend of mine, he told me that he remembered seeing it dusted on poultices when he was first apprenticed to a surgeon.

Dr. de Rey Pailhade, a civil engineer of mines and also a doctor of medicine, has been experimenting on the medicinal action of sulphur, and has come to the conclusion that there is diffused through the animal kingdom a principle he calls philothion, which combines with sulphur at 40° C., producing sulphuretted hydrogen. For full information as to the evidence upon which this assumption is based I would refer to that author's elaborate works.¹

Mr. Pakes is making a research into the several chemical changes which result from the introduction of sulphur into the human body, and hopes to lay the results before the Society at a future meeting.

I need hardly point out that as tubercle very rapidly relapses when the part appears quite healthy the patient must be kept under treatment for some considerable time after apparent recovery. The neglect of this precaution is well illustrated by the case of A. L.— (see foot-note, p. 63).

¹ 'Recherches expérimentales sur le philothion,' 8vo., Paris, 1892; 'Rôle du philothion dans l'absorption du soufre,' 8vo., Paris, 1892; 'Le philothion et le soufre,' 8vo., Toulouse, 1894; 'Rôle physiologique du philothion dans la respiration des tissus,' 8vo., Toulouse, 1891.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. vii, p. 25.)