OSTEOMYELITIS OF THE STERNUM

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In a previous communication by one of us (Wilensky) the mechanism of acute infection of bone—osteomyelitis—was extensively discussed. The present paper concerns itself with osteomyelitis of the sternum, a rather uncommon form of this disease. The principles of the mechanism of osteomyelitis in general, as previously described, will be incorporated in this communication as it applies to osteomyelitis of the sternum; and the phenomena and extraordinary features of pyogenic infection of the latter bone will be found to be entirely explainable on the essential mechanism described.

The last comprehensive report on osteomyelitis of the sternum is one by Drews and appeared in 1910. Drews was able to collect only 12 cases from the literature up to that time, and reported an additional case from Muller's Clinic. A more thorough search, however, has since brought to light 5 more cases reported prior to 1910 and 2 cases reported since last year, making with the 3 we shall describe, a total of 23 cases reported to date.

Henschen, in Von Bergman and Brun's system, estimates the relative occurrence of osteomyelitis of the sternum as one-third of one per cent. of all forms of osteomyelitis. In the last ten years there have been treated at the Mount Sinai Hospital, 578 cases of osteomyelitis of all kinds and varieties. Among these there were only two cases of osteomyelitis of the sternum; the percentage relation is the same as the estimation of Henschen. At the Brownsville and East New York Hospital, there has been admitted in the last four years 54 cases of osteomyelitis. Among these there has been only one case of osteomyelitis of the sternum; the percentage relation is 1.8 per cent., which is considerably higher and is explainable on the relative shortness of the time interval and the smaller number of cases in the series. The important fact to be noted is that the sternum is one of the bones of the body which is least apt to be involved as a secondary and subsidiary focus in general infections and one in which a thrombo-embolic lesion is least apt to develop into a fixation point.

Henschen estimates the mortality of osteomyelitis of the sternum as 50 per cent. Of the 11 cases we shall note, besides the 13 of Drew's, 3 died and 8 recovered, giving a mortality of 27 per cent.

CASE REPORTS

Case I.—Male; twenty-four years old. Five months before admission to the hospital, the patient had had a bilateral pneumonia. On the tenth day of the pneumonia, a nodule appeared over the upper part of the sternum which soon opened spontaneously and dis-

charged pus. The resulting wound, at approximately the junction of the manubrium and the gladiolus, has been discharging ever since. At the radical operation a partial and local resection of the sternum was done (Doctor Wilensky). The skin around the sinus was excised, and a piece of the gladiolus through which the sinus ran was resected. The sinus went right through the bone. The posterior periosteum and anterior mediastinum was intact. The wound was sutured with a small drain at one end and this was followed by primary union. After healing of the wound, an X-ray picture showed a defect at the junction of the manubrium and the gladiolus. The Wassermann reaction was negative.

CASE II.—Female; thirty-five years old. Five years previously the patient had had typhoid (?) fever. Two years previously an abscess of the thigh was incised and the resulting wound continued to discharge until one month before the present admission to the hospital. Six weeks before the present admission to the hospital, the patient developed a "cold" with pain in the chest. At this time she noticed a lump over the sternum which progressively increased in size. There was no malaise or fever.

It was demonstrated at operation that a large abscess was present over the upper end of the sternum which contained several ounces of pus. On exposing the bone a sinus was found at the right border of the sternum between the first and second ribs, which admitted a fine probe for one-half inch. The abscess cavity was emptied and the sinus was thoroughly curetted. Healing followed. Doctor Moschcowitz operated upon this patient; we are indebted to him for permission to use these notes.

The Widal reaction was negative. The Wassermann reaction was negative. The pus from the abscess contained paratyphoid bacilli B, but agglutination tests with B. typhosus and paratyphoid A and B bacilli were negative in dilutions of 1 to 50 to 1 to 6000. Duodenal contents contained no paratyphoid bacilli. The urine and stools contained no typhoid or paratyphoid bacilli. No tubercle bacilli were found in the pus.

CASE III.—Male, twenty-four years old. Four years before the present admission to the hospital the patient was struck over the sternum while playing football. There was some tenderness over the sternum but no other symptoms and the tenderness subsequently disappeared. Six months later the patient began to have pain over the sternum and an abscess developed which was incised and drained. There have been numerous recurrences of this abscess formation in the last eighteen months.

At the time of admission to the hospital a funnel-shaped sinus was present over the middle of the sternum at approximately its junction with the third costal cartilage. Surrounding this there was an area of inflammation occupying about one-half of the chest wall; an abscess was present.

The abscess was first incised and drained; bare bone was felt at the bottom of the abscess. Two weeks later the radical operation was done (Doctor Wilensky). A sinus was found extending through the sternum into the anterior mediastinum. The second and third costal cartilages were involved in the inflammatory focus. The entire extent of the sternum which was involved in the focus was excised and with it the entire second and third costal cartilages. There was considerable scarring of the posterior periosteum of the sternum, and of the connective tissues of the anterior mediastinum. A brisk hemorrhage from the internal mammary artery was controlled by suture. The resulting wound was packed wide open. Healing took place slowly.

CASE IV.—Six days before admission to the hospital, the patient—a child of eight years was struck in the chest by the elbow of a playmate. On the next day pain was felt in the region of the sternum. Three days later the pain was more severe and the temperature had risen to 103° F.; on the next day the temperature had reached 106° F. and the child became delirious.

At the time of admission, there was a red, tender area over the sternum at the level of the fifth rib. There was some question as to the presence of a pneumonia on the right side; the röntgenographic examination of the lungs was, however, negative. There were 12,000 white blood cells to the cubic millimetre with a differential polymorphonuclear count of 86 per cent. On the second day after admission the general condition of the child

grew rapidly worse. A cultivation of the peripheral blood showed 300 colonies of staphylococcus aureus to the cubic centimetre of blood.

Doctor Klingenstein operated upon this patient. A focus was demonstrated to be present in the body of the sternum at the level of the third rib, which reached over and involved the costo-sternal articulation. There was no perforation into the pleura although the anterior mediastinum was involved.

The child died soon after the operation. There was no post-mortem examination.

CASES FROM THE LITERATURE

CASE V.—Drews' case was in a young adult. The entire manubrium was found lying unattached in the middle of an abscess cavity. There were no blood culture studies; but the pus contained staphylococcus aureus. The patient recovered.

Drews' report contains the following cases from the literature previous to 1910.

CASE VI.—Solomon's case also occurred in a young adult; there was a fatal issue. There were coincident involvement of the right sterno-clavicular joint and pulmonary symptoms. The post-mortem examination showed involvement of the manubrium and the gladiolus to about its middle; a retrosternal abscess in the anterior mediastinum; a right sterno-clavicular suppurative arthritis. No blood culture study was made; but, from the character of the clinical course, a bacteriæmia must have been present.

Sick's cases included the following:

CASE VII.—A nine-year-old boy had an osteomyelitis limited to the body of the sternum between the second and fifth ribs; a perforation was present into the mediastinum. There was a fatal issue. The post-mortem examination showed multiple foci in the femur, radius and lungs. No blood culture studies were reported; undoubtedly, however, a bacteriæmia must have been present at some time.

CASE VIII.—A sixteen-year-old boy had an acute osteomyelitis of the entire body of the sternum with fatal issue. The post-mortem examination showed in addition a fibrinous pericarditis, a bilateral hemorrhagic pleuritis, a liver abscess, and a purulent peritonitis. The manubrium was intact. This is a typical example of a general infection. It is difficult to make out from the published report whether the pericarditis and pleuritis were due to direct extension of the infection by contiguity of tissue or by perforation, or whether they represented metastatic foci. There are no blood culture studies on record.

CASE IX.—A fifteen-year-old girl had an osteomyelitis of the body of the sternum with a subperiosteal abscess. A recovery was made.

CASE X.—A twenty-one-year-old man had an osteomyelitis of the upper part of the body of the sternum with a subperiosteal abscess. There was a secondary focus in the right wrist-joint. A recovery followed.

Neither of the last two cases had blood culture or other bacteriological studies.

CASE XI.—von Tungel's case was referred to by von Bergman: An eighteen-year-old man died five days after the onset of a severe acute general infection. No localizing foci were discovered during life. The post-mortem examination showed multiple hemorrhages in the heart muscle; several bone foci in the femur and acromion and a focus in the lower end of the sternum. No blood culture studies were reported.

CASE XII.—Jochman's case was in a seventeen-year-old boy. The patient died two days after the onset of a fulminant acute general infection. A focus was present involving the sternum and the contiguous portion of one of the ribs; an abscess had developed which had broken through into the anterior mediastinum. No blood culture or other bacteriological studies were reported.

CASE XIII.—Muhlein's case was in a twenty-two-year-old man. An abscess developed in the synchondrosis between the manubrium and the gladiolus. The post-mortem examination showed in addition a lung abscess and a splenic tumor.

CASE XIV.—Korte's case was in a young girl of eighteen years in whom at the post-mortem examination it was demonstrated that a purulent mediastinitis had complicated

an osteomyelitis of the manubrium and gladiolus; a pericarditis was also present. In spite of the fact that there were manifestations of a severe general infection, it seems more probable that the mediastinitis and pericarditis had occurred by direct extension of the focus. No blood culture or other bacteriological studies were reported.

CASE XV.—Albertin's case occurred in a young adult and followed typhus fever. Four other cases developed rib foci after typhus fever. There are insufficient data in the report.

CASE XVI.—von Thiem's case was a twenty-six-year-old woman. The lesion followed the severe exertion of threshing grain. There are insufficient data in the report.

CASE XVII.—Batut's case was a twenty-two-year-old sailor. Three months after typhoid, he noticed a swelling over the sternum at the level of the third and fourth ribs; this was incised and the sternum was curetted; healing followed. Two months later the swelling reappeared and numerous fistulæ formed; these were curetted. New fistulæ appeared near the xiphoid two weeks later which extended to the sternum. The condition was treated conservatively. A more radical operation was contemplated but the patient objected and disappeared from observation. No bacteriological studies were reported.

CASE XVIII.—Vaughn's case was a twenty-six-year-old man. There was no history of trauma and a gradual onset with pain in the chest over the upper part of the sternum. Four days after the onset of symptoms a swelling appeared in the latter location. The swelling was explored on the sixth day: the upper middle portion of the sternum was found to be involved in an osteomyelitic focus; the periosteum was thickened but stripped easily. The anterior cortex and medulla was cleared out as far as the posterior cortex. The anterior mediastinum was not involved. The wound was packed wide open; healing took place and a recovery followed. The sterno-clavicular and sternochondral joints were not involved.

CASE XIX.—Peloquin, Peradon and Vogelin report a case which occurred seventeen months after an attack of paratyphoid fever. Persistent sinuses formed which led to the sternum. Four operative revisions were necessary. Vaccines were used. Finally the patient succumbed to a pleuro-pneumonia. The sputum contained paratyphoid bacilli and streptococci.

CASE XX.—Merchant's case in a forty-one-year-old man. There was a sudden onset with pain in the chest, chill and fever. A general infection was present. A localization occurred over the sternum and seven days after the onset an incision was made over the bone. There was complete involvement of the sternum down to the xiphoid with complete separation of the first and second portions of the gladiolus. On inserting a finger behind the sternum, respiratory movements were felt. Secondary fracture occurred and was due to bone necrosis. Death occurred after sixteen days.

The post-mortem examination showed the following: (1) Right encapsulated empyema; (2) small left pleural effusion; (3) subcutaneous abscesses over the sternum; (4) congestion of the lungs; (5) sequestration of the sternum; (6) suppurative chondro-sternal arthritides; (7) dense adhesions of posterior periosteum to pericardium and mediastinal pleural (no perforation).

CASE XXI.—In Bidwell's case a swelling appeared over the sterno-clavicular joint two weeks before admission which contained pus. This was followed by dyspnœa and a depression formed at the site of the sternal swelling: on the next day there was a discharge of pus from the aspiration opening and the child died four days later. The autopsy showed a pus sac the size of a walnut overlying the upper part of the breast bone; on opening the sac the upper part of the gladiolus and the lower part of the manubrium were found to be absent. The cavity communicated with the left sterno-clavicular joint and with the anterior mediastinum. The umbilical vein was filled with pus. A liver abscess was present also.

CASE XXII.—Koch's case was a thirty-year-old man. There was a sudden onset with epigastric pains and high fever. A diagnosis of pneumonia was made. After nine days the pain localized to the sternum and a fluctuating mass soon appeared over the

ensiform process. This was incised. Two days later another abscess formed near the right breast, which was also incised. From both of these, fistulæ developed. Five weeks after the onset, a radical operation was done. The sternum from the second to the sixth ribs were completely riddled with abscesses, to which the fistulæ extended. The pericardium and the mediastinum were exposed after the removal of the necrosed sternum, and were found to be covered with granulations. The pus contained staphylococci. No blood cultures were reported. The patient recovered.

CASE XXIII.—Janz's case was in a twenty-one-year-old soldier. There was a sudden onset with fever, chill and pain in the chest. A diagnosis of pneumonia was made. Three days later a tender swelling appeared over the sternum. One week after the onset an incision was made over the sternum. After going through the skin, a large amount of pus escaped from the depths at the level of the second and third ribs. The periosteum was thickened. The corpus sterni was intact, but there was a separation of the corpus and the manubrium. There was a large cavity behind the sternum in the anterior mediastinum about the size of a fist. The pericardium was visible at the bottom of the cavity. The pericardium, pleura and lungs were not involved. The sterno-chondral and sterno-clavicular joints were not involved.

CASE XXIV.—Busch's case was in an eighteen-year-old girl. A purulent anterior mediastinitis followed an osteomyelitis of the sternum (manubrium and corpus). Both sterno-clavicular joints were involved and they as well as the manubrium and corpus were resected. A pericarditis was also present.

One year after operation, the patient was presented as a completely recovered case with hardly any change in the shape of the thorax or interference with the stability of the shoulder girdle.

In previous communications the mechanism of bacterial infection in general, and of osteomyelitis in particular, were extensively discussed. As far as these observations apply to osteomyelitis of the sternum, it suffices to summarize them as follows:

The ordinary case of acute osteomyelitis results from a bacteriæmia or general blood infection, the origin of which is in the greatest number of cases obscure. In these cases it is thought that the entry point of the infection must necessarily be some surface (skin or alimentary canal) of the body; in actual practice it is assumed that, with very few exceptions (genito-urinary infections, furuncular infections of the skin, this surface is the mucous membrane lining of the alimentary canal at points where collections of lymph-adenoid tissue are especially prominent (tonsils, especially; Peyer's patches, etc.). At the latter areas a lesion need not necessarily be demonstrable. In a small minority the bacteriæmia or general blood infection accompanies or follows a definite entity such as a pneumonia or a definite focus of infection is present somewhere in the body—phlebitis, post-partum sepsis, a furunculosis, etc.,—to which the bacteriæmia or general blood infection is subsidiary and through which in turn the osteomyelitis originates. One of the cases reported by us here belongs in this latter group, the sternal lesion having followed a paratyphoid infection.

In any case the focus in the sternum is a fixation point to which the bacteria circulating in the blood are attracted; commonly only a single one of these fixation points develops in the sternum. When the number of subsidiary foci which develop following the original bacteriæmia or general blood infection is more than one, some of the fixation points may be located

in other tissues and structures, as for instance, in another bone or joint. Examples of these are to be found among the cases reported herewith. The possibility of any of these subsidiary lesions in turn, forming a point of distribution from which a bacteriæmia of general blood infection may occur and from which subsidiary foci can develop in exactly the same way, were fully discussed on several other occasions by one of us.

The bacteriæmia through which joint infections become established and develop are not always demonstrable. It is well known that these states may be of temporary duration; that they occur during apparent health as well as during disease; that the natural forces of the body are usually amply sufficient to overcome these so promptly that no evidence of their presence is perceptible in any way; and that in exceptional cases, when these protective factors break down, the presence of bacteria in the blood, even for these short periods, is sufficient to infect any locality. While in extraordinary circumstances it may be possible for bacteria to pass through a surface of the body (tonsils, for instance) and multiply in the blood, the available knowledge seems to show that ordinarily bacteria circulating in the blood depend for their existence there primarily upon the presence of an infected thrombus. Then the course of events is one of two: (1) Microscopic pieces of the thrombus carrying a number of living organisms break off and circulate through the blood stream, or isolated organisms growing on the surface of the thrombus, or groups of them in the forms of bacterial emboli, are cast off into the blood stream. In the small minority of these instances in which the natural antibodies are not sufficient to destroy the organisms as fast as they are discharged into the circulation, the infected thrombus-embolus becomes caught into the capillary network of the sternum, and becomes a fixation point and furnishes the initial stage of a focus of osteomyelitis. (2) In addition to the preceding the virulence of the bacteria may be sufficient to enable them to multiply in the blood stream.

The physical characteristics of the infected thrombus-embolus formation (fixation point), the consequent disturbances of the local circulation and its resultant effects on the tissues of the sternum have direct effects on the clinical and pathological anatomical picture.

A fixation point is formed by the arresting or location of a thrombus-embolus at some point of the vascular network of the sternum. The actual point depends more on chance than on anything else, and is decided by the physics of the local bone circulation at the given moment. Various pathological pictures result, depending on the size of the plugged vessel, the relative position of the plug, the powers of vascular anastomosis, etc., in conjunction with the character, virulence, etc., of the bacteria giving rise to the infection. The dominant characteristics of the pathological pictures are: (1) A thromboarteritis or thrombophlebitis; and (2) a necrosis of bone and cartilage cells consequent to the disturbance of circulation. The physical characteristics of the pathological picture depend to the largest extent upon the second factor.

In actual disease the position of fixation points are probably determined

by some kind of local trauma at the given point. This has been extensively referred to on several previous occasions. I include under the general term of trauma all varieties—mechanical and physical trauma, chemical trauma, etc. In clinical experience the cases group themselves into (*a*) those in which there is a distinct history of a definite physical trauma, and (*b*) those in which no such history is elicitable.

The physical basis for the predisposing effect of trauma consists in the tearing of some of the vessels and in a consequent gross or microscopic hæmatoma associated with blocking and slowing of the local circulation at one or more points, this is a fixation point in the sense that any living organisms floating in the circulation can and may be arrested at the point blocked and develop there. Trauma was an important factor in one of the cases reported in this paper.

The sternum—including its three divisions—is composed of delicate cancellous tissue, covered by a thin layer of compact tissue, the latter being thickest in the manubrium between the articular facets for the clavicles. Although preformed in cartilage, the finished structure approximates that of bones which are developed in membrane. Because of this the physical characteristics of the circulation in the sternum is an important factor in the occurrence of foci of infection within the bone.

The blood supply of the sternum does not originate from any single vessel. Numerous vessels derived, form muscular and other branches in the muscles and tissues attached to the sternum or derived from larger trunks nearby—the internal mammary vessels—perforate the three divisions of the sternum and supply it with blood. The vascular network within the sternum resembles that of other flat bones and is of the periosteal type. The extensive anastomosing network in the periosteum of the sternum sends down short branches into the cancellous tissue of the sternum which resemble in their structure and distribution the Sharpey's fibres of the long bones. Apparently there are no end vessels such as one finds towards the avascular areas of the long bones.

Because of these circumstances thrombo-embolic formations occur as one of two manifestations. In the one kind the focus develops between the periosteal membrane and the external compact layer of the sternum. Subperiosteal abscesses result and are quite common; they are illustrated in the cases quoted or reported in this communication. The periosteum of the sternum is very firm and strong and the path of least resistance for the purulent collection is between it and the underlying bone; so that quite frequently the progressive accumulations of pus causes a dissection of the sternal segments from their ensheathing periosteum. This is seen frequently clinically and is illustrated in some of the cases reported herewith in which it is described that one or other of the sternal divisions was found free in a large abscess. As in the bones of the skull the dissection is limited at the synchondroses; any further accumulation results in perforations, in front, into the subcutaneous tissue, and, behind, into the thorax. The segment of

bone lying free in the abscess is deprived of its nourishment by such dissections and necroses.

When the subperiosteal abscesses occur on the anterior aspect of the sternum they have little or no clinical importance. Those occurring on the posterior aspect are important factors in the production of complications peculiar to osteomyelitis of the sternum because of its anatomical position: these complications form determining factors in the extraordinary mortality accompanying acute osteomyelitis of the breast bone.

The chief of these complications are mediastinal, intrapleural and intrapericardial suppurations. Some of these are due to frank perforations of a retrosternal subperiosteal abscess; others are sympathetic processes called forth by the presence of infectious processes in the sternum and its periosteum and are produced by bacterial progression through the lymphatics either into the lymphatic network of the mediastinum or into the lymphatic spaces of the pleural and pericardial sacs. Both varieties are usually accompanied by the clinical signs of a profound infection and are frequently unrecognized either before operation or before their post-mortem demonstration. Except in those cases in which the osteomyelitic foci in the sternum are accompanied by states of bacteriæmia or general blood infection, practically the entire mortality is due to these complications within the interior of the thorax.

In the second variety the focus of infection develops in the cancellous substance of the sternum. A peculiar form of creeping, molecular destruction of the bony texture results which is very difficult to control except by resection of the sternum in healthy tissue. The physical basis for this advancing process was referred to in another communication; this consists in a continual progression of the thrombus-embolus formation in the focus of infection in the cancellous tissue of the sternum because of the extension of the area of venous thrombosis; from the facts at hand and previously referred to this seems to be due to the unchecked bacterial growth in the clotted area.

STATISTICS

Age.—The ages of the patients included in this report are the following:

4 weeks old	1 case	22 years old	2 cases
9 years old	1 case	24 years old	2 cases
15 years old	1 case	26 years old	2 cases
16 years old	1 case	30 years old	2 cases
17 years old	1 case	35 years old	1 case
18 years old	4 cases	41 years old	1 case
21 years old	3 cases	(Age not noted in one case)	

Two-thirds of the cases occurred in patients between the fifteenth and twenty-sixth years. This must have some relation to the period of time in which the various ossification centres are at their maximum activity. Coincident with the full ossification of the sternum and thereafter, the number of cases of osteomyelitis of the sternum decrease rapidly.

Sex.—There were eighteen male patients in this series as opposed to six females. The sex is not noted in one reported case.

Position of Focus.—The distribution of the osteomyelitic process in the sternum was as follows: Manubrium, six times; gladiolus, thirteen times; ensiform process, two times; synchondroses, two times.

In a number of the cases more than one segment of the sternum was involved in the focus of infection. In one case all these segments were involved. The much more frequent involvement of the gladiolus is most probably related to the anatomical peculiarities of the local vascular network and to the arrangement of the various centres of ossification.

Complications.—The most important phenomena of osteomyelitis of the sternum are formed by the characters and numbers of the complicating lesions which are met during the course of the illness. As indicated previously, some of these are due to the anatomical position of the sternum and to the fact that the organs, tissues or spaces in which these complicating foci of infection develop are in direct anatomical relationship with the sternum. The others, in spite of their close anatomical relationship to the sternum, are, undoubtedly, metastatic (subsidiary, secondary) foci of infection in the true sense of the word as previously defined.

In this series of cases the following were the complications which were encountered:

Pneumonia	10 cases	7 died
Pleurisy and pulmonary congestion	1 case	1 died
Pulmonary abscess	3 cases	3 died
Pulmonary and renal infarct	1 case	1 died
Retrosternal abscess	2 cases	
Anterior mediastinitis	10 cases	4 died
Pericarditis	2 cases	1 died
Chondro-sternal involvement	1 case	1 died
Sterno-clavicular joint involvement	3 cases	2 died
Peritonitis	1 case	1 died
Liver abscess	2 cases	2 died
Renal abscess	1 case	1 died
Splenic abscess	1 case	1 died
Prostatic abscess	1 case	

In many of the cases these complicating lesions did not exist as isolated foci but existed in combination with other foci. Under these circumstances, the fatalities which occurred could not be directly imputed to any one of the lesions, but, rather, to a state of infection in which the entire organism partook, and in which the demonstrable foci were, perhaps, incidental factors and could be regarded as expressions of the general infection.

Retrosternal Abscess and Anterior Mediastinitis.—Retrosternal abscess and anterior mediastinitis formed the most common complication encountered. It was difficult sometimes to make the distinction between retrosternal abscess and anterior mediastinitis from the published records of the cases and in some of them, at least, the distinction would disappear in that the inflammatory area could be classified under either or both of these terms. Four of the ten cases classified as anterior mediastinitis died. Some of these were recognized only at the post-mortem examination, and it is possible, had

efficient drainage been instituted at an early period of the disease, that the fatality would have been averted. As indicated previously in this report, both retrosternal abscess and anterior mediastinitis find their origins in the formation of a subperiosteal abscess on the posterior surface of the sternum.

Pneumonia.—Pneumonia formed the next most important complication of osteomyelitis of the sternum. The lesion described is that of a frank consolidation. It is a debatable point whether this lesion was metastatic to the sternal focus of infection, whether it was brought about by a relative immobility of the chest owing to the presence of a focus of infection in the sternum, or whether both of these contributed equally to the pulmonary consolidations. It seems difficult to make an adequate distinction. Pneumonia is apparently a very grave complication; in this series two-thirds of the patients with this complication died.

Pleurisy and Pulmonary Congestion.—The two cases of pleurisy and pulmonary congestion most probably belong with the cases of pneumonia. Both of the patients with this complication died.

Pericarditis.—There were three cases of pericarditis; two of these died. One of the latter was evidently a case of general infection in which the pericarditis was only one of a number of lesions. In the other, there were coincident mediastinitis and pericarditis and the assumption seems justified that the pericarditis occurred by direct extension of the inflammatory area.

These are the more important complications. All of the others listed in the classification are due to the presence of a general infection in which they form metastatic or subsidiary foci. In one of the cases with liver abscess the umbilical vein was found to contain purulent material.

Differential Diagnosis.—The differential diagnosis of osteomyelitis of the sternum is apparently sometimes difficult. The differentiation between osteomyelitis of the sternum and that of the adjacent cartilages or ribs can, on occasion, be an academic one; fortunately in actual practice this is not of much importance. The diagnosis of pneumonia has been made a number of times and the presence of the sternal focus was not recognized until comparatively late, or only at the time of the post-mortem examination. The difficulty can be quite well understood in the extraordinary frequency with which the two conditions coexist. Other conditions—an eroding aneurism, a tumor of the sternum, tuberculosis or syphilis—are conditions to be thought of; these, however, should be easily excluded.

An interesting condition has been described by Ruediger and later by Narat, which the latter calls "xiphoiditis." This should not be confused with true osteomyelitis of the sternum. Xiphoiditis is not an osteomyelitis but, apparently, an isolated perichondritis of the ensiform process, giving rise to tenderness and pain over the xiphoid and to pain in the epigastrium. Narat removed the xiphoid in five cases and microscopic examination showed evidence of chronic periostitis. The pain disappeared spontaneously in some cases; in others it disappeared after the exhibition of salicylates.

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