

never been demonstrated, and attributes the cure, in the cases that have been cited in support of the theory, to impaction of a clot. There is no doubt that inflammation about an artery or vein can and does often lead to the formation of a thrombus within the vessel, but the conditions in an aneurismal sac are so different that it is perhaps unjustifiable to argue from a supposed analogy.

The sudden formation of a soft clot within an aneurism may excite inflammation and suppuration of the sac with subsequent rupture. In a few cases this has been followed by a cure; but the cure must be attributed to the obstruction of the vessel, either by the original clot previous to the rupture, or by a secondary clot after the hemorrhage that has followed the rupture.

In like manner, tardy suppuration may follow cure, and after an aneurism has remained quiescent and shrunken, in fact cured, for months or even years, such suppuration may lead to the casting out of the clot in whole or in part.

Changes in laminated fibrin after the cure of an aneurism are slight and gradual, and rarely amount to more than a diminution in size by shrinking; sometimes the fibrin becomes soft, and sometimes lime salts are deposited in it. A unique case of late transformation into a blood cyst has been mentioned above.

Diagnosis.—The typical symptoms of aneurism are the existence of a more or less well-defined tumor that pulsates synchronously with the beat of the heart, has a distinct intermittent bruit, and diminishes in size while pressure is made upon it or upon the proximal portion of the artery from which it arises. But these signs may be variously modified or abolished by the varying conditions that have been described above, or may be undemonstrable because of the position of the tumor, or may be simulated by those of other affections. An additional sign is sometimes found in a difference in the character of the pulse in the distal branches of the artery when compared with that in the branches of the corresponding artery of the other side, a difference that may be recognized by the finger, but much more certainly by the sphygmograph.

The diagnosis of aneurism of the thoracic aorta is made by recognition of an abnormal area of dulness, pulsation, and bruit, perhaps with dysphagia, hoarseness, diminished respiratory murmur on one side, interference with the return venous flow from the neck, pain in the chest, and perhaps differences in the radial or carotid pulse. The differential diagnosis between this aneurism and one of the innominate may be difficult or impossible, for an aneurism of the arch of the aorta frequently presents itself as a tumor in the neck, and may even extend into the posterior cervical triangle.

In abdominal aneurism of the aorta, celiac axis, or mesenteric arteries, the only symptoms may be the indefinite ones of pain and pulsation, with an ill-defined tumor, and it may be impossible to determine whether the tumor itself pulsates or whether the pulsation is not merely communicated to it by the underlying aorta. If it can be grasped and lifted up, the diagnosis can be made, for in such case the pulsation will persist if it is an aneurism, and will cease if it is not. This exploration is not devoid of danger, since the handling may cause the sac to burst, as in a case in which the patient, himself a physician, sought to prove to the attendants that the tumor was a mass of hardened feces which could be lifted away from the aorta; these gentlemen retired to an adjoining room for consultation, and on their return found the patient dying. The sac had been ruptured.

The symptoms in external aneurism may be modified by the partial or complete consolidation of its contents, or by the temporary obstruction of its orifice, either of which occurrences may greatly diminish or arrest the pulsation and bruit.

The affections with which an aneurism is most likely to be confounded are solid or liquid tumors overlying an artery and very vascular tumors lying in or near the course of a large artery. In all, the common signs are a

pulsating tumor with bruit, and the circumstance that the pulsation and bruit may be arrested by pressure on the artery. The pulsation of an aneurism is *expansive*, the tumor enlarging laterally at each pulsation; that of an overlying tumor is a simple lifting of the entire mass; but this difference cannot always be recognized with certainty, for if the fingers cannot be pressed down to the widest part of the tumor, the simple rising of the sloping sides of the globular mass between them forces them apart and simulates lateral expansion. A bruit may be caused in an artery or vein by pressure upon it. In a vein such a bruit is harsh and continuous; in an artery it is intermittent and more "blowing" in character than that of an aneurism.

In the case of a suspected liquid collection simulating aneurism, the diagnosis may be aided by aspiration with a fine needle. An aneurism has been mistaken for an abscess frequently enough to make great caution necessary in the diagnosis and treatment of any supposed abscess lying in the course of a large artery. The fingers should always be pressed deeply into the swelling in search of pulsation, and even if an abscess is certainly present, it should be remembered that it may have formed over an aneurism.

As pulsation and bruit have their origin in the stream of blood brought by the artery, pressure upon the proximal portion of the vessel will arrest them, whether they belong to an aneurism or are simply communicated through a tumor. Vascular tumors, especially those arising from bone, often have well-marked pulsation and bruit; but their pulsation is less "heaving" or "massive" than in aneurism, and the bruit is rarely well marked. The diagnosis may be extremely difficult, or only possible by the aid of exceptional explorations. In a case of large pulsating tumor of the gluteal region, under the care of Prof. Henry B. Sands, in the Roosevelt Hospital, New York, in 1880, the diagnosis of aneurism was made by passing the hand into the rectum, and thus learning that the internal iliac artery was enlarged, the enlargement increasing from above downward to the sacro-sciatic notch. The frequent presence, in vascular tumors, of large collections of blood contained within sacs formed by the rupture or dilatation of capillaries or small vessels, increases the resemblance to an aneurism.

An aneurism which has just ruptured into the adjoining tissues does not pulsate, and may have no bruit; under such circumstances the diagnosis must be made by the history of the case, the pre-existence of a pulsating tumor, and the cessation of the pulsation coincidently with a marked change in the shape and size of the tumor. In like manner, where an artery has just been ruptured or perforated and the blood has been effused into the adjoining tissues, pulsation and bruit are not present until after the effusion has become circumscribed by a distinct firm wall composed of the condensed tissues ("traumatic aneurism" or "ruptured artery").

For the differential diagnosis of arterio-venous aneurism and cirroid aneurism or arterial varix, *vide infra*.

Prognosis.—The gravity of the prognosis varies with the artery involved, and the size and character of the aneurism. In internal aneurisms the prognosis is very grave; in external aneurisms it is commonly much less so, since in most of them suitable treatment offers a reasonable hope of cure.

Treatment.—**Medical treatment.**—The medical treatment of aneurism, especially of internal aneurisms, which are commonly regarded, and with much reason, as practically incurable, consists in absolute rest in the recumbent position, maintained for weeks or months, combined with a restricted diet, and aided, perhaps, by the use of various drugs. The absolute rest and the low diet are unquestionably the most efficient part of the treatment, and the drugs, even those for which most has been claimed, are only adjuvants of uncertain and often very doubtful utility. Systematic treatment of this kind dates from the time of Valsalva, and even in his hands the rest was subordinate to repeated venesection, which he carried to

such an extent that rest in bed was a matter not of choice, but of necessity. This active depletion was never regarded with much favor, and as it was long deemed an essential part of treatment by rest, the latter shared in the disfavor of its associate, and patients affected with internal aneurisms were habitually looked upon as beyond the reach of art, and the interference of the physician was restricted to relief of pain and the occasional employment of drugs from which it was thought some benefit might possibly accrue. To Mr. Tufnell,² of Dublin, belongs the credit of demonstrating the value of absolute rest in bed and restricted diet in promoting a cure or affording great relief. He insists upon the absolute maintenance of the recumbent posture, and restricts the amount of food to about eight ounces of solid food and six ounces of liquid daily, the solid food being bread, butter, and meat, the liquid milk and a little claret wine.

Of drugs, the iodide of potassium has been most employed, in doses of from half an ounce to one ounce daily. A number of cases of aortic aneurism apparently cured or greatly relieved by its use have been reported.

Digitalis, veratrum viride, and ergot have also been used, with the object of slowing the circulation; occasional supposed cures or temporary arrests by their agency have been reported, but they are not regarded with favor by the authors of systematic treatises on the subject. Ergot is given internally in the form of the fluid extract, or subcutaneously as ergotine. Mr. Holmes regards the acetate of lead as offering the best promise. Dr. F. Flint³ reported a case of aneurism of the abdominal aorta apparently cured by the use of the chloride of barium in doses of from one-fifth to three-fifths of a grain three times daily for about five months, after Tufnell's method had entirely failed. The most rapid improvement coincided with the smallest dose.

Surgical methods of treatment may be grouped in three classes:

1. Radical obliteration of the sac by opening it and tying the artery immediately above and below its point of communication with the aneurism. This is known as the "old method," or the "method of Antyllus." Under the same head may be included the new method of extirpation of the sac, with ligature of the artery above and below.

2. Permanent or temporary arrest of the afferent stream at a point on the proximal side somewhat removed from the aneurism.

- (a) Ligature of the artery (Anel's method, or the Hunterian method).

- (b) Compression of the artery—direct, indirect, digital.

- (c) Esmarch's elastic bandage.

- (d) Flexion of the limb.

3. Permanent arrest or obstruction of the stream on the distal side.

- (a) Distal ligature.

- (b) Manipulation to produce an embolus or impacted clot.

4. Rapid coagulation of the blood in the sac (with or without temporary arrest of the stream).

- (a) Coagulating injections.

- (b) Introduction of solid bodies.

- (c) Galvano-puncture.

5. Promotion of the formation of a laminated clot by irritation of the wall—"needling."

1. The "old method" (or the method of Antyllus). The aneurisms with which the ancient surgeons had mainly to deal, or at least those to which operative interference was mainly limited, were traumatic aneurisms at the bend of the elbow following venesection. It has been claimed for them that they knew and practised the method of cure by ligature of the artery in continuity above the sac, but Hodgson's statement, which is quoted by Mr. Holmes in support of this claim, does not fully and accurately present the practice. Ligature of the brachial artery "three or four finger-breadths below the axilla" was indeed recommended by Aëtius in the fifth century, but only as a preliminary to the opening of the

sac at the elbow and the application of another ligature there, and solely with the object of preventing hemorrhage during the operation proper. The main object of treatment was to remove the clot, which was thought to be a source of danger, and to prevent subsequent hemorrhage by obliterating the artery or closing the opening by which it communicated with the sac. The operation appears to have fallen into disuse and not to have been revived until about the seventeenth century, when it was again used with various modifications, but at first only in traumatic aneurisms at the elbow. It appears to have been first used in popliteal aneurism by Keyserle; the date of his first operation is not known, his second and third were done in 1747 and 1748 respectively. His first three cases were successful; the fourth died.

The method of operation, as practised in popliteal and brachial aneurisms until the end of the eighteenth century, was to control the artery by a tourniquet or the fingers, divide the sac by a longitudinal incision, turn out the clots, find the point of communication with the artery, isolate the latter, and tie it above and below the opening. The cavity was then packed with lint and allowed to fill by granulation.

The difficulties and the dangers were great. The opening into the artery was often deeply placed and difficult of access, so that the external incision needed to be very long (ten inches in a case of popliteal aneurism), and after the opening had been found the isolation of the artery was difficult; it was recommended to seek for it with a catheter or probe, and, after having found it, to introduce this instrument into it and use it as a guide and help in denudation, a suggestion that has recently been revived and practised in similar cases.

The results in popliteal aneurism were so bad that most surgeons appear to have preferred amputation. Pott says he had tried it more than once or twice himself, and had seen it tried by others, but always with a fatal result; and, as Mr. Holmes points out, the immediate acceptance and substitution of the Hunterian operation, which was itself nearly as fatal as amputation of the thigh, shows that the mortality after the old operation must have been frightful. Secondary hemorrhage on the fall of the ligatures was frequent, and so, too, was gangrene of the distal portion of the limb, probably because of the pressure of the lint with which the cavity was stuffed, or of injury to the vein, or of its inclusion in the ligature.

The causes of the bad results are not far to seek: difficult and deep dissection, a large wound, imperfect hæmostasis during the operation, the ligature placed upon an unhealthy portion of the artery, and officious and dangerous modes of dressing make a group of hostile conditions so numerous and powerful that it is not strange so few escaped with their lives. Modern improvements in operative methods, anaesthetics, the catgut or antiseptic ligature, and antiseptic dressings have brought a much larger measure of success in cases even less promising than the average, and the "old method" is still in use and gives fairly good results in cases in which the Hunterian method is impracticable, and, indeed, it even receives the preference in some others. Syme, after a long experience, which included some of the most brilliant and successful operations upon arteries recorded in the history of surgery, formally declared his preference for the old method over the Hunterian, except for aneurisms of the popliteal, femoral, and carotid arteries. The cases in which it has recently been used with success, and for which it is formally recommended⁴ after lesser measures have failed, are some traumatic aneurisms, aneurisms of the subclavian, axillary, and gluteal arteries, also after rupture of the sac, as a means of avoiding amputation (Holmes), when the diagnosis is uncertain and the tumor may be cancerous, and when the aneurism has recurred after apparent cure by ligature.

The frequency of secondary hemorrhage was thought by Hunter to be due to the diseased condition of the arterial wall near the sac, where the ligature was applied, and this has always been deemed one of the most weighty

reasons for preferring the Hunterian method, in which the ligature is placed upon a more distant and presumably healthy part of the artery. It must be remembered, however, that secondary hemorrhage was much more common in former days, after all operations in which a large artery was tied, than it is at present, when it has become very rare after ligature with catgut or aseptic silk; and that arteries so degenerated, or even calcified, that they broke when the ligature was drawn tightly, have remained securely closed by slighter pressure, and the wounds have healed without accident. Moreover, recent experience with the catgut ligature in the "old" operation and in extirpation of the sac has shown that the chance of secondary hemorrhage is slight. The objection raised against the old method, that the condition of the adjoining arterial wall is altered, cannot properly be urged in the case of a traumatic aneurism; and the only other possible objections are, that the operation is more difficult and the wound larger.

Syme's method of operating when the artery could not be controlled on the proximal side of the sac was to make an incision into the tumor just large enough to admit his finger, with which he then felt for and compressed the opening in the vessel. If he could not thus find the opening, he enlarged the incision and then introduced a second and a third finger, and, in one case—so says Mr. Holmes—the entire hand. When the opening was found and commanded, he still further enlarged the incision, turned out the clots, and denuded and tied the artery above and below.

Extirpation of the sac is now done as for the removal of a tumor. The mass is exposed by a long incision, the artery is tied above and then below, and the sac is dissected out with great care to avoid injury to the vein.

2. Permanent or temporary arrest of the afferent stream at a point on the proximal side somewhat removed from the sac.

(a) Ligature by Anel's method, or the Hunterian method. The question of priority in the introduction of the method of tying the artery above the sac, as now practised, has given rise to much controversy, but must here be dealt with very briefly. It is claimed by the French for Anel, a French surgeon practising in Rome in 1710, and by the English for John Hunter in 1785. The reader who is curious in the matter is referred to Broca ("Des anévrysmes," Paris, 1856) and to Holmes ("A System of Surgery") and to a paper by the writer in the *New York Medical Journal*, November 1, 1884. The facts, in brief, are as follows: January 30, 1710, Anel treated a traumatic aneurism at the bend of the elbow by tying the artery close above the sac without opening the latter, and thereby effected a cure. The patient was a priest. The case gave rise to much discussion, the account of it was reprinted in several books and journals, and the method was subsequently used, before 1785, in at least three other cases, in one of which the ligature was applied about two inches above the sac (Broca, p. 446). June 22, 1785, Desault (after having a few months previously sought to cure an axillary aneurism by compression of the subclavian) treated a popliteal aneurism by tying the artery, "immediately below the ring of the third adductor," that is, at the point where the femoral artery ends and the popliteal artery begins; the aneurism was cured, and the patient died eleven months later of disease of the lower end of the tibia. December 12, 1785, John Hunter treated a popliteal aneurism by tying the femoral artery and vein "rather below the middle of the thigh."* In the following March, 1786, Desault, having knowledge of Hunter's case, operated upon another and tied the artery at a still higher point, dividing the sartorius to expose it.

Hunter repeated the operation four times within the four years following his first case, tying the vein as well

* Everard Home, in *Transactions of a Society for the Improvement of Medical and Surgical Knowledge*, London, 1793, p. 148. This appears to be the first official publication of the case; the paper is not dated, but it is printed between two which are dated September, 1788, and September, 1790, respectively.

as the artery, except in the last two; Desault died shortly after his own second case.

These facts are not disputed; the controversy has arisen over the principles which are thought to have led, in the minds of the different operators (Anel, Desault, and Hunter), to the adoption of the method.

It is claimed by the English (Guthrie, Holmes) that Anel did not know what he was doing, did not appreciate the importance of the method, the mode by which it effected a cure, and its applicability to other aneurisms than those at the elbow, and that, as he used it, it was radically defective in placing the ligature too close to the sac, and without the intervention between the two of any collateral branch given off from the artery; that, in short, it was a mere happy chance, stumbled upon without reflection, and passed without appreciation; that Desault's, in like manner, was a mere experiment, but that Hunter's was the result of profound reflection and reasoning upon the nature of the disease and the manner in which coagulation of the blood in the sac is effected, and especially of his knowledge of the fact that complete shutting off of the current from the sac was not necessary. The original reports, on examination, do not appear to justify any of these claims, which seem to have no more solid basis than ignorance of what Anel and Desault really thought, and the crediting of Hunter, before his operation, with knowledge which he obtained at a later period. Hunter's identification with the operation was in large part the result of his exceptional authority at the time, the publicity which attended or was given to the act, the frequent repetitions, and the generalization which promptly followed it, and also of the great ability with which he set forth the principles upon which it rested. These in themselves are an ample title to recognition and respect, and Hunter's glory may well be left to rest on them without robbing others of their just due.

Three months after Desault's first operation, and three months before Hunter's first operation, at a consultation held in London on a case of femoral aneurism as large as an orange, in which Hunter took part, all agreed that it was impossible to resort to the operation ordinarily practised upon aneurisms, and recommended pressure on the artery in the groin; the attempt was made, and abandoned because of the pain it caused. It is apparent that at this time Hunter had not developed his method. The arguments that led Hunter to tie the femoral artery for popliteal aneurism, according to Home, his pupil, assistant, and reporter (*loc. cit.*, p. 145), were "that the disease often extends along the artery for some way from the sac; and that the cause of failure in the common operation arises from tying a diseased artery, which is incapable of union in the time necessary for the separating of the ligature." . . . "If the artery should afterward give way [if tied just above the sac], there will not be a sufficient length of vessel remaining to allow of its being again secured in the ham. To follow the artery up through the insertion of the triceps muscle, to get at a portion of it where it is sound, becomes a very disagreeable part of the operation; and to make an incision upon the fore part of the thigh, to get at and secure the femoral artery, would be breaking new ground, a thing to be avoided, if possible, in all operations. Mr. Hunter, from having made these observations, was led to propose that in this operation the artery should be taken up in the anterior part of the thigh, at some distance from the diseased part, so as to diminish the risk of hemorrhage and admit of the artery being more readily secured, should any such accident happen. The force of the circulation being thus taken off from the aneurismal sac, the progress of the disease would be stopped; and he thought it probable that, if the parts were left to themselves, the sac with its contents might be absorbed and the whole of the tumor removed; which would render any opening into the sac unnecessary."

It is plain, from this, that Hunter's idea in seeking the artery at a higher point was simply to avoid secondary hemorrhage and to make its treatment, if it should occur,

easier; and the extent to which this idea preoccupied his mind is shown in the strange additional precautions he took in the matter of the ligature itself. He tied the artery with four ligatures, "but so slightly as only to compress the sides together. . . . The reason for having four ligatures was to compress such a length of artery as might make up for the want of tightness, it being wished to avoid great pressure on the vessel at any one part."

According to Mr. Holmes, "the great merit of Hunter consists in his having seen, first, that it was not necessary to turn the clots out of the aneurismal tumor; . . . and, second, that it was not necessary to stop the circulation through it absolutely, but only, as he said, 'to take off the force of the circulation.'" The first of these was certainly appreciated by Anel and Desault, for they saw their patients get well; the second is difficult to explain, if it is based upon the fact that the ligatures were tied loosely, for they certainly were intended to, and did, cut out, and therefore occluded the artery entirely; and in Hunter's subsequent operations he used a single ligature and tied it tightly, so that if this was his opinion and object at first, he subsequently abandoned it. The idea, moreover, is expressed by Home (*loc. cit.*, p. 156) as a conclusion drawn from what was found at the autopsy eleven months later: "The conclusion to be drawn from the above account appears a very important one, viz.: That simply taking off the force of the circulation from the aneurismal artery is sufficient to effect a cure of the disease, or at least to put a stop to its progress." It seems much more reasonable to infer that Hunter's object in tying the ligatures loosely was to give the artery more time to become sealed before the ligature cut through. (See the first quotation from Home given above.)

The statement has been generally quoted as meaning that Hunter proposed to leave one or more collateral branches between the ligature and the sac, but there is nothing in the account of the operation or of the autopsy to justify such an opinion. "The femoral artery was impervious from its giving off the arteria profunda as low as the part included in the ligature, and at that part there was an ossification for about an inch and a half along the course of the artery. . . . Below this part the femoral artery was pervious down to the aneurismal sac, and contained blood, but did not communicate with the sac itself, having become imperious just at the entrance [italics mine]. . . . The popliteal artery, a little way below the aneurismal sac, was joined by a small branch, very much contracted, which must have arisen from the profunda, or the trunk of the femoral artery." This is the only collateral branch mentioned, and I do not see how the conclusion can be avoided that even if the phrase "to take off the force of the circulation" meant any more than "to arrest" or "cut off" the circulation, it meant only that the artery was left containing blood, and that this blood was in communication with that brought to the lower part of the same artery by collaterals coming from above the ligature. It would be interesting, too, to know by what "profound reasoning Hunter excogitated the principle" (Holmes) of including the vein in the ligature with the artery.

Even if Hunter afterward declared the presence of a collateral branch between the ligature and the sac to be a favorable condition, it does not affect the original conception; and furthermore, the existence of such a collateral branch is not essential to the method, and it is not found when the carotid or femoral is tied, or in some cases when the external iliac or subclavian is. In short, the method as now employed is to place the ligature at the nearest convenient point, sufficiently far above the sac to find the artery probably healthy; and the claim that has been made that complete arrest of the circulation is more dangerous than partial arrest, because it leads to the formation of a passive clot which is likely to provoke suppuration of the sac, has been proved, especially by the experience with the Esmarch bandage, to be incorrect, or at least the danger of exciting suppuration is much less than was claimed.

The changes within the sac by which a cure is effected after ligature are similar to those above described as effecting a spontaneous cure. The closure of the artery relieves the sac from all expanding pressure, except the slight amount which may be exerted by the blood that comes into the artery below the sac or between it and the ligature through collateral branches. The pressure being removed, the sac shrinks, the blood within it either coagulates in mass, forming a dark passive clot, or a slight movement persists in it and laminated fibrin is deposited on the wall. Pulsation in the sac ceases as soon as the ligature is tied, and usually remains permanently absent, but in some cases it returns after a longer or shorter interval and lasts for a few hours or days. This return is due to the freedom and rapidity with which the collateral circulation is established. The blood leaves the artery through the branches given off above the ligature, which dilate to accommodate the increased supply, makes its way through the minute terminal branches and capillaries into the terminals of the branches given off from the main artery below the ligature, passes through them in the retrograde direction, and thus regains the main artery to be distributed as before through its terminal branches. The greater the length of artery that has been obliterated by the ligature and disease, the greater the difficulty of the re-establishment of the circulation, and thus it is found that when two or three aneurisms are situated upon a single artery, or when, on account of secondary hemorrhage, a second ligature has been placed upon the artery at a higher point, the probability is great that the circulation will be re-established too slowly or imperfectly to preserve the life of the tissues, and the occurrence of gangrene is to be feared.

The method of operation is to expose the artery by a suitable incision, denude it just sufficiently to allow an aneurism needle to be passed under it, and to tie it with antiseptic catgut or silk. Both ends of the ligature are cut short, and the wound closed.

The chief dangers of the operation are secondary hemorrhage and gangrene. Before the introduction of the antiseptic method these dangers were so great that the mortality, after ligature of the femoral, for example, was about twenty-five per cent. They are now very much less. In twenty-nine cases of ligature of the principal arteries with catgut, by New York surgeons, which I collected in 1880 (*Am. Jour. of the Med. Sciences*, January, 1881), there was no secondary hemorrhage, and only one case of gangrene; the latter was of the foot, after ligature of the common iliac artery, and was followed by recovery. The diminution of the risk of secondary hemorrhage is plainly due to the avoidance of suppuration about the ligature, and the freedom from gangrene appears to me to be the result of the same rapidity and ease of healing, through diminution of the interference with the vein by the inflammatory process.

The attempt has been several times made to diminish the chance of the occurrence of gangrene by repeatedly compressing the artery above the aneurism for several days before tying it, in the hope of thereby gradually enlarging the collaterals, and better fitting them for carrying on the circulation when it is finally thrown entirely upon them. The result has not borne out the expectation; on the contrary, gangrene has followed the attempt in a larger proportion of cases than when the artery has been tied without preliminary compression. A satisfactory explanation has not been found.

Other ill results of the ligature of the main artery of a limb may be permanent deterioration of its nutrition, loss of nerve and muscular power, persistent or recurrent ulceration of the skin, and suppuration of the sac.

In order to diminish the chances of the occurrence of gangrene, the limb should be wrapped in cotton immediately after the operation, and kept thus protected from losing heat until the circulation is shown to be fully re-established. If its temperature is found to remain too low, external heat should be cautiously applied in the form of hot bottles, bricks, or sand, but care must be