

Chapter XII

HISTORY OF TREATMENT OF GAS BACILLUS INFECTION WITH X-RAYS

In the foregoing pages, the importance of early diagnosis was emphasized. In the pages which follow, the importance of using the correct procedure for prevention and treatment is emphasized. The treatment of gas bacillus infection has varied from no attempt at therapy to radical débridement, disarticulation and amputation, supplemented during the last quarter-century by serum and other general measures. A brief review of some of the procedures used in treatment in the last hundred years bears out the statement that the disease was a serious problem.

According to Warren,² various surgeons during Civil War days, among them Jones, Keen, Goldsmith and Cleveland, used actual cautery, nitric acid in full strength or solutions of hydrochloric acid. The acid nitrate of mercury and fuming bromine immediately obliterated all gangrenous odor. Warren gives the mortality for all forms of gangrene during the Civil War as 45.6 per cent.

The exact mortality for gas gangrene during the Civil War period cannot be ascertained, because the etiology was unknown and gas gangrene could not be distinguished from other forms of gangrene. The organisms involved in the disease were isolated during the last 10 years of the nineteenth century but were not fully identified until Welch³ and his fellow-workers completed the work about 1900.

With localization of the cause of the disease to a group of organisms of similar characteristics and with increased knowledge of antiseptics, aseptic surgery, bacteriology and anesthesia, the painful and unscientific methods of treatment in use during the Civil War were discontinued.

Despite the fact that the disease had been recognized as a distinct clinical entity since 1900 and advances had been made in surgical technic and serologic measures had been used, treatment remained difficult. A high mortality rate was still the rule throughout the first quarter of the present century. During World War I, serum was used with radical surgical procedures,

of which irrigating the wound with antiseptic and oxidizing fluids (Carrel-Dakin solution) after débridement was the mildest and amputation above the involved tissues the severest but the most effective. With the use of those heroic measures, the mortality rate in the American Expeditionary Forces was 48.52 per cent, but loss of extremities by amputation and disability from muscle stripping was common.

The mortality in 507 cases collected and analyzed in that excellent and much-quoted report by Millar¹ in 1932 was 48.7 per cent. Subsequent to Millar's report, there appeared in American literature several excellent articles by renowned surgeons, teachers in our best institutions, on the combined use of serum and surgery. These reports show an average mortality rate of not less than 35 per cent. They also include data relating to numerous early amputations.

Occasionally, some other special measure was added to surgery and serum therapy during the last 25 years in an effort to lower the mortality and morbidity rates. A review of the literature suggests that the addition of x-rays gives a much better result in every respect than any combination so far employed. The mortality in cases treated by x-rays with limited surgery and with or without serum is 5 to 15 per cent. The variation in the mortality rate depends on the number of x-ray treatments given and the type of case.

EARLY X-RAY THERAPY FOR GAS BACILLUS INFECTION

Full consideration of the x-ray treatment of gas bacillus infection would not be complete without the records of the first six patients treated with x-rays. The observations made in treating these first few patients led to the development of the technical procedures recommended in the first report.¹⁰ No reason for any essential change has yet appeared.

The following review of the first report on the x-ray treatment of gas gangrene is followed by an analysis of all available data which have been submitted to us in writing or have been reported in the literature. From these data, the importance of x-ray therapy in gas bacillus infections should be evident to anyone having a sincere interest in the subject.

Our first experience in treating gas bacillus infection was

the result of unusual circumstances. We saw the patient in consultation with other physicians at the request of Dr. J. R. Dwyer, Staff Surgeon at St. Catherine's Hospital, an affiliated hospital of Creighton University School of Medicine. Our rôle in the consultation concerned the diagnosis as interpreted by the x-ray film, with no thought of using x-ray therapy.

CASE 1.—F. R., a farmer aged 21, entered the hospital Aug. 30, 1928, with an injury below the right knee the day after an automobile accident. Clinically, the infection which followed looked like gas gangrene. Cultures from the wound were positive for *Bacillus welchii* (Dr. Fred Niehaus, pathologist), and x-ray films showed considerable gas in the soft tissues. When we saw the patient with Dr. Dwyer and other consultants the morning after he was admitted, he appeared far beyond the reach of any surgical procedure, was comatose and apparently, as one surgeon expressed it, "regardless of what is done he will die."

It was obviously too late for any attempt at disarticulation at the hip. For want of something better to do, with little thought of influencing the course of the disease, he was given an x-ray treatment late in the forenoon.

Since we had previously treated patients with erysipelas and other acute infections with small doses of x-rays twice each day, we thought we should treat this patient with gas gangrene—a toxic and fulminating disease—twice each day. We returned to the hospital that evening to treat him again. We were surprised to find him alive, but our real surprise came the following morning when we found him sitting up in bed. He had completely recovered from the coma, and his general condition was much better. We treated him twice that day and finished the series of treatments during the next few days. During this time all evidence of the disease disappeared and the tissues improved considerably. Amputation was not necessary. The patient was dismissed after seven weeks of hospitalization.

To say that we were surprised at this outcome would be putting it mildly, especially as the patient recovered complete functional use of all the soft parts which were swollen and badly discolored when x-ray therapy was started. That no amputation was necessary was the most impressive part of the experience, since amputation was considered an essential therapeutic procedure. This one experience suggested that amputation might not be necessary in gas bacillus infection if x-ray therapy were used.

In this first case treated with x-rays, we had proof that x-ray therapy would cause favorable changes in the most important clinical signs and symptoms of such an infection. The patient's temperature, pulse and respiratory rates improved perceptibly

in 24 hours; the progress of the infection was stopped; the leg was not amputated—an important conservation of tissue for this young man; the coma completely disappeared in 24 hours; appetite improved and other signs of lessened toxemia were evident. The fact that his leg was saved and he ultimately recovered after the condition was considered too far advanced for surgical aid is evidence of the ability of x-rays to lessen morbidity and mortality. Although the patient spent seven weeks in the hospital, he undoubtedly would have been there longer if his leg had been amputated. The economic value of x-ray therapy in this instance need not be emphasized.

CASE 2.—J. B., a schoolboy aged 10, entered the hospital on Aug. 24, 1930. He had stepped on a nail which penetrated deeply into the tissues of the left os calcis area. Antitetanus serum was given immediately. Two days later the wound had the appearance and odor of gas gangrene; cultures of the wound were positive for *B. welchii*. X-ray treatments were started after amputation had been strongly advocated by several consultants. The patient improved rapidly and amputation was not necessary. He was dismissed after three weeks' hospitalization.

CASE 3.—In this case, no surgery was necessary except that required to rebuild the stump of the forearm and other minor repair work. K. B., a laborer aged 23, entered the hospital on Nov. 15, 1930, following an injury sustained while blasting with dynamite. Some had exploded prematurely, injuring the face, right arm and left leg; the right hand was missing. The débris on the lower part of the right forearm received surgical attention and tetanus antitoxin was given. Two days later, cultures of the wounds in the left leg area were positive for *B. welchii*. Gas bacillus serum was administered, and x-ray treatments were given the left leg and the stump of the right arm. The patient recovered with no further loss of extremities and was dismissed after five weeks' hospitalization.

CASE 4.—C. H., a merchant aged 42, entered the hospital on Jan. 8, 1931, with the bones of the left leg shattered by a bullet just below the knee. Cultures from the wound showed *B. welchii* infection, and x-ray films showed considerable gas in the soft parts (Fig. 17). Serum was given. The leg was disarticulated at the knee, but the infection progressed up the limb, and all the tissues to the hip were swollen, crepitant and discolored at the time the first x-ray treatment was given. Improvement began with x-ray treatment, and four days later the patient was free from evidence of active gas bacillus infection. He was dismissed after eight weeks' hospitalization.

Case 4 was highly instructive from several points of view. Gas bacillus infection developed, and the patient was immediately

given large doses of serum, injected circularly into the soft parts around the thigh. Despite this, disarticulation at the knee was necessary. The infection then progressed up the limb to the inguinal region. The tissues of the thigh were discolored at the time x-ray treatments were started, after six surgical consultants, including a past commander in an A. E. F. base hospital



FIG. 17.—Case 4. Anteroposterior view of knee area showing injury of bone and gas in soft tissues at time of admission and just before disarticulation which obviously was below the distribution of gas in the soft parts.

in France, had agreed that amputation higher up would be useless. All agreed that the condition seemed hopeless and consented to x-ray therapy only when assured it would do no harm. They scoffed at the idea that it would do any good.

From our point of view, much time had been lost; the infection had progressed and the patient was extremely toxic before

x-ray therapy was ordered. Despite this late start, we were not especially surprised when the toxemia cleared up and he showed clinical improvement. But when the badly damaged tissues of the thigh lost their bluish color and returned to normal and no further amputation or débridement was necessary, there was general surprise.

This was the second case which impressed on us the fact that all tissue discolored as a result of gas bacillus infection is not dead tissue. It strongly suggested that in this type of case débridement should be reserved until after the toxic phase of the disease has passed, at which time one may remove tissue which fails to recover. In this instance, as in our first case, recovery was complete.*

Other lessons learned from this case were the futility of giving large amounts of serum when the serum is evidently for bacteria other than those involved in the infection and also the lack of therapeutic value of disarticulation when the infection has already invaded tissue higher up in the extremity.

Many skeptics who refuse to believe that x-ray therapy is of any value in the treatment of gas gangrene have judged the x-ray film taken early in the course of the disease (Fig. 17) as negative for evidence of gas bacillus infection. They do not hesitate to assert that it is on such cases as this that x-ray therapy bases its claim of therapeutic value. However, this patient had an advanced clinical case at the time we first saw him, many hours after this film had been taken. The culture was positive for *B. welchii*; his leg had been amputated; a large amount of serum had proved ineffective, and the tissues of the thigh were distended with gas and discolored to the inguinal area. Evidence of gas gangrene was so strong that no one questioned the diagnosis or the advisability of amputation to stop the disease. This case came early in our experiences, and we were well pleased when the patient responded to radiation and recovered. Now we would be greatly disappointed if we did not have an opportunity to give x-ray treatments when the disease was no farther advanced than is shown in this film. The patient's leg as well as his life might then have been salvaged.

* We were accustomed to see these areas recover following x-ray therapy until the advent of sulfanilamide. Then, to our dismay, tissues which were in good condition became hopelessly gangrenous when x-rays and sulfanilamide were used simultaneously in treatment. (See section on sulfanilamide.)

CASE 5.—C. H., aged 61, was admitted to the hospital on April 1, 1931, suffering from an injury to the left ankle area in a fall from a tractor. Clinically there appeared to be a gas bacillus infection. The laboratory report showed cultures positive for *B. welchii*. Amputation was immediately performed and serum administered, but apparently the infection was not entirely stopped and a second amputation was performed. After the second amputation, roentgen therapy was ordered. The patient promptly recovered. He was dismissed after six weeks' hospitalization, but lost a leg.

This is another instance in which a poor therapeutic result was obtained by the use of serum and two amputations. The progress of the disease was stopped promptly with x-ray therapy. This patient's age, 61 years, the character of his original injury, the shock of two amputations and the toxic effect of the gas bacillus infection constitute a group of factors which would undoubtedly lead to a fatal outcome in most instances.

CASE 6.—J. F., aged 8, entered the hospital on June 18, 1931, two days after a compound fracture of the left forearm. The laboratory report showed cultures positive for *B. welchii* and x-ray films showed some gas scattered through the soft tissues around the fractured bones. Consultation was called and amputation was advised. The administration of serum and x-rays, at least temporarily, was decided on. The boy immediately improved and amputation was not necessary. He left the hospital after a severe serum reaction.

This case is interesting because the surgeons in charge of the boy were preparing to amputate when others in the hospital persuaded them to try x-ray therapy to save the boy's arm. Although exceedingly reluctant, they finally agreed to postpone amputation until evening to see what x-rays could do.

This was a new experience for them, since they had never heard of the use of the x-ray in treating gas bacillus infection. Therefore they could not be blamed for their anxious attitude while waiting to see what one day's x-ray therapy would do for the youngster. They realized that they were depending on a new measure which had no recognition or status in the literature on the treatment of a serious disease and were thus subjecting themselves to severe criticism if the child died. They were sufficiently satisfied at the end of the day to wait until morning, when the necessity for amputation seemed more remote. By the end of the second day they were surprised and pleased with the outcome and have since that time been among

the strongest advocates we have for x-ray therapy in infections, including acute peritonitis, postoperative parotitis, cellulitis and boils on the upper half of the face.

SUMMARY

In the analysis of these six cases, the following facts are evident: that no aid came to any of these patients as a result of amputation, since amputation and disarticulation failed to check the disease or improve the patients' conditions in any way; that tissue which was apparently definitely involved at the time x-ray therapy was started fully recovered and required no débridement; that all of the patients became steadily worse until x-ray therapy was used; that x-rays definitely controlled the disease in each instance, including the four cases in which amputations were not performed.

One of the greatest sources of worry in the whole series was the delayed serum reaction which occurred in Case 6. It gave all concerned a decided scare, for the boy looked as though he might die.

The conclusion to the first report was as follows:

Furthermore, it is sincerely hoped that the widespread use of the x-rays in many cases will be as generally successful as it has been in the few cases reported here. If so, there will be fewer amputations and transfusions, a lower mortality, and, probably, the use of less serum, which sometimes leads to severe reactions and much discomfort.