A MEMOIR

ON OSTEO-MYELITIS.

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Mr. President and Gentlemen of the Academy.—The term osteo-myelitis, derived from two Greek words, οστεον, bone, and μυελος, medulla or marrow, signifies *inflammation of the medullary tissue of bone.* As the word periostitis is employed for a symbol to represent inflammation of the tough periosteal membrane, and ostitis to represent inflammation of the calcified bone-tissue, so the term osteo-myelitis is used to signify inflammation of the soft medullary tissue, or marrow. The statement, therefore, of M. Jules Roux, representing that osteo-myelitis is inflammation of bone in its totality, is not correct. For the production of the last-named affection, it is requisite that there should be not only inflammation of the medullary tissue, but also inflammation of the osseous tissue, or ostitis, and inflammation of the periosteal membrane, or periostitis. Now, while it happens not unfrequently that inflammation of the marrow is associated with either coincident or consecutive inflammation of the bone-tissue and the periosteum, and this remark is especially true of cases of this disease that have either become chronic or have a spontaneous origin, it also happens not unfrequently that we meet with cases wherein the inflammation of the medullary tissue has reached the stage

of suppuration, and at the same time the osseous tissue and the periosteum present a natural appearance, a circumstance which we have sometimes witnessed in the stumps of amputated limbs that have been fatally involved in the acute forms of the disease. It is clear, then, that osteo-myelitis may exist as an independent affection, at least so far as inflammation of the adjoining tissues is concerned; and it is in that sense that we shall employ the term.

During the late internecine strife in this country, this disease proved very destructive to our wounded soldiers, and was one of the chief causes of a fatal result in cases where the osseous tissue had been injured by gunshot projectiles, or surgical operations involving bone had been performed. It was by this circumstance that my attention was first called to, and then fixed upon this disease. It was by this circumstance that I have been induced to devote some time to the study of its nature and relations.

On investigating the literature of the subject, I find that the disease now known by the name of osteo-myelitis is not a new thing. Cases and fragmentary accounts of said disease, under a considerable variety of names and appellations, have, from time to time, been placed on record by a considerable number of surgeons, commencing more than one hundred and fifty years ago. *J. L. Petit* speaks of it in his Treatise on the Diseases of the Bones (anno 1705), in the chapter on exostosis, and presents it as one of the effects of those osseous tumors which, instead of growing out from the surface of the bone, are developed towards the medullary canal. *Duverney*, in a chapter where he treats of that form of fracture of the long bones which is sometimes called a fissure or splint, relates three cases of it, one of which, especially, leaves no room for doubt with regard to its real character (Nélaton). In 1740, *Gooch* saw a patient having osteo-myelitis, which he has quaintly described as "A case in which the tibia was affected to an extraordinary degree in a very short time, by a critical discharge of febrile matter upon a leg, which had been fractured some years before." (*Gooch's Surgery, Vol. II., p.* 349.) *Cheselden* says: "Sometimes matter is formed in the large medullary cavities of the cylindrical bones, which, constantly

increasing and wanting vent, partly by corroding and rendering the bone carious, and partly by pressure, tears asunder the strongest bone in an human body, of which I have seen several instances." (*The Anatomy of the Human Body, by W. Cheselden, p.* 40. *London*, 1778.) He refers to two cases which he had seen, but does not give the particulars. The celebrated English surgeon, *Hey*, reports two cases of suppurative osteo-myelitis, circumscribed in character, at considerable length, under the title of "Caries of the Tibia." An abscess formed in the medullary canal in both of them, which discharged its contents through a perforation or hole in the walls of the tibia made by nature, after the method called by some *spontaneous trepannation.* The first case occurred in 1786, in the person of a young lady from Richmond. The second in 1792, in a stout young woman, aged fifteen. *Hey* did not amputate, but enlarged the opening in the walls of the bone already made by nature, and removed the diseased tissues lying within the bone. Both patients made good recoveries. (*Hey's Surgical Observations, pp.* 26 *to* 32. *London*, 1810.) *Percival Pott*, in a chapter devoted to "Separation or Destruction of both Tables of the Skull from Contusion," relates at least two cases of osteo-myelitis, involving the diploë; and, while describing the inflammatory consequences of contusion of the cranium, he gives an excellent account of the symptoms produced by cranial osteo-myelitis. (*Pott's Chirurgical Works, Vol. I., p.* 115, *et seq. London*, 1779.) *Abernethy* says: "Suppuration of the diploë, and the death of a portion of the bone, are the common effects of injury done to the cranium; and such a morbid state may indeed occur at some distance of time from the receipt of the injury." (*Surgical Observations. Vol. II., p.* 69. *American ed.*, 1811.) He here obviously speaks of cranial osteo-myelitis. *Hennen*, writing in 1817, alludes to this disease as it affects the long bones, under the name of abscess in the medullary canal, etc. (*Principles of Military Surgery, pp.* 100–115. *Am. ed.*) In 1828, *Craigie* made the following statement in his book on pathological anatomy: "The medullary filamentous web is perhaps still more important than the periosteum, in its morbid influence on bone. It is, in the first place, liable to inflammation; and, accordingly as this

takes place in the medullary web of the cylindrical bones, or in that of their epiphyses, or of the short irregular bones, different effects result." (*Op. cit.*, p. 564.) In 1831, *M. Reynaud*, a French surgeon, published a paper "On Inflammation of the Medullary Tissue of the Long Bones," in which he gives an account of five cases of that disease, all occurring in stumps after amputation performed for diseased conditions, and all terminating fatally. (*Archives Générales de Médecine, tome XXVI., p.* 161 *et seq.*) In 1833, *Mr. B. Phillips*, of Westminster Hospital, wrote a brief but excellent article "On Inflammation of the Medullary Membrane after Amputation." (*Lon. Medical Gazette, Vol. XIII., p.* 189. *Nov.* 9, 1833.) In 1833, also, *Dr. Carswell* gave a picture representing inflammation of the medullary canal of the femur. (*Illustrations of the Elementary Forms of Disease, 4to.*) *Cruveilhier* evidently alludes to cases of osteo-myelitis, although he does not use that term, while discussing the subject of "Phlebitis and Visceral Abscesses," in his "Pathological Anatomy of the Human Body." (*Tome I. Liv. XI., p.* 10.) In 1844, *Nélaton* gave a brief account of that disease, following closely the paper of Reynaud. He also employs the term osteo-myelitis. (*Elemens de Pathologie Chirurgicale, t. I., p.* 595 *et seq.*) Jules Roux says this term was devised by Nélaton in 1834. It has therefore been a long time in use (thirty-two years), although it is the recent designation of the disease. (*Mémoires de l'Academie Impériale de Médecine, t. XXIV., p.* 553.) In 1849, *Mr. Stanley* wrote about it in a very interesting way, and narrated seven cases under the title of "Suppuration in Bone." (Vide *A Treatise on Diseases of the Bones, etc., etc., p.* 48 *et seq. Am. ed.*) In 1855, a valuable memoir on osteo-myelitis, written by *Dr. T. Vallette*, a French military surgeon, was published in the "Recueil de Mémoires de Méd. et de Chirurg. Militaires," a publication which annually emanates from the French minister of war. *M. Vallette* describes the disease as he saw it in the Crimean war, at one of the large military hospitals of Constantinople, among the wounded brought directly from the battles of Alma and Inkerman. The disease appeared in an acute form, and proved very destructive to life. In a work "On Suppuration and Surgical Drainage," published in 1859, *M. Chassaignac* devotes thirty-one pages to an

excellent discussion of osteo-myelitis, as it occurs spontaneously in civil life and unconnected with wounds or surgical operations involving bone, in which he gives a full account of four cases observed by himself. In 1860, a long and very interesting memoir upon traumatic osteo-myelitis, written by *Dr. Jules Roux*, and presented to the Imperial Academy of Medicine, at Paris, was published in the transactions of that body. (Vide *Mémoires, etc., p.* 537 *et seq.*) *M. Roux* had charge in 1859 of the Naval Hospital of St. Mandrier at Toulon, into which he received about two thousand wounded from the battle-fields of the Italian campaign of that year. He saw and described the disease under its chronic conditions, that is, after it had existed for a considerable time. In 1860, after the presentation of M. Roux's memoir to the Academy, osteo-myelitis was the subject of discussion at two successive sittings of that body. It was also the theme of an elaborate discourse by *Baron H. Larrey*, the distinguished Surgeon-in-Chief of the French Army in the Italian campaign, and the subject of a letter to the Academy from *M. Legouest*, the distinguished surgeon of Val-de-Grace. In short, M. Roux's memoir appears to have produced a very deep impression upon that assemblage of learned men. *Mr. Longmore* read a valuable paper on osteo-myelitis before the Royal Medical and Chirurgical Society, February 28, 1865, an abstract of which was published in the Medical Times and Gazette, March 11, 1865. (Vide *American Journal Medical Sciences, July*, 1865, *p.* 230 *et seq.*) But the various systematic treatises on surgery in use in both Europe and this country contain either no account at all, or only a very meagre one of this important disease.

In reviewing the literature of the subject, we are struck by the fact, that it is only within the last dozen years, that osteo-myelitis has fairly begun to attract the attention which its importance demands. The cause of surgical science owes much to Doctors T. Vallette and Jules Roux, for bringing prominently forward their own observations concerning this very destructive disease, as it appeared in the Crimean and Italian campaigns respectively. The experience of those two wars, together with that of our own fratricidal strife, have shown conclusively that osteo-myelitis occurs much more frequently

in military practice than has hitherto been generally supposed; and I believe that testimony is now accumulating which tends to prove that this disease occurs in civil practice also much oftener than has heretofore been imagined. Its existence explains the want of success which oftentimes attends surgical operations involving bone—operations undertaken for the removal of disease as well as for the relief of injury, and occurring in civil as well as in military practice.

Indeed, the physiological and pathological importance of the medullary tissue has, for the most part, been overlooked until a very recent period. It is only of late years, and since the aid of the microscope has been secured in prosecuting the study of histology, both healthy and morbid, that the importance of the medullary tissue to the well-being of the bones has been sufficiently recognised. Formerly, the marrow in the canals of the long bones appears to have been looked upon as a tissue analogous in every respect to the tela adiposa, and as a matter of quite secondary importance, so far as the pathological processes in bone are concerned.

I have thus sketched the historical features of our theme at considerable length, because, by so doing, we get broader views of the subject, and are enabled to perceive the development of ideas, and the progress of knowledge concerning it. In 1831 the memoir of M. Reynaud appears to have fallen coldly upon the medical mind of France. But in 1860 the memoir of M. Jules Roux, on the same subject, excited a very lively interest in even the staid Academy of Medicine at Paris. Thus we behold progress in the midst of even the conservatism of traditional medicine. I have done this also for the purpose of showing that inflammation of the medullary tissue is not a new-fangled notion, but a disease which, under various appellations, has been known for a long time; and that it is not an affection of rare occurrence, but one which is frequently met with, and as frequently recognised, if the examination, whether clinical or post-mortem, be sufficiently thorough and complete.

Since the anatomical distribution of the medullary tissue is such that it may be found in greater or less quantity in every bone* of the body, it follows that osteo-myelitis may be pro-

* *Robin* says: "Marrow is found in all the bones of the body, and it extends

duced in any bone of the body. It has, indeed, been met with in several of the cranial bones, in the upper jaw, in the lower jaw (Prof. Clark, a distinguished fellow of this Academy, has seen two examples wherein this bone was affected), in the sternum, ribs, humerus, radius, ulna, carpus, os innominatum, sacrum, femur, tibia, fibula, patella, and the bones of the tarsus, by various observers. The disease, however, occurs much more frequently in the lower than in the upper extremity, obeying in this respect the general law concerning the development of disease in different parts of the body.

Varieties of Osteo-Myelitis.—The clinical history of this disease exhibits a wide diversity with respect to intensity and duration. In some cases its severity is very great, and it runs through its whole course in a few days; while, in other cases, its progress is sluggish and obscure, requiring, not unfrequently, several weeks, or even months, to attain a full development. Inflammation of the medullary tissue of bone may, on the one hand, be ranked among the most rapidly destructive of all inflammatory disorders with which we are acquainted; while, on the other hand, it appears to be allied to those that are exceedingly slow in their march. There are but few parenchymatous inflammations which destroy life more speedily than acute suppurative osteo-myelitis, and there are none which are slower in their progress than chronic abscess of bone. For the purposes of clinical study and description, and likewise for the development of certain practical considerations connected with the treatment, it will be found convenient to recognise at least *two varieties of osteo-myelitis*, namely, the *acute* and the *chronic*. But, at the same time, it should not be forgotten that this classification, although it is founded upon differences which actually exist in nature, is, in reality, artificial; that cases of this disease, in respect to two of their elements intensity and duration—form a graduated series, represented at

through the vascular canals as far as the periosteum." Indeed, the medullary tissue is not only distributed widely, but is also abundant in quantity. It fills the canals of the long bones, the cancelli of their epiphyses, and of the short and irregularly shaped bones in general, the diploë of the cranium, and the medullary spaces in every part of the osseous system.

one end of the scale by the most acute, and at the other by the most chronic cases; that in the middle of this descending series it is difficult to say whether some of the cases belong to the acute or to the chronic class; and that the inflammatory process is essentially the same in both varieties, so far as the marrow is concerned.

The following case presents a good example of acute inflammation of the medullary tissue, following amputation, as it appeared in our army hospitals during the late war.

A Case of Acute Osteo-Myelitis.

Private Henry Stubblebine, Company C, Ninety-sixth Pennsylvania Volunteers, aged twenty, and of sound constitution, was brought to Stanton U. S. Army General Hospital, May 8, 1863. He had been wounded in the battle near Fredericksburg, Va., five days before (May 3d, 1863), and on that account had suffered primary amputation of the left thigh at the lower third, by the circular method.

When he came to the hospital his general condition was good; a water-dressing was applied to the stump, and his bowels being constipated, a dose of ol. ricini was administered.

May 11.—Oozing of blood from the stump was observed. The stump also had appeared to be swelled (distended) ever since he was admitted to the hospital. It was opened, and found filled with coagulated blood, which was removed. It was left open to heal from the bottom by granulation, and to prevent any possible accumulation of pus in its interior.

May 15.—Suppuration free, and laudable in quality; granulations healthy; the stump is also contracting. He continued to do well till May 27. Has passed a restless night, and complains of a good deal of dull pain in the stump, which he refers to the bone; has no febrile symptoms; ordered morph. sulph., in full doses.

May 28.—The pain continues, but is more severe; pulse quick, skin hot and dry; pus oozing from the sawn end of the bone in the stump (osteo-myelitis); stump swelled, secretion of pus diminished; prescribed potass. iodid. ℈j., dissolved in aqua camphor. f. ℥ iv., to take a tablespoonful every four hours, and stimulants. In the afternoon he had a chill.

May 29.—Was slightly delirious; had rigors and hot flushings at irregular intervals; was rapidly becoming debilitated; same treatment continued.

May 31.—Delirium increased; skin yellow, pulse 130, and very feeble; continued in about the same condition till June 2, when he died.

The stump was examined after death, and a number of small abscesses were found in the muscular tissue of it. Pus was also found in the medullary canal of the femur, forming numerous little collections, varying in size from a mustard-seed to a pea. The internal organs were not examined, as his friends were waiting to remove his body from the hospital.

Comments.—This is a strongly marked instance of acute osteo-myelitis. The following are the essential points pertaining to it: A healthy young man of twenty years sustained primary amputation of his left thigh, for gunshot injuries. He seemed to do well for a period of twenty-four days. Then symptoms of osteo-myelitis appeared in the stump-bone. Of these symptoms, the first was a dull, aching pain in the stump, which the patient referred to the bone. This pain was severe enough to deprive him of sleep. The next day the pain was still more intense, and he now had constitutional disturbance in the shape of irritative fever. At the same time the stump became swelled, and the flow of pus from it diminished in quantity and depraved in quality, showing that the soft tissues of the stump sympathized with the inflammatory mischief which had been lighted up in the medullary tissue of the bone, or, speaking more exactly, that the inflammatory process had spread from the marrow to the soft parts lying exterior to the bone. Pus was also seen oozing out from the marrow at the end of the stump-bone. This occurrence established the diagnosis of osteo-myelitis beyond a doubt. On the next day (the third after the appearance of inflammation of the medullary tissue), his symptoms were all worse. He was beginning to be delirious, and his strength was failing rapidly. He also had rigors, alternating with hot flushings and occurring at irregular intervals. The last group of symptoms belongs to pyæmia. On the next day (the fourth) he was still more delirious, and still more debilitated. His skin had now assumed a

yellowish hue, and the symptoms of pyæmia were still more pronounced. He continued to grow worse, and died on the seventh day after the symptoms of osteo-myelitis made their appearance. The inflammation of the marrow was suppurative in character, and it is worthy of special notice that in the short period of three days it was attended by signs of general purulent infection. It is probable that an examination of the internal organs would have revealed visceral abscesses. The succession of pathological events in this case is clearly defined. The patient did well for more than three weeks; then his stump was attacked with suppurative osteo-myelitis, and pus was seen oozing from the marrow at the end of the bone. In a few days symptoms of purulent infection made their appearance, and a few days later still he died of pyæmia. The focus of suppuration from which the system became infected in this case was obviously located in the medullary tissue of the stump-bone.

The cases of osteo-myelitis reported by *Hey*, under the name of "caries of the tibia," to which reference has already been made, present examples of the chronic variety of the disease.

Cases of chronic osteo-myelitis were very often met with in our military hospitals during the late war. The disease manifested itself in this form mainly in the stumps of amputated limbs, and in gunshot fractures which were being treated conservatively. Chronic inflammation of the medullary tissue of stump-bones was generally accompanied by necrosis and exfoliation of the dead bone. At the same time, the portion of bone that did not perish became more or less thickened, in most instances, by the formation of laminæ of new osseous tissue around the exterior (periostosis). The army medical museum at Washington contains a great number of specimens of necrosed bone that have been extracted from stumps in cases of chronic osteo-myelitis. Such patients generally made good recoveries.

Causes of Osteo-Myelitis.—The time at our disposal will permit us to state in this place, concerning this topic, but little besides the conclusions to which we have been led by our investigations.

1st. Osteo-myelitis is not unfrequently produced by *contusion*

and contused wounds of bone. Pott and Abernethy have abundantly shown that contusion of the cranium often occasions suppuration in the diploë. The writer published in the American Journal of Medical Sciences for July, 1865, several cases of contused wounds of the long bones, inflicted by gunshot projectiles, wherein destructive inflammation of the medullary tissue had been produced. Indeed, the chief source of the great danger to life which attends contusion and contused wounds of bone, arises from the inflammation of the medullary tissue, which is very apt to be kindled thereby.

2d. Osteo-myelitis is not unfrequently occasioned by *compound fracture*, especially gunshot fracture of the long bones. In such cases, the inflammation of the marrow appears to be due not only to the injury it has sustained, but to the admission of air, also.

3d. This disease has been produced by the operation of *resection*, or the excision of a portion of a bone. Of this I have seen several instances.

4th. Osteo-myelitis often follows the performance of *amputation*, especially the major amputations, in both civil and military practice. This has been witnessed by Reynaud and Phillips, by Vallette, Pirogoff, and Roux, and by our own army surgeons during the late war. The first two made their observations exclusively in civil practice.

5th. *Foreign bodies*, such as a bullet, a piece of clothing, or a fragment of bone, when driven into and lodged in the medullary canal of a long bone, have been known to produce fatal osteo-myelitis. Of this I saw an instance not long since in civil practice. The foreign body was a fragment of bone, and the original injury, gunshot fracture of the femur.

6th. The *scrofulous dyscrasia* may induce inflammation of the medullary tissue. Stanley relates two cases belonging to this category. At least one of Chassaignac's cases also was probably occasioned by struma.

7th. *Constitutional syphilis* sometimes occasions osteo-myelitis. *Percival Pott*, admitted by all to have been a very acute observer, states that in cases of syphilitic necrosis of the cranial bones, the disease has its seat in the diploë, or in other words, in the medullary tissue. *Mr. B. Phillips* and *Langston Par-*

ker have reported cases of syphilitic osteo-myelitis occurring in the long bones of the lower extremity, especially the tibia.

8th. The *rheumatic diathesis* sometimes appears to be concerned in the production of osteo-myelitis; or, in other words, we have not only a rheumatic periostitis and a rheumatic ostitis, but also a rheumatic osteo-myelitis. In one of Stanley's and one of Chassaignac's cases the disease seems to have had a rheumatic origin. Dr. Hermann Klose, of Breslau, has given an account of thirteen cases of what appears, in reality, to have been osteo-myelitis under the unique title of *Meningo Osteo-phlebitis* (Vide *Archives Générales de Médecine* for August and November, 1858.) Dr. Klose distinctly recognises the idea that the disease may have a rheumatic origin.

9th. *Idiopathic fever* is occasionally followed by osteo-myelitis. Indeed, this occurrence took place in one of Hey's cases, and he makes the following remarks concerning it: "Upon a review of the case, I am inclined to think that an abscess was formed within the tibia, in consequence of the fever which she had in May, 1786. During the continuance of the fever, she had no particular pain in her leg; but upon the decline of the fever the pain commenced, and continued violent for six weeks. It seems probable that during this time the matter was making its way through the anterior lamella of the tibia, and that the pain abated soon after the matter had perforated the bone; for it ceased immediately on the appearance of a tumor on the shin." (*Op. cit., p.* 26 *et seq.*)

10. Osteo-myelitis sometimes occurs *without apparent cause*, of which Stanley has related two instances.

11th. The *transportation of the wounded*, in military practice, is often attended with unavoidable injury of such a nature as to assist not a little in the production of osteo-myelitis, among such of the wounded as have sustained an injury of the osseous tissue. For example, in cases of gunshot fractures of the long bones of the lower extremity, the jolting incident to ambulance transportation causes the soft parts to be pierced and lacerated by the sharp ends of the broken bone, and sometimes it happens that a fragment of comminution is driven into the medullary canal. Again, in cases where the thigh has been amputated, the jolting causes the soft parts of the stump, but more

especially the flaps, to be bruised against the bone, in consequence of which they become more or less inflamed. Now, this traumatic inflammation may spread to the medullary tissue and kindle in it a suppurative inflammation of a fatal character. However, it seems to be well established, whatever the explanation may be, that, other things being equal, the wounded who are treated on or near battle-fields suffer a much smaller loss from osteo-myelitis than those who are transported to distant parts for surgical care. The writer's personal observations on this point are corroborated by the experience of Surgeon Henry Janes, U. S. Volunteers, at Gettysburg, and likewise of the Confederate Surgeon S. D. Moses, at Charlotteville, Va.

12th. This disease is much aggravated by *impure air, especially the foul air of imperfectly ventilated or uncleanly hospitals.* This is probably one of the most prolific of all the causes of osteo-myelitis; and since it is in great measure a preventible cause, it should claim our earnest attention. Observation has shown that, other things being equal, the wards of a hospital that are most impure in respect to their atmospheric condition, generally furnish the largest proportion of fatal cases of osteo-myelitis. Observation has also shown that surgical patients—for example, those who have sustained gunshot fracture, or amputation, and are treated in the portions of a ward where the air is most likely to stagnate, for example the corners, are considerably more liable to become affected with destructive osteo-myelitis than those who are treated in other portions of the same ward where the air is more free from impurities. Observation has further shown that surgical patients treated in hospital tents, if they are properly pitched and policed, are much less likely to be seized with fatal osteo-myelitis than a similar class of patients treated in the wards of a hospital building. It is probable that under the depressing and poisonous influence of foul hospital air, cases of inflammation of the medullary tissue which, under favorable circumstances, would eventuate in recovery, degenerate into the stage of suppuration, and perhaps a foul suppuration at that, and sooner or later purulent infection is produced, which occasions death.

Osteo-myelitis is also pre-eminently a disease of *youth.* Of seventy-two cases, the notes of which have been preserved,

that occurred under my observation in military practice, the ages were as follows: between eighteen and twenty, *seven;* between twenty and twenty-five, *twenty-four;* between twenty-five and thirty, *seventeen;* between thirty and thirty-five, *thirteen;* between thirty-five and forty, *six;* between forty and forty-five, *three;* between forty-five and forty-nine, *two;* sixty-one of them were less than forty years of age, and only eleven older than that. The youngest case was eighteen, and the oldest forty-nine. But it may be justly objected against statistics of this sort which are drawn from military sources, that in respect to age, soldiers do not represent the average of the population, since neither the very young nor the aged are enrolled in the army to any considerable extent. I have therefore collected from various sources thirty-six cases of osteo-myelitis that occurred in civil practice, which are not open to the objection mentioned above. An analysis of their ages yields the following results: between ten and fifteen, *five;* between fifteen and twenty-five, *fourteen;* between twenty-five and thirty-five, *five;* between thirty-five and forty-five, *one;* between forty-five and fifty-five, *two;* between fifty-five and sixty-five, *one;* between sixty-five and seventy-five, *one;* and in *seven* instances the age was not stated. It will thus be seen that of the twenty-nine cases whereof the ages are given, nineteen, or about two-thirds, were less than twenty-five years old, and that in only five instances were the subjects more than thirty-five years of age. The youngest case was aged eleven, and the oldest seventy years.

Furthermore, osteo-myelitis is pre-eminently a disease not only of the period of youth, but also of the *male sex.* Of the thirty-six cases mentioned above as occurring in civil practice, twenty-seven were males, eight females, and in one instance the sex was not stated.

Pathological Anatomy of Osteo-Myelitis.—The morbid conditions of the marrow in respect to structure which are produced by the inflammatory process, are threefold: 1st. *carnification* or *hepatization;* 2d. *suppuration;* and 3d. *gangrene.*

1st. *Of the Carnified or Hepatized Marrow.*—The medullary tissue in the long bones of the adult, when healthy, is loaded

with fat, and on that account presents a pale yellow color. Among the first effects of the inflammatory process upon this tissue are a reddening of its hue, and an increase in its density and tenacity. The color of the marrow during the first stage of osteo-myelitis varies from coppery red to crimson, to brown, and almost to black. In this form, the inflamed marrow is said to be *carnified* or *hepatized*, on account of the resemblance in appearance which it is supposed to bear to red muscular tissue or flesh, on the one hand, and dark-red or reddish-brown hepatic tissue on the other. The inflammatory process produces this change in the color of medullary tissue by the following means:

1st. By diminishing the quantity of the fat, to which the yellow hue of the healthy adult marrow in the long bones must be ascribed.

2d. By increasing the quantity of one of the cellular elements of the medullary tissue, namely, the marrow cells, which, under such circumstances, are more or less granular, and resemble closely, if they are not identical with, what were formerly called exudation cells.

3d. By increasing the quantity of blood contained in the inflamed tissue, thus producing an active hyperæmia, which is proved by the fact that the inflamed marrow bleeds readily on touching it.

When the carnified marrow has a yellowish red, or a copper-colored hue, it is because fat vesicles in considerable quantity still constitute one of its histological elements. As muscular tissue acquires a yellowish tinge from undergoing the fatty degeneration, even so the inflamed marrow may retain some of that tint, because the oil has not been sufficiently expelled from it by the inflammatory process. Other things being equal, the greater the proportion of oil contained in the inflamed marrow, the deeper the yellowish tinge is found to be. But even when the carnified or hepatized marrow has a deep red, or brownish hue, the examination of it with the microscope shows, that although the proportion of fat vesicles is very much reduced, still the fat has not entirely disappeared, provided the specimen examined belongs to an adult, and has been taken from a long bone. Such at least have uniformly been the results of our own observations.

The extent to which the quantity of blood in the inflamed marrow is increased above the healthy standard, or, in other words, the amount of the congestion, has also an important bearing upon the morbid coloration of the medullary tissue.

What occasions the increase in density, consistence, and tenacity, which characterizes the carnified or hepatized marrow?

It seems to be produced, at least to some extent, by the development under inflammatory irritation of a rudimentary fibrous material, represented, when examined under the microscope, for the most part, by elongated and spindle-shaped fibre cells. But this new growth of fibrous tissue has generally appeared to me to be quite insufficient in quantity to account satisfactorily for the amount of the increase in the density and consistence of the diseased marrow, and I have therefore been compelled to seek some other cause which may assist in producing it. Such a cause is probably constituted by *sclerosis* of the intercellular substance, or, in other words, *sclerosis* of the substance which lies between the free marrow cells and connects them together. The induration of the intercellular substance in such cases appears to be a result of the inflammatory process, and to depend upon the grade or degree of the inflammatory irritation. For if, from any cause, the intensity of the inflammatory irritation be sufficiently increased, the intercellular substance will soften and liquefy, there will also be a very rapid production or proliferation of the cells, and suppuration will be established; or, in other words, the carnified medullary tissue will be directly transformed into pus through the agency of a high grade of inflammatory irritation.

2d. *Of Suppuration of the Marrow.*—Carnification or hepatization appears to be the result of the *first* stage of inflammation of the medullary tissue, and suppuration to be the result of the *second* stage of that disease. Before the marrow suppurates it always undergoes the process of carnification or hepatization. Hence it happens that the abscesses produced by suppurative osteo-myelitis, in the shafts of the long bones, are surrounded by carnified or hepatized medullary tissue. Hence it also happens that as these abscesses increase in size, it is constantly done at the expense of the carnified or hepatized tissue, and by its transformation into purulent matter in the way just

pointed out. We say, again, that the transformation of new medullary growths into pus is attended by the following phenomena. The granular medullary cells multiply themselves with very great rapidity, and become still more granular. At the same time the intercellular substance softens and finally liquefies, the marrow cells become converted into pus corpuscles, and the intercellular substance into *liquor puris*, or the liquid intercellular material of purulent matter. Some of our own observations strongly corroborate these views of Virchow. We say, then, that carnification, or hepatization and suppuration of the medullary tissue, are successive stages in the transformations of the histological elements of that tissue, which are produced by the inflammatory process. Hence, it comes to pass, that we not unfrequently find, in stump-bones affected with osteo-myelitis, the marrow in a state of suppuration at the lower end where the morbid process began, and above that in a state of carnification or hepatization.

3d. *Of Gangrene of the Marrow.*—One grade of inflammatory irritation produces carnification or hepatization of the medullary tissue; another grade suppuration; and a still higher degree of inflammatory irritation produces gangrene of that tissue. When the marrow mortifies, its color usually becomes very dark or nearly black, and it emits an offensive gangrenous odor. When the mortified medullary tissue is examined with the microscope, it is found that all the cell-structures are destroyed, that all the fat vesicles are broken up, and the oil which they contained is set free. The fibres of connective tissue, however, may withstand the putrefactive process for some time; and we therefore generally find the gangrenous marrow to consist of connective tissue, free oil, and granular matter, all stained with decomposing hæmatoidin.

Robin mentions a pathological condition of the marrow which is closely allied to gangrene, and has an important bearing on the prognosis of the case in which it occurs. I have seen it several times, and I doubt not that it has attracted the attention of most surgeons. He says: "In some conditions the inflammation of the marrow becomes so intense, that the medullary cells cease to receive materials fit for their continuous molecular renovation. *The marrow then softens and*

becomes liquid, and flows from the extremity of the fractured or amputated bone. When this liquid is examined, there are found in it only molecular granules in suspension, sometimes nucleated medullary cells, and always drops of oil; for the liquefaction melts down the walls of the fat vesicles and sets the oil free. This is always a grave occurrence, as has been demonstrated in the study of fractures, especially those of the long bones, and in certain other pathological conditions, such as amputation followed by so-called purulent infection."—Vide *Am. Journal Med. Sciences, Oct.*, 1865, *p.* 498 *et seq.*

We sometimes find all three of the pathological conditions of the marrow which may be produced by the inflammatory process, present in the same specimen. Thus, I have seen a stump-bone affected with osteo-myelitis, in the lower part of which the marrow was gangrenous; above that, in the stage of suppuration; and still higher up, in the stage of carnification or hepatization.

Symptoms and Diagnosis of Osteo-Myelitis.—The first sign which announces that the medullary tissue has been attacked by inflammation is, for the most part, local pain. It usually appears to the patient to be situated in the bone at the place where the marrow is diseased. It varies much in character and intensity in different cases. In some instances, it seems to be dull, heavy, and aching; in others, it appears to be gnawing; and in still other instances, it is stabbing in character. Sometimes it is but slight in degree, while in other cases it is very intense. Occasionally, however, it is not present, or at least the patient, when asked if he has pain, always replies in the negative. This circumstance in some cases appears to be due to the hebetude of typhoid disease, in others to extreme debility; but in other instances cannot be accounted for in the present state of our knowledge of the subject.*

* The pain produced by osteo-myelitis is more likely to be intense if the disease involve a bone whose continuity has not been destroyed by amputation, resection, or fracture. Thus, I have seen a case of osteo-myelitis of the tibia which was caused by a contused wound of that bone, wherein the pain was very severe—almost agonizing. In some cases of inflammation of the medullary tissue of fractured, and likewise of stump bones, that have come under my observation, the pain

To the local pain is generally superadded local swelling as a symptom of osteo-myelitis, which appears not immediately, but after the lapse of a period varying from a few hours to several days or even weeks in duration. The tumefaction is usually more or less indurated in feel, puffy in appearance, and pits under pressure. It is generally more or less flattened in shape, and coëxtensive with the suppuration of the medullary tissue lying beneath it, at a line corresponding with the boundaries of which it usually terminates abruptly. The "puffy tumor" of Pott affords a good illustration of the various features which characterize the swelling of the soft parts produced by osteo-myelitis.

When this disease invades the stumps of amputated limbs, it is generally found that carnified or hepatized medullary tissue protrudes from the canal at the sawn end of the bone, and after the lapse of a few days, pus will not unfrequently be seen exuding guttatim from this portion of the inflamed marrow.*

Furthermore, as the stump becomes tumefied in consequence of inflammation of the medullary tissue of its bone, the purulent discharge from its granulating surface generally exhibits considerable alteration. It usually becomes considerably diminished in quantity, and thin, flaky, and serous in quality. Sometimes it becomes changed to a scanty quantity of bloody serum. Occasionally it is completely arrested, and the stump presents a dry and pork-like appearance.

When acute osteo-myelitis invades the cranium or any of the limbs in their continuity, a collection of purulent matter is not unfrequently formed in relation with the exterior of the bone at the seat of the disease. Now, on incising this abscess,

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was slight, apparently because the purulent matter could readily escape from the medullary canal.

Again, the pain which accompanies osteo-myelitis is generally very intense if the neighboring osseous tissue also is inflamed; for in such case there is superadded to the pain pertaining to the inflammation of the medullary tissue, that which is produced by the ostitis.

* If the marrow liquefies and the fat vesicles burst on account of the intensity of the inflammation, as pointed out by *Robin*, then free oil will be found flowing out of the medullary canal at the end of the *stump-bone* in a case of amputation, or from the wound of the soft parts, mixed with purulent matter in a case of compound fracture.

the matter as it flows away will often be found to contain numerous oil-globules. This circumstance denotes that the disease is either acute osteo-myelitis, or acute periosteal abscess, and is of great value in a diagnostic point of view. Chassaignac asserts that the sub-aponeurotic pus in cases of osteo-myelitis is *always* mixed with oil-globules. While I am not prepared to yield full assent to this statement, I am ready to say that I am fully satisfied, from my own experience, that the sub-aponeurotic pus of osteo-myelitis is *very often* mixed with oil-globules.

The only diseases which are likely to be mistaken for acute osteo-myelitis, are *acute periosteal abscess*, and *diffuse cellulitis* or *phlegmonous erysipelas.*

With regard to the diagnosis of osteo-myelitis itself, irrespective of any other disorder, we have to say that the only signs which can be properly considered as pathognomonic of that disease are the reddened and sclerosed or hepatized appearance of the marrow, with perhaps some drops of pus exuding from it, which are sometimes detected by ocular examination. But the clinical observation of all such signs is practically restricted to the cases wherein osteo-myelitis follows amputation, with the addition, perhaps, of some instances of resection. Now, in view of the great value of these signs, and in view of the great danger which always attends acute suppurative osteo-myelitis, it is advisable for the surgeon to open the stump sufficiently far to permit him to ascertain the condition of the marrow at the sawn end of the bone, in every case where there is good reason to suspect the presence of the disease in that form.

But with regard to osteo-myelitis produced by compound fracture, by contusion, by scrofula, by syphilis, by rheumatism, and indeed by any cause besides amputation, there are no individual symptoms of which the surgeon can avail himself that can be considered as diagnostic of the disease, especially so far as the long bones of the extremities are concerned. In cases of cranial osteo-myelitis, however, the "puffy tumor" of Pott may be considered as characteristic of the affection.

Osteo-myelitis affecting the bones of the extremities can generally be distinguished from *phlegmonous erysipelas* by attending to the following points: 1. The pain produced by the

former is usually much more severe than that occasioned by the latter disease; 2. The character of the pain is different in the two diseases; that of osteo-myelitis being mostly of an aching and gnawing character, and that of phlegmonous erysipelas being throbbing and burning, and much less intense; 3. The swelling produced by phlegmonous erysipelas is more boggy than that occasioned by osteo-myelitis; 4. The swelling produced by the former differs considerably in shape from that occasioned by the latter disease; the tumefaction resulting from osteo-myelitis terminates by an abrupt rim or border which corresponds with the boundaries of the suppurating portion of the marrow; but the swelling occasioned by phlegmonous erysipelas does not terminate in that way, since it usually sinks down gradually until it is lost in the surrounding parts; 5. If an explorative incision be made to sufficient depth it will be found that the sub-aponeurotic pus does not contain oil-globules in cases of phlegmonous erysipelas, while it generally does contain oil-globules in cases of osteo-myelitis; 6. If evacuative incisions be made to sufficient extent, they will afford great relief from the pain and distress in cases of phlegmonous erysipelas, but not in cases of osteo-myelitis.

The last-named can oftentimes be distinguished from the first-named disease by the shape of the swelling alone; which in osteo-myelitis terminates by an abrupt rim or border corresponding with the limits of the suppuration of the medullary tissue, and in phlegmonous erysipelas does not terminate in that way, as has already been pointed out.

Osteo-myelitis can be distinguished from *acute periosteal abscess* by the following circumstances: 1. In acute periosteal abscess fluctuation precedes puffiness in the swelling; in osteo-myelitis it is just the contrary (Chassaignac); 2. The painful œdema which accompanies osteo-myelitis terminates abruptly by a projecting and hard brim, just at the height where the bone ceases to be diseased (Chassaignac); 3. Osteo-myelitis may be accompanied by suppurative inflammation of the periosteum, and diffuse inflammation of the cellular tissue; the acute periosteal abscess occasions neither medullary suppuration of the bone, nor purulent infiltration of the limb (Chassaignac); 4. Osteo-myelitis spreads from one bone to another in a direction

upwards and towards the root of the limbs; the acute periosteal abscess generally remains confined to the part of a limb in which it appeared (Chassaignac); 5. If evacuative incisions are made in cases of acute periosteal abscess, they generally afford much relief from pain and distress; not so, however, in cases of osteo-myelitis.

Again, acute suppurative osteo-myelitis may sometimes be distinguished from acute periosteal abscess by still another sign—one that is founded on the condition of the bone that underlies the suppurating periosteum, which is generally necrosed in such cases, and oftentimes to great extent. Now, if the death of the bone have been occasioned by osteo-myelitis, and the suppuration of the periosteum and the neighboring parts be secondary in character, and produced by extension of the inflammatory process to them from the diseased marrow, then the surface of the dead bone is apt to present a rough, eroded, or worm-eaten appearance, occasioned by the adhesion of living particles of osseous tissue to the periosteum at the time of its separation from the dead osseous tissue; but if the necrosis be occasioned primarily by diffuse periostitis, then the surface of the dead bone is found to be comparatively smooth, the longitudinal furrows are perhaps somewhat deeper and wider than natural, but the circumferential laminæ are not eroded.

If there be any doubt concerning the diagnosis as between osteo-myelitis, acute periosteal abscess, and phlegmonous erysipelas, it is generally advisable to make an explorative incision down to the bone, for the purpose of gaining such information as will settle the question definitely; for even extensive incisions made in such cases do not do harm, but, on the contrary, usually prove beneficial.

If for any reason it be deemed inexpedient to make explorative incisions for the purpose of verifying the diagnosis, much valuable information may not unfrequently be obtained by using the exploring needle, in cases where the periosteum is detached and separated from the bone by a quantity of pus. If in such a case the needle be thrust into the swelling in a direction towards the bone, and it be attempted to move it in circular sweeps, an equable resistance will be found as long as

it remains in the soft parts; but if it be thrust down to the bone, and then drawn back a little (about a line), its point may be turned in any direction. (Barwell.)

If, when purulent matter has been withdrawn from deep-seated parts either by incision, or through an exploring canula, or by spontaneous discharge, there be doubt as to whether its production is dependent upon disease of the osseous tissue, the question may not unfrequently be put to rest by finding in the pus particles of disintegrated bone resembling fine sand, which, on examination with the microscope, are found to contain lacunæ, canaliculi, and Haversian canals; and by finding in the purulent matter, on the application of chemical tests, the calcareous salts belonging to bone, in at least considerable quantity.

But, while endeavoring to establish the diagnosis in an acute case of suspected osteo-myelitis, it is a matter of the first importance not only to interpret each symptom with rigidity, but also to consider the *tout-ensemble* of the morbid phenomena, or to give attention to the symptoms as a whole; and while so doing, the method of exclusion may be advantageously employed. If all the symptoms can be satisfactorily accounted for on the hypothesis that the disease is osteo-myelitis, and not by any other hypothesis, then it is certain that the case consists of that disorder.

The diagnosis of *chronic osteo-myelitis* is, in general, not difficult to make. The clinical history of the case; the length of time it has lasted; the order in which the morbid phenomena have been developed; the bone-pain, the heat, the swelling, together with the suppuration of the soft parts; and, in patients who have previously suffered a solution of the continuity of the diseased bone either by fracture, or resection, or amputation, the occurrence of necrosis with the development of new osseous tissue from the periosteum and from the portion of the bone that did not lose its vitality, which, for the most part, can be readily ascertained; the persistent suppuration of the parts contiguous to the sequestrum, resulting from the mechanical irritation occasioned by its presence; and, perhaps, the exfoliation from time to time of fragments of necrosed bone—do not leave us long in doubt with regard to the real nature of the disease.

Terminations, Complications, and Consequences of Osteo-Myelitis.—Here time permits us to state but little more than the results of our investigations. It forbids us to relate in detail the cases, the pathological researches and arguments, upon which our conclusions are founded.

1st. Osteo-myelitis, even when acute, not unfrequently terminates in *recovery by resolution.* Of this I have seen two notable instances. In such cases the inflammatory irritation subsides, the symptoms which indicate to the clinical observer the presence of the inflammatory process in the marrow disappear, and the diseased tissue is gradually restored to a healthy condition, without the intervention of suppuration. But the acute variety of the disease much more frequently degenerates into a chronic form, which is, for the most part, susceptible of relief by surgical means.

2d. Osteo-myelitis often occasions *central necrosis.* The army medical museum at Washington contains a large number of specimens belonging to this category. When the disease affects the shafts of the long bones, the internal laminæ, that is, the laminæ which lie next to the marrow, may become necrosed, or, in other words, affected with dry gangrene (for necrosis is in reality dry gangrene of the osseous tissue), by being deprived of an adequate supply of blood because of the morbid condition or destruction of the medullary tissue. When the disease affects the epiphyses of the long bones, it may occasion necrosis of a portion of the cancellous structure—indeed, it may destroy the vitality of any part of the osseous structure which lies within the shell formed by the external layers of compact tissue.

3d. The inflammatory process may spread from the marrow to the osseous tissue and periosteum, and thus occasion necrosis of the whole thickness of the bone, or *necrosis in totality.*

4th. Osteo-myelitis not unfrequently produces *pyarthrosis.* In fifty-one cases of said disease, suppurative arthritis is known to have occurred in five instances. As already stated, inflammation of the medullary tissue exhibits a strong tendency to travel upwards from one bone to another, towards the roots of the limbs, and in this way invades the neighboring or inter-

vening articulations. Thus, when the disease commences in the bones of the tarsus, it not unfrequently occasions pyarthrosis of the ankle; when it begins in the tibia and spreads upwards, it produces pyarthrosis of the knee; and when it originates in the femur, it often occasions pyarthrosis of the hip. Oftentimes the morbid process appears to enter the joint by perforating the cartilage of incrustation, which then contains a number of small reddish-colored holes, that look as if they had been made with a punch. In the specimens I have examined, the cancelli underlying these holes were found to contain purulent matter, that is, matter containing pus-corpuscles.

5th. Osteo-myelitis may occur simultaneously in more than one bone. Stanley and Chassaignac have each reported a case. The writer has seen one instance.

6th. Osteo-myelitis very often occasions the *development of new osseous tissue*, which may be formed either in connexion with the medullary tissue, when the new bony growth is called *endostosis;* or in relation with the periosteum, when it is called *periostosis;* or in the connective tissue of a limb, when it is known by the name of *osteoid tissue.*

7th. Osteo-myelitis frequently produces *abscesses in the neighboring soft parts*, of which we have observed numerous examples.

8th. Osteo-myelitis not unfrequently causes the blood to coagulate in the veins leading from the affected part, thus producing thrombi, and inaugurating the peculiar morbid process which Virchow has called *thrombosis.* In fifty-one cases of this disorder, six are known to have had thrombosis. Several of them had parenchymatous hæmorrhage in consequence of the venous obstruction. In one of them it was very profuse, and proved fatal. This patient did not have pyæmia.

9th. Osteo-myelitis often occasions *pyæmia.* Of the fifty-one cases of inflammation of the medullary tissue, pyæmia supervened in eighteen, and all of them died. In each of these cases the suppurating marrow appears to have been the focus from which the purulent infection sprang. Furthermore, in cases of osteo-myelitis having a fatal termination, pyæmia is the immediate cause of death more frequently than all other causes combined. Thus of fifty-one cases of osteo-

myelitis, thirty proved fatal; and of these, eighteen, or considerably more than one-half, died of pyæmia. Hence, it is believed that pyæmia is the form of systemic intoxication which is produced by suppurative inflammation of the marrow. Clinical observation has also abundantly shown that purulent infection occurs in surgical cases but seldom, speaking comparatively, unless the osseous tissue is injured.

10th. Osteo-myelitis is sometimes complicated with *leukæmia*, of which I have seen one remarkable instance.

11th. Osteo-myelitis not unfrequently occasions death by *exhaustion*. Of thirty fatal cases of said disease, six died from that cause.

But the closeness of the relationship which exists between suppurative inflammation of the medullary tissue of bone and pyæmia is very remarkable. No such relationship obtains between suppurative inflammation of any other tissue in the whole body and that disease. It is but seldom that we meet with pyæmia in a severe form in military practice, unless it has followed a traumatic lesion of the osseous tissue, or a surgical operation rendered necessary by such lesion. The writer has seen only two cases of pyæmia in military practice which were entirely disconnected with injury of bone, among a large number of instances of that disease.

Now, this question naturally arises, namely: Why is it that purulent infection is very apt to follow after suppurative inflammation involving the medullary tissue of the femur, for example, and almost never occurs in connexion with suppurative inflammation of the muscular and connective tissues of the thigh, unless a lesion of the osseous tissue also is present? In answer to this question it has been suggested, that the patulous condition of the veins in the osseous tissue and the marrow itself occasions the difference. It is believed that the patulous condition of the veins belonging to those tissues facilitates the absorption of the liquor puris, and the contamination of the system at large with a purulent infection.

Treatment of Osteo-Myelitis.—The treatment of this disease must be considered in respect to that which is best

adapted to procure relief from the acute and chronic varieties of it respectively.

1st. The *prophylaxis* and the *hygienic treatment* of osteo-myelitis constitute a subject of very great importance. The chief objects to be accomplished by the prophylactic treatment, in cases of injured bones, are to prevent a simple formative irritation of the marrow from becoming an inflammatory irritation; and if, perchance, the inflammatory process has been excited in the medullary tissue, to prevent it from running into the stage of suppuration; and if, again, suppuration has been established, to prevent it from degenerating into the putrid forms thereof, which are almost certain to induce pyæmia, and thus occasion the death of the subject. The elements of the hygienic treatment of osteo-myelitis consist in placing the patient beyond the reach of certain deleterious influences, which tend to impair the forces of his system and to poison his circulating fluids, and thereby convert a simple into a destructive osteo-myelitis, and finally produce death by pyæmia. The deleterious agencies of which the hygienic or prophylactic treatment takes cognisance, are chiefly foul air, especially the foul air of imperfectly ventilated hospitals, the overcrowding of patients, especially those who are wounded, and want of cleanliness. The principles of the hygienic treatment require that the wounded, especially such of them as have sustained lesions of the osseous tissue from any cause whatever, should not be treated in the wards of imperfectly ventilated hospitals; that it is much preferable to place them in hospital tents; that an air-space of at least twelve hundred cubic feet should be allowed each patient, even in well ventilated hospitals, that have been constructed with special reference to the care of the wounded; that an allowance of less than twelve hundred cubic feet of air-space to each patient (I am speaking of the wounded) amounts practically to overcrowding; that the hospital quarters, utensils, bedding, clothing, etc., and the person and wounds of the patient, should be kept scrupulously clean; and that the patient himself should be kept in a quiet and composed state of mind and body. The air of the ward or apartment in which the wounded are treated should not be allowed to become contaminated with the effluvia arising from suppurating wounds.

To prevent such an occurrence, the ventilating apparatus should be so constructed as to furnish a constant and abundant supply of pure atmospheric air. It should have the capacity of renewing all the air of the ward as often as once in every hour, at least, if necessary, and the supply should be constant and equable.

2d. *Internal Medication.*—Since osteo-myelitis is, for the most part, a disease of debility, the internal treatment should partake of a supporting, tonic, and soothing character. The diet should generally be nourishing and easy of assimilation, and care should be taken that it is sufficient in quantity. It should consist very largely of strong beef-tea, or strong broths made from other forms of animal food. Both the mineral and the vegetable tonics have been found serviceable in this disease. Among the former the ferruginous preparations, such as tinct. ferri muriat., and ferri et potassæ tart., and among the latter quiniæ sulphas, have appeared to be the most useful. The citrate of iron and quinine is a convenient remedy. When the inflammation of the medullary tissue was complicated with a scorbutic taint, as it not unfrequently is in military practice, the tartrate of iron and potassa was administered with very good results. In some cases of this disease which I have seen in military practice, the debility or the depression of the systemic forces has been so great as to require the administration of alcoholic stimulants in the form of ale, porter, wine, milk-punch, etc., together with nutrients and tonics, from the outset of the attack. For the alleviation of pain, which, in both the acute and chronic varieties of this disease, is often very considerable, it has been found necessary to give anodynes, of which the various salts of morphia, especially when administered hypodermically, have proved extremely valuable. The febrile movement which is always present in the acute variety of the disease, oftentimes renders it advisable to prescribe aconite, with febrifuge remedies such as mistura neutralis, spts. mindereri, etc. Stanley recommends that in cases of acute inflammation of the medullary tissue, mercury should be administered internally, "in the view of producing its full influence upon the system." (Op. cit., p. 45.) Now, inasmuch as this affection is one which belongs especially to debilitated subjects, and

is also essentially a disease of debility, the propriety of administering mercury to the extent of ptyalism in its treatment is, to say the least, questionable. I have never seen a case of osteo-myelitis which would, in my opinion, have been benefited by a mercurial course of treatment. On the other hand, it has always seemed to me probable that such a course of medication would have done much harm to the subjects of that disease which have come under my observation. Indeed, I should as soon think of ptyalizing a patient affected with tubercular pneumonia, in order to cure his disease, as to ptyalize the patients affected with osteo-myelitis that have come under my notice. There is, however, one remedy which can often be administered, in the subacute and chronic forms of the disease, with much benefit, and that remedy is the iodide of potassium. It generally proves most serviceable in cases where nocturnal bone-pains are present. In some cases it is necessary to administer large doses of this remedy in order to obtain the relief desired. It is therefore a good plan to give this medicine in increasing doses in all obstinate cases of the disease wherein its administration is indicated.

The *rheumatic*, the *syphilitic*, and the *scrofulous* types of osteo-myelitis, require internal medication appropriate for the removal of the special diathesis upon which the local affection depends.

3d. *Topical Medication.*—The part affected with acute osteo-myelitis should be placed in such a position as does not favor the stagnation of blood in its vessels; that is, it should be placed in an elevated position, and should be kept in a state of perfect rest.

If the severity of the attack be very great, and the patient's strength considerable, it may be advisable to abstract blood locally with leeches or cups. This means of subduing inflammation should not be overlooked, especially when the disease appears in a sthenic form.

In most cases of acute inflammation of the medullary tissue, the ice-dressing can be applied to the diseased part with benefit. Should the ice-dressing prove to be uncomfortable, because of its weight, the cold irrigation can be employed in its stead. Should the cold applications cause the patient to be chilly and

to feel disagreeably, warm applications, such as the warm-water dressing, should be substituted for them; and, generally, the patient's sensations will afford a guide that is sufficiently correct with regard to the use of cold, tepid, or warm applications, in the treatment of the acute variety of this disease.

In the subacute and chronic forms of osteo-myelitis, the tincture of iodine can often be applied to the affected part with marked advantage. It should be applied daily, and over a large extent of surface.

4th. *Operative Medication.*—Incisions into the inflamed soft parts down to the bone may often be advantageously made in treating both the acute and chronic varieties of this disease, for a considerable amount of local depletion is always obtained in this way. Furthermore, they are always required when accumulations of matter (abscesses) are formed, and for the relief of such a condition should be made at an early period—indeed, the earlier the better after the presence of pus is once detected. Osteo-myelitis, when it occurs spontaneously, is very apt to be accompanied by diffuse inflammation of the soft parts, which, to a greater or less extent, masks the real nature of the disease. In all such cases, free incisions carried down to the bone prove decidedly beneficial. They relieve the painful tension of the soft parts immediately, and, at the same time, evacuate any purulent matter which may have collected between the detached periosteum and the bone. Even in cases where the diagnosis is doubtful, and the soft parts are in a state of diffuse inflammation, it is considered justifiable practice to cut down to the bone in order to ascertain the condition of the periosteum, and whether it is detached, and likewise the condition and appearance of the bone, and whether it is necrosed, for by so doing the diagnosis can be settled.

The operation of *trephining* the diseased bone may sometimes be advantageously practised in cases of osteo-myelitis. In that form of chronic inflammation of the medullary tissue, which is called chronic abscess of bone, the evacuation of the purulent matter, and the removal of the diseased tissue by means of this operation, afford the only means of obtaining a cure short of amputation. Thus, *Duverney* states that in two cases where matter was imprisoned in the bony tissue, it was

necessary to perforate with a trephine. (Vide *Traité pratique d'Anatomie Medico-Chirurgicale, par A. Richet, p.* 61. Paris, 1860.) *Hey*, as we have already shown, performed an analogous operation upon the tibia in two instances of abscess of the medullary canal, with a good result in both of them. It also appears that the trephine has sometimes been usefully employed in treating inflammation of the medullary tissue, having a more acute form. *Mr. Abernethy* states in his Surgical Observations, that he has seen several cases of suppuration in the diploë of the cranium, where, the trephine having been applied early, the external table of the skull came away in the crown of the instrument; "the matter was discharged from the medullary part of the bone, and the internal table remained sound and entire, covering the dura mater. Granulations soon arose, and the patients got well with the exfoliation only of a portion of the outer table." (Vide *op. cit.*, Vol. II.; also Stanley on the Bones, p. 59.)

Again, excision of the diseased part by surgical operation, not unfrequently becomes necessary in the treatment of osteo-myelitis involving the bones of the extremities. Thus, of seven cases of that disease reported by *Mr. Stanley*, three were treated successfully by amputation. The arm was amputated in one instance, and the thigh in the other two. One case recovered without the performance of any operation. In it a large part of the tibia exfoliated, and the knee-joint became permanently anchylosed. In this case, also, the pain, which was very great, and the inflammatory fever which ran very high and was accompanied by delirium, were all relieved by the bursting of a large abscess a little below the knee. Could not relief from these distressing symptoms have been obtained at an earlier date by making free incisions? In the remaining three of Mr. Stanley's cases no operation could be practised, and they proved fatal.

Limbs affected with destructive osteo-myelitis may be excised either by amputation or by exarticulation. *Mr. Stanley*, as we have just seen, employed the operation of amputation. *Dr. T. Vallette*, however, finding all his attempts to save patients affected with acute osteo-myelitis following gunshot fracture of the long bones, in the Crimean war, by secondary

amputation, performed in the continuity of the limb, ineffectual, recommended that amputation should be abandoned in the treatment of such cases, and that exarticulation of the diseased bone should be practised in its stead. *Dr. Jules Roux*, at the hospital of St. Mandrier, at Toulon, also found that he could not save his osteo-myelitic patients (they were soldiers who had been wounded in the Italian campaign of 1859) by secondary amputations, and therefore put into practice the recommendation of Vallette. He achieved a remarkable success thereby; for in twenty-two successive cases wherein the operation of exarticulation was performed for osteo-myelitis, no death occurred. Moreover, four of these exarticulations were performed at the hip.

The operation of exarticulation presents the following advantages over amputation performed in the continuity of the diseased bone in cases of osteo-myelitis: 1st. It effects the removal of the whole of the diseased medullary tissue, while amputation in the continuity does not. Now, the inflamed medullary tissue which is left behind in the stump-bone by amputation performed in such cases, proceeds unchecked to the stage of suppuration and ultimately destroys the patient by inducing pyæmia, with about the same certainty that it would if no operation had been performed, of which I have seen at least one remarkable instance, and have had the pathological specimens belonging to the case figured in colors, after nature. 2d. The operation of exarticulation does not expose the medullary tissue to injury; and 3d, A longer stump can be obtained for the patient in this way than by amputation performed in the continuity of the sound part of the limb. The operation of exarticulation has already been performed several times in this city for osteo-myelitis. Thus, *Dr. Weir* has exarticulated the thigh at the hip, for chronic osteo-myelitis of the femur following gunshot fracture with a good result, at St. Luke's Hospital. *Prof. Van Buren* exarticulated the leg at the knee for acute osteo-myelitis of the tibia last March, in private practice, with a good result also; and recently, *Prof. Hamilton* has exarticulated the thigh at the hip, for chronic osteo-myelitis of the femur, at Bellevue Hospital. In this case, the disease occurred spontaneously. The operation was not attended with

shock. The patient did well for a period of two weeks, but ultimately died with symptoms of pyæmia.

Chronic osteo-myelitis involving the stumps of amputated limbs, often produces morbid conditions which require operative interference. For example, it often occasions deep-seated abscesses which demand early and free incision. Furthermore, osteo-myelitis, in its subacute and chronic forms, is very apt to occasion *necrosis of stump-bones.* In most instances belonging to this category, the necrosis is limited to the lower portion of such bones; but occasionally it involves the whole of the shaft up to the superior epiphysis. Many cases of necrosis of stump-bones, produced by osteo-myelitis, were witnessed in our military hospitals during the late war. The operative treatment usually employed consisted in the extraction of the necrosed portion of bone from the stump by surgical means, as soon as it had become detached from the living osseous tissue. For this purpose incisions were made in the end of the stump to such extent and in such directions as might be necessary in order to effect the liberation of the dead bone, which was then generally extracted with necrosis forceps without further difficulty. The result of such cases was almost invariably favorable.

In concluding this memoir, the writer desires to say that it has, in the main, been drawn up in connexion with an extended report on the subject of osteo-myelitis, which he has prepared at the instance of the U. S. Sanitary Commission; and that the clinical observations, pathological investigations, anatomical facts, and arguments upon which the conclusions exhibited in this memoir are founded, are stated at length in said report.

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