Douglas' pouch, he considers it quite as well to open the peritoneum if it presents and then tampon this for six to eight days with iodoform gauze. This was done in 13 cases, several with prolapse of intestine. Very important is the complete removal of glands in the sacral space. In women a portion of the posterior vaginal wall often had to be included.

The later function of the anus was fairly satisfactory, although unable to control flatus and liquid motions. Two patients, operated in 1883, lived each about five years. He treats at some length the recently much discussed method of colotomy. In many cases simple fixation to the wound and opening will answer. But in general it is well to completely sever the gut and either sink the closed lower end or better unite each carefully to the wound-opening.

Finally he tabulates very fully his 20 cases of excision of the rectum, 7 of colostomy and 1 of ileostomy.

W. BROWNING.

SENN ON THE HEALING OF ASEPTIC BONE CAVITIES BY IMPLANTATION OF ANTISEPTIC DECALCIFIED BONE.[1]

In an interesting paper Dr. Senn remarks that the antiseptic treatment of wounds as now almost universally practiced constitutes the greatest triumph of modern surgery. Since this treatment has become developed to its present state of perfection primary union is no longer the exception, but the rule. The failure to obtain healing by first intention of an intentional wound made by the knife of the surgeon through aseptic tissues, or of a recent accidental wound, in which parts of the same anatomical structure can be approximated and coaptation uninterruptedly maintained, must be looked upon as an evidence of a faulty technique or want of proper care on the part of the surgeon or his assistants in carrying out the principles of antiseptic surgery. Primary union in the sense in which this expression should be now used means the restoration of injured or lost parts without suppuration. It

[1] N. SENN, M.D., PH.D. (Milwaukee, Wis.), in the American Journal of Medical Sciences.

is a purely reparative process in which all the newly-formed tissues are utilized in permanently cementing together divided parts or in restoring tissues lost by injury or disease. If a definitive union or repair is accomplished without suppuration, it must be called primary union whether this result has been obtained with or without visible granulation tissue.

An ideal primary union is one where the surface and deep parts can be brought together and held in perfect approximation until in a few days, by interposition of new living tissue between the divided structures, the interrupted anatomical continuities have become permanently restored and the suspended physiological functions established. Practically such a result is not often obtainable. Even the most improved methods of approximation and coaptation frequently fail in securing such accurate apposition of similar tissues as to enable organic union to take place in such a short space of time and accomplished by such a small amount of reparative material. Under most circumstances spaces are left here and there between the surfaces of the wound which are first occupied by blood or serum and later by granulation tissue, which in the course of time is transformed into cicatricial tissue and by contraction unites or brings in closer contact the divided tissues.

The time required for the definitive healing of a wound, other things being equal, will therefore depend largely upon the accuracy with which coaptation can be effected and maintained. In wounds with considerable loss of tissue, and in the healing of cavities with rigid, unyielding walls where coaptation of surfaces which it is the intention to unite, for physical reasons is rendered impossible, we have to rely upon the process of granulation in effecting repair and in restoring interrupted continuities. Under the old treatment the healing of wounds by secondary intention was often prolonged for an indefinite period of time because under the influence of pus microbes or their ptomaines the embryonal cells of which the granulation tissue is composed were transformed into pus corpuscles, and thus the reparative process was delayed until the infective process had exhausted itself, as it were, or until the granulation tissue was in a condition to resist successfully the deleterious effect of pus microbes or their products.

The most signal success of the antiseptic treatment has been obtained in the repair of parts where healing has to be accomplished by the formation of an extensive mass of granulation tissue. If an aseptic condition is maintained throughout, all of the granulations are transformed into tissue of a higher type and extensive defects are healed in a few weeks under a single dressing. Primary healing of an empty large cavity with unyielding walls, even without suppuration, requires often weeks and months, and not infrequently is but incompletely accomplished, as the granulations find no temporary support, and from the absence of such support the process comes to a standstill, while epidermization takes place on its surface *pari passu* with the disappearance of the temporary bloodvessels in the deeper parts which are undergoing cicatrization. When the healing process is finally completed it is at the expense of a considerable loss of substance. Such difficulties are almost invariably met with in the treatment of bone cavities.

Before giving a description of a new method of treatment which he found exceedingly useful in overcoming the obstacle to favorable and rapid healing by granulation in such cases, he called attention to a number of attempts made in the same direction during the past.

A few years ago Dr. Neuber, then assistant to Professor von Esmarch, of Kiel, introduced a method which was intended to secure a speedy definite healing of the wound without aiming at reproduction of the tissues destroyed by the disease or removed by the operation. It consisted in fully exposing a tuberculous depot in bone or an osteomyelitic deposit, after thorough removal of the products of inflammation with spoon, gouge, or chisel, and chiseling away the margins of the cavity sufficiently to permit the soft parts to be turned inward, thus covering the entire surface of the denuded bone. The cavity was thoroughly disinfected before the flaps were implanted. The flaps were fastened with bone nails. In case the cavity was limited, and, as is so often the case near a joint, the skin flap was made in such a manner that the base was directed toward the joint. In diffuse osteomyelitis of the long bone a gutter was chiseled out and the flaps on each side turned inward in such a manner that their margins came in contact in

the bottom of the gutter. Two great objections can be raised against this method:

1. It requires the removal of an unnecessary amount of healthy bone in order to enable implantation of the skin flaps.

2. As the result of tension from fixation of flaps, pressure on the part of the dressings, and more particularly on account of a serious diminution of the vascular supply of tissues predisposed by antecedent disease, gangrene of the flaps has frequently occurred.

The author gave this method a fair trial in a number of cases, but he never obtained an ideal result—that is, primary union between flaps and between flaps and the subjacent bone. In a number of cases gangrene of some portion of the margins of the flaps occurred, leaving defects which required a long time to become repaired by a slow process of granulation, cicatrization and epidermization. This method has a legitimate sphere of usefulness and application in cases of superficial osteomyelitis followed by necrosis, but should never be employed if the disease is centrally located, requiring in its operative treatment the formation of a deep gutter. The next idea that presented itself was to utilize a blood-clot for the purpose of expediting the definitive healing of the bone cavities. Years ago Lister observed that under the antiseptic dressings in aseptic wounds coagula between the surfaces of the wound did not undergo putrefactive or degenerative changes, but, as he believed and asserted, became supplied with blood-vessels and were organized. A few weeks after the operation or accident which inflicted the wound he saw that the blood-clot had undergone vascularization and presented other evidences of organization.

In 1876 Lesser visited Lister's wards and made a special study of the organization of blood-clots in aseptic wounds, and reported the results of his observations in the *Deutsche Zeitschrift f. Chirurgie*, vol. iii. Neuber, as early as 1879, after operations for necrosis, allowed the cavity to fill with blood with the expectation that the same favorable conditions could be secured for the blood-clot by thorough antisepsis as in recent wounds, but the results in these cases were so unsatisfactory that he soon abandoned the idea.

In the admirable paper of Professor von Volkmann, read at the Lon-

don meeting of the International Medical Congress, special attention was called to the part taken in the healing process by the blood clot between the fragments in compound fractures. At the end of six weeks he found at the site previously occupied by the coagulum living vascular tissue. Watson Cheyne gives a full description of the organization of blood-clots in recent wounds in his work on *Antiseptic Surgery*.

T. B. Hamilton (*Journal of Anatomy and Physiology*, vol. xiii., 1879; *Edinburgh Medical Journal*, November, 1881, p. 385) substituted for the blood-clot aseptic sponge, as he found that this substance was promptly removed by absorption in aseptic granulating wounds. Sponge-grafting was for a time quite extensively resorted to in hastening the process of repair of hollow wounds in soft parts, but was seldom practised after operations on bone.

In a paper read at the meeting of the German Congress of Surgeons in 1886 ("Ueber Heilung von Wunden unter dem feuchten Blutschorf") Schede described what he deemed a new method of treating wounds where accurate coaptation of the parts could not be secured. Schede's method consists in a careful conservation of the blood-coagulum combined with the completion of the healing process under a moist blood-crust. For instance, in operating on a long bone for necrosis, osteomyelitis, or any other lesion centrally located requiring in the removal of the pathological product the formation of a cavity, he renders the parts bloodless by applying an Esmarch's constrictor on the proximal side, and, after having removed the dead bone or diseased tissue, he disinfects the cavity thoroughly and then sutures the soft parts in such a manner that a space is left open at a point corresponding to the summit of the cavity. This insures complete filling of the cavity with blood after the removal of Esmarch's bandage. No drainage-tube is introduced. The wound is covered with a strip of protective silk, over which is applied a copious absorbent antiseptic compress. The bandage for retaining this dressing is not firmly applied, in order that a sufficient amount of bleeding may take place to fill the cavity. The protective silk prevents the drying up of the exposed portion of the clot and secures at the surface of the wound the formation of the moist blood-crust, upon the presence of which so much stress is laid by that

author for the subsequent favorable and rapid healing in the depth of the wound.

Schede's experience with this method of treatment has been exceedingly favorable. Small cavities in bone he has healed completely in from 11 to 14 days, while large cavities require from 3 to 6 weeks. In some instances this treatment proved a failure even in his hands, and in these cases the unfavorable result could sometimes be traced to an inadequate hæmorrhage, the cavity filling only partly with blood. When imperfect filling of the cavity with blood was found the cause of failure of the entire cavity closing under one dressing, the healing was found to have proceeded only as far as the coagulum reached, and the balance of the cavity closed later by the usual tedious process of granulation from the wound surfaces and the upper surface of the granulation mass. In operations for tuberculous affections of bone he found not infrequently a recurrence of the disease in the cicatrix of the wound which had healed by primary union. In severe cases of general tuberculosis the so-called organization of the coagulum did not take place. The author insists that only clean and aseptic wounds are adapted to this form of treatment. In cases where it is impossible to secure asepticity of the bone cavity, or where the primary treatment failed, he waits until suppuration has ceased, and then, by scratching the granulation surfaces, obtains enough blood to fill the cavity and then applies the same dressing as in recent cases. A number of cases are reported to show that this plan has proved successful.

In the discussion which followed the reading of this paper, von Bergmann reiterated his views that he had so strongly expressed on a previous occasion, that in the treatment of all wounds it should be the surgeon's imperative duty to effect complete hæmostasis, as the accumulation of blood in wounds renders antiseptic treatment more difficult and less efficient. Volkmann stated that he did not believe in the transmutation of blood as a tissue, as extravasated blood is removed by absorption and gradual substitution on the part of the granulations. He favors moderate compression of the wound, so as to prevent unnecessary loss of blood, as the escape of blood beyond what is necessary to fill the minute spaces between the wound surfaces is unnecessary and injurious.

At a meeting of the German Congress of Surgeons last year, Launstein ("Zur Heilung der Wunden unter dem feuchten Blutschorf") read a paper on Schede's treatment of wounds, wherein he compared the healing under a moist blood-crust to the healing under a dry crust as described by John Hunter. He regards the superficial portion of the coagulum in the light of an occlusive dressing. During two years he resorted to this treatment in seventy-four cases, with the result that in sixty-four it proved successful, and proved a failure only in ten. A cavity in the head of the tibia the size of a walnut, caused by the removal of tuberculous deposit, he found completely healed under one dressing after three weeks. In four operations for extensive necrosis the treatment failed. In one case coagulation of the blood in the cavity failed to take place, a circumstance which he attributed to imperfect antisepsis, and yet the final result was favorable.

Schleich has studied this subject experimentally, and, as a result of his observations, he claims that the aseptic coagulum must be considered as a porous organic substance which, by compression, occlusion, and by diminishing wound secretion, places the cavity in which it is located in a more favorable condition for healing.

Landerer asserts that extravasated blood takes no active part in the healing of a wound, and he attributes Schede's success more to faultless antiseptic measures than the presence of the coagulated blood. In the light of modern research, it must be conceded that, when blood escapes from vessels into the tissues or accumulates between the surfaces of a wound, it has lost its physiological functions and has become a foreign substance. If the blood and its surroundings remain in an aseptic condition, it is removed sooner or later by absorption on the part of the granulations which take place by substitution. The blood-coagulum in Schede's treatment of wounds serves as a temporary nidus for the granulations which permeate it from all directions, thus placing the cavity in a condition capable of becoming filled with a mass of active granulation tissue and a reticulum of blood-vessels, which furnish ample nutrition for the growth and development of new tissue while the blood is removed by the encroaching granulations. A hollow, empty space, particularly in a bone, where its walls are firm and immovable,

presents the most unfavorable conditions for healing by the process of granulation. As the granulations and vessels have no support toward the centre of the cavity, the defect is repaired in a slow and unsatisfactory manner. The deeper portions of the granulation tissue undergo transformation into tissue of a higher type, and, while this change is undergoing perfection, the vascular supply towards the surface is diminished by disappearance of many of the new temporray vessels, and the conditions for the growth and development of the granulations are correspondingly impaired. A coagulum, as long as it remains aseptic and sufficiently firm, furnishes an admirable support for the granulations and delicate new bloodvessels, and constitutes the direct means by which the entire cavity is filled with active and exceedingly vascular granulation tissue in a remarkably short time. Schede's treatment marks a decided advancement in the treatment of bone cavities, but is open to the following objections·

1. It implies an unnecessary loss of blood, which, in some cases at least, must be detrimental to the patient. The loss of from two to eight ounces of blood required to fill a bone cavity in an anæmic child or a marantic adult might result in a collapse which a careful hæmostasis would have prevented.

2. The blood coagulum is at best but an aseptic substance. Careful hæmostasis is one of the essential requirements of good surgery. Perfect asepsis is not always attainable. Recent experiments have demonstrated the fact that pathogenic microbes are more likely to become the cause of disease when they come in contact with substances that serve the purpose of a culture soil. Coagulated and fluid bood, at the temperature of the body furnish an admirable culture substance for a number of the most dangerous varieties of pathogenic microbes. In case perfect asepsis is not obtained, the coagulum of necessity must become a source of danger.

3. The bleeding may not be sufficient in quantity to fill the entire cavity. In such cases the prompt and early production of embryonal tissue will be limited to the size of the coagulum, and the balance of the cavity has to close by the ordinary slow process of granulation and cicatrization.

4. The extravasated blood may fail to undergo coagulation, and fluid blood would not form a good medium for the rapid diffusion of the granulations throughout the entire cavity.

It occurred to Dr. Senn that if in the healing of bone cavities an absorbable, firm, antiseptic substance could be substituted for the coagulum, it would present a number of advantages not obtainable by Schede's method. The substance whtch he selected for his experimental and practical work was thoroughly decalcified bone, rendered not only thoroughly aseptic, but thoroughly antiseptic by keeping it immersed for a considerable length of time in sublimate alcohol (1: 5000). Before the removal of Esmarch's bandage, and after thorough disinfection of the cavity, its walls and the bone chips are lightly dusted with iodoform before implantation is made. The wound is completely closed, with the exception of the lower angle, where a capillary drain of a few threads of catgut is introduced.

All of the experiments were made under strict antiseptic precautions. The part to be operated on was shaved, thoroughly washed with warm water and potash soap, and disinfected with a 1: 2000 solution of sublimate. The same solution was used for irrigation during the operation. The bone was exposed by a straight incision, and after reflecting the soft parts the bone defect was made either with a trephine or chisel, the former instrument being used mostly in the operations on the skull, and the latter in excavating the long bones. The operations on the extremities were rendered bloodless by using elastic constriction. In all instances the cavity was filled by a piece of well-decalcified antiseptic bone, which was so cut as to fit the cavity as accurately as possible. In some cases the bone plate, after implanting it in a trephine opening, was fastened in its place by driving two or more small aseptic nails into the margins of the opening. Before implantation the cavity and the bone plate were dusted with iodoform. The external wound was completely closed, without making any provision for drainage. In some instances the plates were perforated with numerous small openings, so as to enable the granulations to penetrate it more readily and thus expedite the process of absorption and substitution.

He gives the details of ten experiments upon dogs, which demonstrate the value of implantation of a disk or plate of decalcified bone after operations on the skull where re-implantation of the bone removed cannot by practised. It is applicable in cases where loss of bone has been sustained by injury or after operations for osteomyelitis, tumors. or syphilitic or tuberculous disease of the cranial bones. Implantation of decalcified bone prevents direct union between the pericranium and the brain or its envelopes. The implanted bone is removed by the granulation tissue which forms all around it, and thus a large mass of embryonal tissue is interposed between the soft tissues covering the skull and the underlying coverings of the brain, a condition favorable to the formation of new bone at the site of the operation. In all instances where this procedure was resorted to, the defect in the skull had been more perfectly repaired than on the opposite side, where the soft parts were brought in direct contact with the cranial contents. In cases where the trephine disks or the chips of a chisel operation are aseptic and healthy, Macewen's method of re-implantation should be done; but where this plan cannot be followed, implantation of decalcified bone constitutes the best substitute.

Aside from favoring the process of osteogenesis, the bone disk answers a most useful purpose in affording protection to the brain, and in arresting hæmorrhage from the vessels of the diploë. It is unsafe to rely on the hæmostatic effect of the implanted bone when the hæmorrhage takes place from the surface of the dura mater, as in such a case there is danger arising from compression of the brain from a blood-clot forming between the disk and the dura mater, but when troublesome hæmorrhage is encountered from the vessels of the bone, it is promptly arrested by pressure made by the implanted disk. If the implantation is intended to act as a hæmostatic, then the plate of bone should fit the opening closely, so as to exercise direct compression against the orifice of the bleeding vessel. Bone, when thoroughly decalcified, is an elastic substance ,and can be readily compressed at the time of implantation. He was strongly impressed with the advantage to be derived from multiple perforations in the disk, as the perforations, in the first place, afford free drainage to the space between

the dura mater and the disk; secondly, they increase the elasticity and compressibility of the disk; and, thirdly, they expedite the removal of the disk by absorption and substitution by the granulation tissue. For the purpose of retaining the disk in place after implantation, one of two expedients may be resorted to:

1. The opening in the bone is shaped, at least at some points, in such a manner that the margins are bevelled at the expense of the internal table.

2. Two or more fine bone nails, rendered thoroughly aseptic, can be driven into the margins of the opening.

The bone plates should correspond in thickness to the opening. If implantation of decalcified bone after operations on the skull does not entirely prevent the inconveniences incident to defective repair of the cranial defect, it can be relied upon as a measure which is well calculated to favor the reparative process, and to secure for the cranial defect which remains after the process of ossification has ceased, a firm, thick and unyielding protective cicatrix, far superior to the cicatrix which forms where no re implantation of bone or implantation of decalcified bone is resorted to.

The author details ten cases in which he has practiced the method which he advocates, mainly with entire success, following which he gives general directions for treatment of bone defects by implantation of antiseptic decalcified bone, viz.

1. *Decalcification and disinfection of bone.*—A fresh tibia of an ox is the best material for decalcification. The bone is cut in sections two inches in length, and, after carefully removing the medullary tissue, is kept in dilute muriatic acid, the fluid being changed every few days until the process of decalcification has been completed. After this has been accomplished the bone can be readily cut into pieces about one millimetre in thickness, making the sections paralled to the long axis of the bone. The acid is then removed by washing and by keeping the bone immersed in a weak solution of caustic potash. The bone is then rendered antiseptic by keeping it until it is needed in a solution of sublimate in alcohol 1: 500 in a wide-mouthed bottle, which is kept hermetically sealed by a glass stopper to prevent evaporation

of the solution. When the bone is needed, it is taken from the bottle and placed in a five per cent solution of carbolic acid, or a weak solution of sublimate. In making the plates or disks for filling a cranial defect the bone is cut so as to correspond in thickness to the bone removed, and accurately to fit into the opening. A number of small perforations in the disk or plate should always be made, as through these openings the space underneath the bone is kept drained; at the same time the early entrance of granulation tissue into these openings effects fixation of the bone *in situ* and favors the early removal of the implanted substance by substitution with permanent living tissue. Before implantation both sides of the plate should be dusted with iodoform. For packing bone cavities the decalcified bone shouid be cut in thin slices or chips, which should be laid upon a compress of aseptic gauze, so as to remove the surface moisture, when they are dusted with iodoform before they are implanted into the cavity. Aseptic decalcified bone drains, in the absence of more suitable material, can be used in packing bone cavities.

2. *Asepsis at the seat of implantation.*—The most essential condition for success in the treatment of bone defects by implantation of decalcified bone is a perfectly aseptic condition of the tissues to be brought in contact with the implanted bone. This condition is easily procured in operations on bones for lesions other than those caused by infection with pus microbes, such as tumors, parasites, and tuberculous and syphilitic affections uncomplicated by suppuration. In the surgical treatment of these affections after the removal of the diseased tissue the seat of operation must be aseptic if the ordinary precautions in the prevention of infection from without have been observed, In such cases speedy healing of the external wound and the early partial to complete reproduction of the lost bone are assured.

The next most favorable cases for this procedure are circumscribed osteomyelitic processes in the epiphyseal extremities of the long bones as we observe them in cases of primary circumscribed epiphyseal osteomyelitis, or in the form of a recurring attack in the same place, perhaps years after a diffuse osteomyelitis of the entire shaft. Under such circumstances the inflammatory focus can be located externally

by the presence of a circumscribed area of tenderness, and the tender spot constitutes the guide in the search for the abscess. The seat of inflammation is freely exposed with a chisel and the walls of the abscess cavity are scraped out with a sharp spoon until healthy tissue is reached all around. The precaution should be taken to wash out the cavity with an antiseptic solution before attacking the abscess wall so as to prevent the contamination of the healthy tissues with the products of the infection by the mechanical diffusion of the pus microbes.

For the final disinfection of such a cavity a strong solution of sublimate is used, and after thoroughly drying its walls it is dusted with iodoform. Iodoformization of the cavity and the implantation of antiseptic bone chips are measures which are well calculated to resist the pathogenic action of pus microbes which might still remain, and in the majority of cases will secure an aseptic healing of the wound.

This method of treating bone cavities is also applicable after operations for necrosis resulting from a previous attack of acute suppurative osteomyelitis. With a view to obtain an aseptic condition of the cavity it is necessary that the line of demarcation between dead and living tissue should have formed, the involucrum must be well developed and the soft parts in a healthy condition. The operation which precedes the implantation must accomplish more than the simple extraction of the necrosed bone, it implies the removal of all infected tissue lining the interior of the involucrum and the fistulous tracts in the soft tissues. The involucrum must be laid open with the chisel sufficiently to expose to sight and direct treatment its entire interior for the purpose of removing with the sharp spoon all of the infected granulations, at the same time the fistulous tracts in the soft tissues must be made accessible to the same treatment. After the thorough mechanical removal of all infected tissues the wound surfaces must be irrigated freely with a hot solution of sublimate, and for final disinfection a twelve per cent solution of chloride of zinc may be applied with a brush, after which the cavity is flushed again, dried and iodoformized. In operations for acute diffuse osteomyelitis all known surgical resources are inadequate in rendering the field of operation aseptic, and hence contraindicate the subsequent treatment by implantation with decalcified bone.

3. *Necessity of performing the operation by bloodless method.* It has already been remarked that in the implantation of a disk or plate of bone into a defect in the skull the hæmorrhage from the brain and its coverings should be carefully arrested before the implantation is made, as otherwise compression of the brain might arise from accumulation of blood underneath the implanted bone. The disk or plate may be relied upon in arresting hæmorrhage from the vessels in the bone which by other measures it is sometimes found difficult to control. In the treatment of bone cavities in regions where it is possible to render the operation bloodless by elastic constriction, this should always be resorted to, as it prevents unnecessary loss of blood during the operation and enables the surgeon to resort to means and measures for procuring an aseptic condition, which otherwise it would be impossible to apply with the same degree of thoroughness and efficiency. Unless special indications present themselves the elastic constriction is continued until after the dressing has been applied.

4. *Implantation.* In the treatment of a bone cavity by implantation with decalcified bone, the chips are poured into the cavity and are packed quite firmly until the surface of the cavity is reached. The bone chips act as an antiseptic tampon which arrests the free oozing from the surface of the bone which always takes place after the removal of the constrictor. Some blood escapes between the bone chips and coagulates at once, thus forming a desirable and useful cement substance, which permeates the entire packing and temporarily glues, as it were, the chips together and the entire mass to the surrounding tissues.

5. *Treatment of external wound.* The periosteum should be carefully preserved in exposing the bone and, after the implantation, is sutured over the surface of the bone chips with catgut sutures. If the bone is deeply located, it may become necessary to apply another row of buried sutures in bringing into accurate apposition other soft parts. The skin is finally sutured with silk. It is of great importance to secure accurate apposition of the divided soft parts in order to preserve for its subjacent bone all of its natural coverings.

6. *Drainage.* In some instances it would be undoubtedly superflu-

ous to secure any form of drainage, as when the cavity is perfectly aseptic and hæmorrhage is not in excess of requirements, healing of the entire wound would be accomplished under one dressing. Experience, however, has taught me that tension arising from extravasation of blood often exerts an injurious influence upon the process of healing and should be carefully avoided. As it is desirable to heal as much of the wound as possible without interfering with drainage, an absorbable capillary drain has been invariably introduced in the lower angle of the wound. A string of catgut twisted into a small cord answers an admirable purpose.

7. *Dressing of wound.* The wound is covered with a strip of aseptic silk over which a few layers of iodoform gauze are applied. Over this a cushion of sublimated moss is placed with a thick layer of salicylated cotton along its margins for the purpose of guarding more securely against the entrance ot unfiltered air; the whole of it is retained by a circular bandage of gauze evenly and smoothly applied. For the purpose of securing absolute rest for the limb it is placed upon a posterior splint and kept in a slightly elevated position. If no indications arise, the first dressing is not removed for two weeks, when the entire wound will usually be found healed, except a few granulations at the place where the catgut drain was inserted. A smaller antiseptic compress is applied and the limb dressed in a similar manner. It is advisable to enforce rest not only till the external wound has healed, but until the whole process of repair has been completed, which embraces a period varying from four weeks to three months, according to the size of the cavity and the age of the patient.

8. *Secondary implantation.* If an operation is followed by suppuration, the result of imperfect antisepsis, tubular drainage must be established and the same treatment pursued as in suppurating wounds. If suppuration takes place soon after the operation and is profuse, it is probable that all of the bone chips will be lost. If it develops after granulation tissue has had time to form and the purulent discharge is moderate in quantity, the prospects are that the bone will remain and serve its purpose as a nidus for the granulation tissue. In such cases an antiseptic irrigation should be made every three or four days unti

suppuration has ceased. If the bone chips are lost by suppuration or have to be removed for the purpose of a more thorough disinfection of the cavity, no attempt should be made at re-implantation until suppuration has been arrested, or, in other words, until the cavity has become lined with granulations, and is in a comparatively aseptic condition, when the time for secondary implantation has arrived. After the cavity has been irrigated with a strong antiseptic solution it is dusted with iodoform and the granulations are scarified in a number of places for the purpose of obtaining a sufficient amount of blood to fill the spaces between the bone chips, which are implanted in the same manner as in the treatment of a recent cavity. Complete closure of the external wound under these circumstances is seldom obtainable and the surface of the exposed portion of the cavity should be provided with a thin layer of Schede's moist blood-clot. The antiseptic properties of the material used in packing the cavity exerts a potent influence in maintaining asepticity after secondary implantation.

The author closes his paper with the following conclusions:

1. Antiseptic decalcified bone is the best substitute for living bone grafts in the restoration of a loss of substance in bone.

2. In the treatment of bone cavities, antiseptic decalcified bone is preferable to Schede's blood-clot, as it is not only a perfectly aseptic, but at the same time also a strongly antiseptic substance.

3. Implantation of a disk or plate of antiseptic decalcified bone into a cranial defect may be relied upon as a hæmostatic measure in arresting bleeding from the vessels of the diploe, it constitutes a good temporary substitute for the lost portion of the cranium, it prevents the direct union of the brain or its envelopes with the pericranium, and, finally, it furnishes the most favorable condition for the production of new bone from the margins and the closure of the remaining defect by a firm and unyielding membrane.

4. The packing of an aseptic bone cavity with chips of antiseptic decalcified bone guards against unnecessary loss of blood and exerts a potent influence in the prevention of infection by pus microbes that might have remained upon the surface of the wound or in the tissues.

5. Capillary drainage by an absorbable drain should be established

after implantation for the purpose of preventing the accumulation of more blood in the wound than is necessary to form a temporary cement substance between the bone chips and between the contents of the cavity and the surrounding tissues.

6. In the treatment of an aseptic bone cavity by implantation of chips of antiseptic decalcified bone, the packing answers the purpose of an antiseptic tampon and furnishes the best medium for the growth and development of the tissue resulting from the regenerative process initiated by the trauma.

7. Secondary implantation can be successfully practised in the treatment of a suppurating bone cavity after suppuration has ceased, and the cavity can be transformed into the same favorable conditions for healing as an aseptic wound.