PART III.

MEDICAL MISCELLANY.

Reports, Transactions, and Scientific Intelligence.

GAS-GANGRENE.

By M. ANDRÉ CHALIER, Chief of the Surgical Clinique of the Faculty of Lyons, and Medical Aide-Major of the first class, which he contributed to the *Gazette des Hôpitaux*, 1915. 88-ième Année. Translated in abstract by GEORGE MAHOOD FOY, M.D., F.R.C.S.I.

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IV.

Pathology.—From the preceding ætiological hypotheses we are prepared to consider the following pathological theory :—

The infective germs are of telluric origin, they are carried by the projectile, which in actual conflict ricochets from the ground, the site of entrance being recognised by fragments of clothing, earth and other débris. From the vantage ground of a sinus, unaerated, undrained, deficient in blood supply, and containing extravasated blood, or from a traumatic aneurysm, or from the site of a compound comminuted fracture, or from a muscle cavity formed by tissue attrition, the germs swarm and multiply. They are for the most part anaerobic, and their development in number, vitality, and virulence is fostered by cold, moist weather and surroundings, the transporting of the wounded for long distances, and inopportune interventions (untimely wound explorations and wound suturing). To these may be added the torture of the wounded blood vessels (tourniquetted, too tightly compressed). The gas-gangrene which follows is more or less of the precocious type, more or less tardy, always serious, but it in every case has a period of incubation which varies from eight hours to five days. We consider that the wounded suffer from an insufficient aseptic dressing in the front zone and from too great a delay in treatment. Gas-gangrene is, without doubt,

a primary infection, initially conveyed to the wound by the projectile, and not a secondary infection inoculated into the wound. But it makes for the development of a series of conditions favouring a secondary infection. It is possible that in these subjects the projectiles do carry many different varieties of germs. And yet one and all the infections are grave ; the more complex the origin, the more formidable the complication. Neither the nature of the projectile nor that of the soil, nor that of the pathogenic germs, but the different local conditions of the wound explain the development of gas-gangrene from this or that wound, or in this or that region. Moreover, the contagion of this disease undeniably inspires intense fear. All gas-gangrene cases are isolated from those of other diseases in a special ward, which accommodates fourteen patients. But we know that during war, when troops are actively advancing, we cannot secure sites (operation theatres or dressing rooms), or assistants (bearers or hospital attendants), or materials (instruments, litters, bandages and so forth) necessary for an exclusive ward for gas-gangrene cases. Notwithstanding this M. Chalié has not seen a case of hospital infection. It seems, on the contrary, that when gas-gangrene attacks a wound it confers immunity on the other wounds from which the patient suffers.

He has not known of a case of double gas-gangrene, or of a recurrence after an attack even of a mild and short character. He had two very analogous cases of wounds of the legs with gas-gangrene in one limb, and in the other a complicated fracture of the patella ; the dressings of the two wounds very freely imbibed the secretions, and in spite of all precautions were mutually soiled, and yet not for a moment did the gas-gangrene pass to the opposite side. [Since this went to press M. Chalié has seen a case of gas-gangrene with a double seat, one on the left thigh and the other on the right buttock.]

V.

Prophylaxis—Although perhaps only slightly contagious, gas-gangrene should be isolated and treated in an isolated manner as a transmissible disease. But it is above all an avoidable disease, and its prophylaxis should be based on our knowledge of its history. A wounded man is seen to fall on the field of

battle ; in his wound, soiled by the ground, by portions of his clothing, he carries the pathogenic germs of gas-gangrene. How is this dreadful complication to be prevented?

To be of service, the prophylactic treatment should be prompt, for the gas-gangrene may develop a few hours after the infliction of the wound. It is then of the utmost importance to relieve the man quickly, and to give attention to the most urgent lesions : rapid disinfection of the wound with tincture of iodine, or, still better, oxygenated water. Arrest the bleeding by catch forceps, or, if forceps are not obtainable, but purely as a temporary expedient, apply a tourniquet, immobilise the limb, as the majority of these cases are fractures.

As much as possible protect the patient from rough handling and from cold. Let him be removed as quickly as possible to the nearest ambulance, which should travel without delay, and have a supply of dressings. Make the wound and the surrounding tissues aseptic, remove all superficial foreign bodies (splinters of bone, bits of clothing, projectiles), remove the tourniquet and stay the bleeding under an anæsthetic if necessary ; apply dressing, splint or a plastic apparatus, that immobilisation may be secured. But under no pretext nor in any way insert a suture, superficial or deep : this is a fundamental principle of the surgery of the war during advance. No doubt in gaping wounds of the face, wounds of the orifices, notably of the lips or eyelids, or to prevent eversion of the same, or to prevent a fold of skin or flesh from falling down, we are justified in applying one or more sutures. But the suture should be made without delay—any delay is dangerous, for it almost always nullifies any good that might have resulted from the suturing, and may be followed by dangerous complications. How often have we seen such suturing determine terrible consequences—gaseous phlegmon, bronze erysipelas, gas-gangrene—besides which oftentimes in the centre in which we operate, suturing may expose septic foci with fatal result. The wounds contracted during war are, as a rule, septic, not only when unsutured, but oftentimes even when it is necessary to incise and drain them. In every case the primary precaution is a scrupulous examination of all the wounds, even repeatedly in the seemingly insignificant injuries : a surveillance continuous and untiring for the first

few days. And through this self-imposed duty we are in a position to note the wounds which show a tendency to develop gas-gangrene—that is to say, those which contain the ætiological characters which we have already passed in review—vast muscular destruction, osseous and articular, tortuous passages and sinuses, pouches of blood, and vascular lesions. It is for these that the attendants ought to be on the alert and ever vigilant. The preventive measures consist in free openings of the wound, admission of air and the drainage of burrows, of sinuses, removal of splinters of bone, of projectiles, of shreds of clothing, irrigation by solution of peroxide of hydrogen. If there are œdematous patches, bronzed or copper coloured, close to the wound, we correct them by the application of the actual cautery over all the tumefied zone. This is of the nature of a therapeutic method, very simple, as we see, and have before noticed, for in this way, as it were by a blow, we overcome all the infectious complications of the wounds of warfare, and in particular gas-gangrene. The author has seen a proof of this in the case of a suspected wound in a patient whom it became necessary to hurriedly place in an ambulance. This treatment stayed the production of gas-gangrene.

All our experience, as we have indicated, is that wounds suspected of gas-gangrene should be carefully watched and thoughtfully considered every day, or at least for the first five days, which correspond to those which we have named as the period of incubation of gas-gangrene. The author made many observations in the systematic daily treatment of the first five days with the object of detecting gas-gangrene, which otherwise would pass unrecognised, or if detected, the discovery would come too late. He considers that all grave wounds susceptible of gas-gangrene should be treated surgically from the beginning and grouped as dangerous for six or eight days, and about this time, if no symptom of complication develops, the patients may be transmitted to an hospital in the interior.

We have personally adopted this treatment, and we have had no occasion to be dissatisfied.

VI.

Treatment.—Preventable by a good prophylactic, gas-gangrene is curable if taken in time; for this we have two

great surgical methods, one conservative, the other radical, each of which has its indications.

(A) *Conservative Treatment*.—In the tentative measures of conservatism which the author adopted he always practised three surgical courses :—(1) Free incisions ; (2) the application of the actual cautery ; (3) interstitial injections of solution of peroxide of hydrogen. In so doing his object was to disinfect the wound by facilitating the escape of gas and of secretions from the regions invaded by gas-gangrene, and to drain the seat of the toxin ; secondly, to prevent the spread of the infection and to free the circulation of the blood from the tension produced by the emphysematous swelling. The majority of suitable cases can be so treated without being anæsthetised, since they are, in the greater number of instances, found in regions which the disease has made more or less insensible to pain. He prefers in all cases to have recourse to a brief and safe anæsthesia under chloroform, which in all the serious cases has been well borne, even in radical operations which occupied hours in their performance.

The Large Incisions.—The patient being anæsthetised, we, after a rapid disinfection of the wound by tincture of iodine, commence by incising with a thermo-cautery or bistoury, adopting longitudinal incisions, very long and deep, and opening the enveloping aponeurosis. There is nothing to fear from a heavy hand. The cellular tissue on being cut appears always more or less infiltrated, oftentimes brownish or black ; there wells up a quantity of reddish serous-like fluid, at the same time the escaping gas crepitates under the bistoury, and the stench of the gas fills the atmosphere. The aponeurotic section discloses two torn leaves of tissue and muscle hernias, as they present themselves in the different ways which we have already described. Sometimes there is gas in the muscle grooves or in the muscle substance, which necessitates the separation of the inter-muscular spaces and the clearing out of all nests of the poison, and the free admission of air to all the deeper lodgments of the gangrene, which we carefully drain bit by bit, after removing spicula of bone and such foreign bodies as they contain.

One general rule is to extend the incision completely across the crepitant area ; it is convenient when making the incisions to utilise the wounds made by the projectiles, but the incisions must be adapted to the seat and nature of the injury.

In a typical case of gas-gangrene of the buttock, consecutive to the insertion of a long vertical seton, M. Chaliér joined the two wounds by an incision of about twelve inches long, cutting through the entire thickness of the great gluteus, which resembled a large wet sponge, crepitant and stinking, from which for days afterwards collops of flesh had to be cut away in proportion to the extent of the sphacelus. In a case of gas-gangrene of the thigh the author made a long antero-internal incision, parallel to the femoral vessels, opening the sheath of the vessels and the muscular aponeurosis. Besides this he sometimes also makes an incision along the outer border of the vastus externus, and occasionally an internal counter opening posterior to the adductors.

In a very complicated case of gangrene extending upwards on the abdomen a large curved external incision exposed a shell in contact with an unbroken femur; the cut extended along the whole length of the crural *linea aspera*; another similar opening, an inch anterior, commencing at the iliac fossa, parallel to the axis of the vessels for some length and finally becoming vertical, for a short length, at the superior external border of the gluteus, became very useful for drainage of the wound.

For gangrene of the leg and foot, M. Chaliér makes three ordinary longitudinal incisions—one antero-external, following the line for ligation of the anterior tibial artery, and opening the anterior aponeurosis; the other, posterior-internal, following the line for ligation of the posterior tibial artery, and opening the interspace between the gastrocnemius and the soleus muscles; the third, posterior, median, prolonged to the popliteal space, occupies all the length of the calf of the leg. Sometimes he found it necessary to make one or two longitudinal incisions on the dorsum of the foot parallel to the tendons of the extensors.

Finally, for total gangrene he has practised in association the greater number of the incisions enumerated above.

In a unique case of gas-gangrene of the arm, in which conservative treatment was tentatively followed, four longitudinal incisions were made on the forearm and three on the arm.

The Actual Caution.—The cautery was a precious aid to the incisions made, which underwent the same treatment of

aeration and drainage. These are "*incisions en miniature*," and, from their number, they are equivalent to interrupted incisions. As a rule it is necessary to make the cautery points numerous and close together, and to stab all the small openings of the diseased surface, from which brown or citron-yellow serous fluid exudes. M. Chaliier ordinarily uses the thermo-cautery knife, and makes a fairly deep incision to drain the cellular tissue, especially if the incisions were not sufficient for the purpose. It is accordingly necessary to apply the cautery, not alone to the points of the longitudinal bands which separate the incisions, but to all the parts affected by the gangrene, both to those above and to those below the incised zones. It is, at the same time, advisable to go beyond the apparent upper limit of the gangrene to try and create a sort of "*barrière des pointes de feu*," with the object of limiting superiorly the progress of the infection.

The Injection of Peroxide of Hydrogen.—Finally, to the incisions and the actual cautery which remain, in the author's opinion, the two fundamental steps of the conservative operation, must be added the antiseptics of a 12 per cent. solution of peroxide of hydrogen—it should be pure and diluted with a small quantity of boiling water. The antiseptic should be used by means of a Lueri syringe, of a capacity of 10 or 20 cubic centimetres, armed with a strong needle. The injection should first be made into the deepest incisions, into the cavities of attrition, or at the point of development of the gangrene which the incisions exposed in the muscle tissue and aponeurosis. When we can put 2 or 3 cubic centimetres of the antiseptic fluid into each cavity, or into the majority of the orifices of the "points of fire," the infected nest is bathed in a "*bain oxygéné*" unsuitable for the development of anaerobics. These injections should be made to the utmost limits of the gangrene.

Post-operative Care.—The operation finished, we cover the "*zone des pointes de feu*" with a very broad, very absorbent, dry dressing, suitable for absorbing the peroxide of hydrogen solution and that of the permanganate. As the secretions are abundant and as, on the other hand, it is incumbent to watch the spread of the gangrene, it is necessary to renew the dressing once or twice a day and to excise all gangrenous tissue. If

the conservative treatment is sufficient this is quickly noticeable—we shall see little by little the elimination of more or less of the gangrenous débris, in the form of yellow granules, sometimes by suppuration, and in eight or ten days the wounds assume a healthy appearance. The treatment of gangrenous wounds usually consists in washing with peroxide solution, permanganate water, or a solution of an ioduret of iodine ; each of these antiseptics has given the author good results. He also used ether, alcohol and neo-salvarsan, but the former measures were more satisfactory.

Results.—The results of the conservative operations are, as already stated, most satisfactory. In all the cases, save one, the gas-gangrene was aborted. No doubt, the wound will kill by intoxication if the operation is unduly deferred, even if amputation becomes necessary to eliminate the infection ; even so it cannot be denied that the surgeon by free incisions, the actual cautery, and peroxide of hydrogen lavage is sufficiently equipped to stay the progress of gas-gangrene.

Here are the results of conservative operations furnished to the author by others, in twenty-eight cases :—In eight cases one finally called for amputation ; four cases were of twenty-four hours' duration ; two cases were of forty-eight hours' duration ; one case was of three days' duration ; and one case was of thirteen days' duration (from accidents unconnected with gas-gangrene). It is remarkable that these wounds were all cases of compound comminuted fracture.

Of the twenty cases which were in M. Chaliér's personal charge, fourteen recovered and six died. In one case death occurred in less than forty-eight hours, from the extension of the gas-gangrene ; it is quite true that it was one of the first of these cases which came under the author's care, of the foudroyante type, which was grafted on other very serious lesions : comminuted fracture of the femur and a diffuse traumatic aneurysm of the femoral vessels ; the treatment employed (incisions and actual cautery) was not thorough enough. In four cases death followed in from twenty-four to forty-eight hours after operation, from intoxication. The patients suffered from many lesions. Finally, in the sixth case, that of a young soldier, twenty years old, suffering from many grave wounds, inflicted by a hand grenade, gas-gangrene first showed itself on a wound of

the right leg, a complicated fracture of the peroneal bone ; taken in time it was arrested by conservative treatment. The peroneal muscles and portions of the extensor tendons were destroyed by gangrene ; the wound was in a good way of cure, but there were other infected wounds, notably a penetrating wound of the left knee with suppurative arthritis, which produced cachexia, and the patient died with a large gluteal scar in about a month. The fourteen cases of recovery from gas-gangrene by the conservative operation include one of the gluteus, nine of the thigh, three of the leg, and one of the head of the humerus and of the scapular region. The author had also to excise in one case the whole of the great gluteus, and, in another, all the muscles of the antero-external surface of the left leg, with the exception of the bundle of the vasculo-nervous system ; these two cases made a complete recovery.

Before discussing the indications for the conservative operation, let us consider the results of the radical treatment, which consists purely and simply in the sacrifice of a limb.

(B) *Treatment, Radical—Amputation or Disarticulation.*—The older surgeons, impressed with a knowledge of the rapidity of the spread of gas-gangrene, were wont to amputate high up and quickly, from its origin, not considering any other site safe. It is certain that from one point of view, the point of high selection is absolutely correct, seeing that in the case of the wounded, we are unwilling to operate too freely. From this it appears that disarticulation is superior to amputation, and also a more radical procedure. We should therefore have recourse to disarticulation at the hip-joint for the lower limb ; and in the case of the upper limb we should disarticulate at the shoulder or in the intoscapulo-thoracic space.

But we may truly say that disarticulation is not preferable to amputation in cases of gas-gangrene, for two reasons :—

First, all things being equal, disarticulation is without contradiction the more difficult and the graver operation. The shreds of tissue which of necessity are formed are invaded or threatened by the gangrene, and you become bound to see to its elimination ; it forms, with the articular cavity, a vast surface for absorption and one which is very favourable for it. Amputation is much less liable to such dangers.

In the second place, it is not always possible to get beyond

the site of the disease by disarticulation—this is notably the case when, in gaseous gangrene of the thigh, the crepitation extends to the abdominal wall, where incisions and the cautery alone are possible. In parallel cases where amputation is necessary, the operation may be done above the articulation more readily and with less risk.

For these reasons amputation is to be preferred to disarticulation as a radical operation, and as a protection against excessive sacrifices the conservative operation, over the full crepitant area, which ordinarily suffices to effect a cure.

Technique of the Amputation for Gas-gangrene.—The amputation should be done quickly : the method most readily performed should be chosen. M. Chalié adopts the circular operation, save in two cases of intra-deltoid amputation of the arm, in which he operated by the flap method, and he never sutures the stump. The avoidance of sutures is all the more necessary if gas-gangrene still continues to spread from the stump, and there is less chance of its infecting the tissues when the raw surface is unbound and simply covered with suitable dressing. But it is necessary to apply the actual cautery to the whole crepitant zone, and at the same time to inject solution of peroxide of hydrogen.

Results. The after-effects of amputations for gas-gangrene are ordinarily most simple, though cicatrization is slow. But, as a rule, the results are most brilliant and very rapid. In some cases, in the very agony of death, we got in some hours veritable resurrections the general condition of the wounded is rapidly improved by the destruction of the centres of morbidity.

Of twenty-five amputations for gas-gangrene, thirteen were of the thigh, nine of the arm, and three were of the leg.

Of these operations seventeen were primary and eight were consecutive to conservative operations. Among all primary and secondary operations there were five deaths.

In one case death supervened two days after operation, by intoxication, for the gangrene had not spread on the surface of the stump. The patient was a young chasseur who had been dressed the same day on which he was wounded, but he was compelled to remain two days in a wood before he

could be brought by an ambulance from the first line ; when seen his case was desperate.

In the second case death supervened on a violent disturbance, three days after the amputation, of a wound, which two days previously had been enlarged to allow of the femoral being ligatured at the apex of Scarpa's triangle for an enormous traumatic aneurysm.

The third death occurred on the day of operation, which was necessitated by an abundant secondary bleeding, supervening on the thirteenth day.

Finally, in two wounded, death occurred in the third and fourth week respectively from pneumonia in one case and from empyema in the other. Apart from these five fatal cases, the cure of the other operative cases was uneventful.

One patient, who had received a hypodermic of 10 centimetres of antitetanic serum on the day on which he was wounded, developed subacute tetanus, which appeared twenty days after the injury, three days after the amputation, and was cured in about two weeks.

Two amputation cases only had secondary bleeding, one on the eighteenth day and one on the twelfth ; they were not followed by any unpleasant results.

As we have seen, the results of amputations in gas-gangrene cases are excellent, seeing that the operation gives such good results as 80 per cent. of successes, especially as all the cases were of a grave character, many of them being terribly so. That is to say, following the phrase of Daniel Molière, relative to colotomy in cases of strangulated hernia, the operation of amputation in a case of gas-gangrene is not performed as a contraindication of death.

(C) *Indications for the Conservative and Radical Operations, respectively.*—Amputation constitutes the method of choice, that by which we should save the great majority of patients, but yet not all.

In effect, in the surgery of the limbs, preservation represents the ideal of all surgery, with the limitation that this tentative measure does not involve the life of the wounded. Experience has shown us that the conservative operation is sufficient for many of the cases, and that, in those in which it is insufficient,

we still possess an efficient remedy in secondary amputation, a method fully recognised.

M. Chalié advises that in local cases of gas-gangrene, above all in the benign forms uncomplicated by fractures, the surgeon should be able to make a loyal and hopeful effort at conservation, but he should be admonished to practise close observation of the wounded, not alone of the local injury, but also of the general condition of the patient (pulse, respiration, facies). You will thus sometimes have the gratification of obtaining a complete cure, in preserving the life of the wounded and saving the affected limb. But, if local and general improvement does not quickly result, say in twelve or twenty-four hours, and much more so if, in this interval, an aggravation of the unfavourable symptoms appears, immediate resort to the last resource of surgery is urgently demanded.

A further group of cases calls for the conservative operation, the patients being wounded, so that the conservative method is *the sole method possible*. Such are the cases of gas-gangrene of the thigh in which the gangrene has extended to the abdomen, gangrene of the buttock, gangrene of the arm extending to the scapular region. In such cases, amputation is no more than a useless mutilation, an incomplete operation; only a conservative operation, very large and very circumspect, can then save "*la fonction et la fonctionnaire*."

Emphatically, this is a treatment surgically elastic, ever associated with energetic medications (inhalations of oxygen, subcutaneous injections of massive doses of camphorated oil, artificial serum and alcoholic drinks), to which we must have recourse to overcome gas-gangrene. It is by the co-ordinate use of these two methods, radical and conservative, that we obtained thirty-four cures in forty-five cases—that is to say, seventy-five per cent. of success.