

## Appendix

### REVIEW OF THE LITERATURE

About three years after we made our first report on the x-ray treatment of gas gangrene before the Radiological Society of North America in November, 1931, other reports began to appear in the literature. Twenty-five reports have come to our attention up to the present time, including our first two reports. In all, we have made six reports, but we do not include them all in this comment because it might appear that we were padding the number of reports in the literature. Of the 25 reports, 24 have been favorable and one unfavorable to the method.

To aid the reader, brief abstracts of these reports with our analysis and comment are presented here. This section has been added because of the exaggerated importance placed on the one unfavorable report by those who still wish to amputate every extremity which has or may soon have gas bacillus infection. Lately, that group has included those who maintain that chemotherapy is as efficient as x-rays in the prevention or treatment of gas bacillus infection. In our community, we have found only one really efficient means of prevention and treatment, and that is x-ray therapy without amputation, chemotherapy or serum. The following abstracts show that others have had the same experience.

Faust,<sup>9</sup> who has contributed much to this study, reported five cases in January, 1934. Four of these were infections of extremities. All patients received more than five x-ray treatments and received serum, and all recovered. In one case of infection of the trunk gas bacillus infection developed following appendectomy; this patient also recovered.

Turmer<sup>11</sup> reported his experience in treating a young man in whom gas bacillus infection developed following drainage of an infected kidney. The infection was diagnosed 22 hours after operation. X-ray treatment was started as soon as the diagnosis was made, and the patient promptly recovered. Anti-gas serum was also given, and there was a serum reaction on the twelfth post-operative day. Previous experience with gas bacillus infections complicating surgical procedures on abscessed kidneys led

Turner to suspect such a possibility in this case. Early diagnosis and early x-ray treatment offer the patient the best chance of recovery.

In Faust's second report<sup>10</sup> he discussed the cases he formerly reported and added two new ones. The first patient died; the second recovered.

Hanchett<sup>12</sup> discussed a series of cases of gas bacillus infection, two of which he saw personally. In these an extremity was involved, with proved gas bacillus infection. In both cases polyvalent serum was given in addition to x-ray therapy. Late amputation was done in one case owing to the extensive nerve and vessel damage which had produced a useless hand; otherwise recovery in both was complete. The 15 other cases included in Hanchett's report were treated by colleagues in his vicinity. All of these had previously been, or were later, included in reports in the literature.

The deferred or late amputation in one of Hanchett's cases is worthy of special mention. We have maintained for a long time that if amputation is necessary, it may be done after the acute toxic phase of the disease has subsided.

Bates<sup>13</sup> reported five cases involving an extremity in which definite gas bacillus infection was present. X-ray therapy and therapeutic serum (two received prophylactic serum) were given. Amputation was necessary in two cases. The entire group recovered.

Anderson<sup>14</sup> reported a case with involvement of an extremity in which prophylactic polyvalent serum was given and gas bacillus infection developed in 20 hours. Large doses of gas gangrene antitoxin were given in addition to x-ray therapy. The severity of the tissue damage at the time of the accident caused a prolonged convalescence, but the patient made a satisfactory recovery.

Eliason, Erb and Gilbert<sup>15</sup> reported two cases of gas bacillus infection treated with x-rays. The first patient was a diabetic who recovered promptly and left the hospital without the necessity of débridement of the stump. The second patient died of streptococcal septicemia in a week; at death there was no clinical evidence of gas bacillus infection.

Anderson and Wirth<sup>16</sup> reported a second case of gas bacillus infection involving an extremity, developing after the patient

had received prophylactic polyvalent antitoxin. Within 36 hours the infection had spread through the entire arm and into the axilla. X-ray treatment was started, and rapid improvement followed. A definite line of demarcation appeared at the elbow a week later, and a disarticulation was performed at this time. Additional prophylactic x-ray therapy was given to the stump, without recurrence of the infection. Recovery was otherwise uneventful.

This case illustrates well how one may wait until the active, toxic phase of the disease has passed and the line of demarcation is established before performing an amputation. This case was, as far as we know, the earliest in which the line of demarcation was awaited before amputation. Omission of major surgery during the acute toxic phase is one of the most important features of the x-ray treatment of gas bacillus infection. If all patients had been treated as Anderson and Wirth treated theirs, many extremities and many lives would have been saved during the last few years.

Gambill and Cupp<sup>17</sup> reported a case of gas bacillus infection of the upper extremity following severe laceration. The following day, polyvalent serum and a transfusion were given. The toxemia became more marked, and on the third day *Bacillus welchii* was cultured from the wound. There was crepitation in the axilla, anterior and posterior chest walls and neck. A transfusion was again given. On the fourth day of the disease, when the patient was apparently moribund, x-ray therapy was given anteriorly and posteriorly to all areas, followed by another transfusion. The patients started to improve immediately and recovered.

In October, 1938, Faust<sup>18</sup> again reported his success with x-ray therapy in gas bacillus infection. He discussed seven cases, five new and two from a previous report.

One patient had a serum reaction when he seemed to be doing well, and later died. The attending physician attributed death to a combination of shock and reaction to the serum. A serum reaction severe enough to be considered a factor in the patient's death is not common, although we have seen some patients in whom alarming symptoms developed as a result of serum therapy. If patients do as well without serum as with it, and present figures seem to indicate that they do, elimination of serum would be much safer and more economical.

We should like to call attention again to the fact that in no instance and in no series of cases of gas bacillus infection treated with x-rays have we been able to observe any benefit from the administration of serum, and in the diabetic group its use seems to be distinctly harmful.

Charbonnet and Cooper<sup>19</sup> reported 20 cases of gas bacillus infection treated with x-rays with two deaths. One death occurred in an arteriosclerotic patient whose leg was amputated for gangrene. An infection developed postoperatively but was not treated with x-rays until seven days after the amputation. At this time, the patient was moribund and he died six hours later. The other death was in a patient admitted to the hospital seven days after his accident. He was delirious and extremely toxic. He received large therapeutic doses of antitoxin and three x-ray treatments, but died 30 hours later.

This report from the deep South, where gas bacillus infection is not uncommon, was a valuable contribution; the two patients who died hardly permitted fair tests of any method.

After showing exhibits on gas bacillus infection at over a dozen national meetings during the past few years, we are impressed by the fact that the average surgeon in the South is much better informed on gas bacillus infection than the surgeon in the North. The disease is seldom encountered by some surgeons of the North, particularly those in the New England states.

Buchanan<sup>20</sup> reported the case of a patient who received a shotgun discharge in the left thigh. Polyvalent serum was given. Four days later, gas bacillus infection was present from the groin to the knee, and an x-ray treatment was given. Recovery from the infection was prompt, but convalescence was prolonged because of the nature of his injury. The following quotations from an article by Williams and Hartzell<sup>21</sup> are self-explanatory. Since these authors carried on a comparative study of a series of patients with gas bacillus infection treated with and without x-ray therapy over the same period of time, their contribution is extraordinary and valuable.

Table 25 shows a difference of 50 per cent in the mortality rates of the two series. The only fatality among those who had x-ray therapy was in a patient practically moribund when treatment was started and who died seven hours after the first treatment. Gas extended from the foot to the midthorax two and

one-half days after a compound fracture of the foot occurred.

TABLE 25

## COMPARATIVE MORTALITY RATES FOR TREATED AND UNTREATED CASES

No. of traumatic cases complicated by gas gangrene.....	24	
No x-ray therapy.....	12	
Died.....	7	
Mortality.....		58.3%
X-ray therapy.....	12	
Died.....	1	
Mortality.....		8.3%

It has been stated that some patients with gas gangrene recover spontaneously. That may be true, but in the series of twelve traumatic cases complicated by gas gangrene where roentgen ray therapy was not used, seven patients did not recover, four recovered with loss of a leg, and one had a severe flexure-contraction of the arm. In the similar series of patients with gas gangrene who had practically the same treatment together with roentgen therapy, there was only one fatality.

Conclusions: That roentgen therapy is of value as a therapeutic agent has been established beyond a reasonable doubt. How valuable, and to what extent it will replace other forms of therapy remains to be proven when larger series of cases are available for study. At present it is submitted not as a substitution but as an adjunct to the present established forms of treatment. We feel that all cases of gas gangrene should have the benefit of this treatment regardless of what other forms of therapy may be used.

1. A series of 34 consecutive, proven cases of gas gangrene studied at the San Francisco Hospital during the past five years has been analyzed. One-half of the patients received roentgen therapy. These cases have been considered in two groups: (1) traumatic cases complicated by gas gangrene; (2) arteriosclerotic and diabetic gangrene cases complicated by gas gangrene.

2. The mortality rate was 58 per cent in the traumatic group not having roentgen ray therapy, and eight per cent in the traumatic group which did have roentgen ray therapy—a difference of 50 per cent, or six living patients.

3. The uncorrected mortality rate of those patients with arteriosclerotic gangrene complicated by gas gangrene who had roentgen ray therapy is the same as those who did not, namely 100 per cent. However, death was proven to be due to other causes in those who had roentgen ray therapy. In two of the untreated cases the patients died of gas gangrene.

4. The diagnostic criteria were the same in both the treated and untreated cases of gas gangrene.

5. Previous mortality rates of gas gangrene are listed. Mortality rates have hitherto averaged about 50 per cent.

6. The value of roentgen examination in early diagnosis of gas gangrene has been discussed.

Gas gangrene will be seen in this war. Are we to rely on the old methods of treatment when we have in our hands what I am convinced is an enormous improvement on any method of treatment yet suggested? It will be said that the cost is high. If serum is used in the heroic doses that appear to be necessary, the cost will be higher, and the supply of serum possibly inadequate. Even if the cost of each unit were £500 its cost to the nation would be saved if one amputation were made unnecessary.

The vast majority of treatment would have to be given in the forward areas in casualty clearing stations or similar hospitals. In these enlightened days all these hospitals will be lit by electricity. I have enough faith in our electrical engineers to be sure they will be able to evolve a machine capable of delivering the requisite number of r units at an adequate kilovoltage.

Bowen<sup>25</sup> reported the use of x-rays for therapy and prophylaxis for 40 patients at the Eighth Corps Area Hospital, Fort Sam Houston, Texas.

Kennedy's<sup>26</sup> patient was a boy, aged 18, who was injured by a full charge from a shotgun in the left leg just below the knee. He lost his leg because of the injury and responded to a combination of x-ray and sulfanilamide therapy.

Newell<sup>27</sup> discussed the x-ray treatment of a patient in whom gas bacillus infection of the trunk developed following a shot gun injury. The patient was given 10 gr. of sulfanilamide every four hours and x-ray treatments twice daily during the first week. The patient recovered. In discussing Newell's presentation, Hancock reported on the x-ray treatment of a gas bacillus infection in a woman, aged 45, whose right forearm was injured in an automobile accident. She also received a combination of sulfanilamide and x-ray and recovered.

Anderson and Olim<sup>28</sup> made a comparative report of gas bacillus infection cases treated with and without x-ray therapy at John Gaston Hospital, Memphis, Tennessee. Of 63 non-irradiated patients, 43 died, giving a mortality rate of 68 per cent, while of the eight irradiated patients, two died, giving a mortality rate of 25 per cent. Both of the deaths in the radiated group occurred in patients who were moribund when sent to the x-ray department and died a few hours after treatment. Both had general peritonitis.

In the closing discussion, Olim made the following comment:

Those of us who have followed the progress of x-ray therapy of gas gangrene infection in the John Gaston Hospital have been greatly

impressed by the results. It has been particularly gratifying to note that during the first year of an intensive prophylactic campaign aimed at suspicious cases, not a single case of gas infection developed in the x-ray treated group. While reviewing the 71 cases of gas gangrene in the John Gaston Hospital from 1933 to 1939, there were several interesting features noted relative to therapy. It was found that every case which developed gas gangrene after admission to the hospital had received previously a prophylactic injection of gas gangrene serum in the admitting ward. In addition, many of the cases had also received large doses of the serum after admission to the hospital in anticipation of a possible gas infection. Intensive treatment with serum in the developed cases of gas gangrene did not appreciably affect the course of the disease in the majority of instances.

Von Briesen<sup>29</sup> reported on the x-ray treatment of 12 patients with gas bacillus infection. Two of them died, but Von Briesen states that neither received adequate treatment; both had involvement of the trunk, were large men, and only 50 kv. was used. Too low kilovoltage was mentioned as a cause of failure in our first report.

Von Briesen's conclusions were :

- (1) X-radiation is a specific for gas gangrene and erysipelas.
- (2) Early treatment is essential and should be repeated when necessary.
- (3) Prophylactic x-radiation of potentially dangerous infections is cheap and without risk.
- (4) Amputation is not a therapeutic procedure for gas gangrene.

Ham<sup>30</sup> reported on successful treatment of five patients with gas bacillus infection with x-ray therapy. His opening statement is interesting: "At a time when the nation is at war and injuries on a scale previously unknown are likely to occur, the recording of the successful treatment of gas gangrene infection is considered of great importance." In his closing comments Ham stated :

It is not too much to say that those of my colleagues on the staff of the Prince Henry Hospital who were associated with these cases and who carried out the medical and surgical care in such an expert manner have been profoundly impressed by the results, and are convinced of the great value of x-ray therapy. It should be especially noted; first, that all patients have recovered from the infection, and secondly, that in no case has amputation been necessary.

It is gratifying to have internists, surgeons and radiologists in Australia impressed with the effectiveness of x-rays in treating gas bacillus infection. In addition, workers from practically

every state in the Union have contributed to this investigation.

Cantril<sup>5</sup> discussed the value of x-ray therapy in the treatment of gas bacillus infection based on five cases, two of which were reported previously by Anderson. The reports of Cantril's three cases follow:

Case III: H. P., white male 50 years of age, was admitted to the Swedish Hospital, January 9, 1941. Five days prior to admission, he sustained a compound fracture of the right tibia and fibula when hit by a rolling log. At that time the wound was débrided and aligned as well as possible. The patient received sulfanilamide, 90 grains during the first 24 hours after injury, which was changed to neoprontosil intramuscularly on the second day because of vomiting. On the third day he received sulfathiazole 60 grains daily for 2 days until his admission to the hospital. When seen the patient was severely toxic. The entire lower extremity was greatly swollen. There was a laceration at the site of bone extrusion about 2 inches above the ankle through which gas could be expressed. A large laceration at the junction of middle and lower third of left lower extremity anteriorly was surrounded by an area of gangrenous skin over a distance of about 6 inches. Gas was escaping through this break in the skin. Crepitus extended from the ankle to the lower part of the knee. Roentgentherapy was begun on the evening of the patient's admission to the hospital, 5½ days after injury. The entire lower extremity up to the inguinal region was treated 2 to 3 times daily for the first 4 days. The gas was less widespread on the second day after beginning treatment and on the third day was localized around the wound. Thereafter treatment was given twice daily to the leg only and then continued once daily to the leg only, a total duration of treatment over 13 days. Crepitus was absent on the 11th day. Débridement of superficial sloughing skin was done on the 11th day and on the 16th day a more extensive débridement and realigning of the fracture with the insertion of a pin in the os calcis was done. The patient received supportive treatment of multiple blood transfusions during the first 3 days, as well as a total of 90,000 units of gas bacillus antitoxin during the first 3 days. Chemotherapy was begun after negative cultures for gas bacillus were obtained. In this patient cultures of pus from the open wound were positive for gas forming bacilli for 40 days after his admission. Although roentgentherapy was stopped on the 13th day because crepitus was absent, the temperature 100° to 101° by rectum and the general condition excellent. Chlorazine 2 per cent packs were begun on the 17th day which greatly improved the secondary infection and cleaned up the denuded surfaces remarkably well. Dr. LeCocq began the instillation of sulfathiazole solution directly into the wound on the day after the appearance of the negative cultures. After the wound had been cleansed and granulations were appearing Dr. LeCocq then proceeded with the more major orthopedic repair of realignment of fragments and fixation of fragments by pins and plaster. Since that time denuded surfaces have



been grafted and at the present time the patient is convalescing with good likelihood of union.

Case IV: H. M., a white male 24 years of age, was admitted to the Swedish Hospital on February 16, 1941, having sustained a compound comminuted fracture of both bones of the leg 9 days before. This accident occurred in a coal mine in a crushing injury between railroad cars. At the time of admission, the patient was extremely toxic. His temperature was 101°, pulse 112, red blood count 2,200,000 and hemoglobin 42 per cent with white blood count of 19,000. When the cast was split by Dr. Roger Anderson one could see that there was a severe contusion of the lower half of the left leg with necrotic skin and muscle bathed in foul smelling pus. There was a sutured incision extending from the knee on the medial side obliquely across the leg to the junction of upper and middle third. From there on the wound was gaping. There was crepitus extending from the ankle to just below the knee joint anteriorly with boggy pockets both laterally and medially in the calf. The foot was moderately cyanotic with reduced peripheral temperature, and diminished sensation. Clinically this had all the appearance of a gas bacillus infection. During the previous 9 days, before the patient was admitted to the hospital, he had received sulfanilamide.

We began roentgentherapy on the night of his admission and he received roentgen irradiation to the entire lower extremity twice daily for the first 3 days. On the third day, there was more cyanosis and pain in the foot, although the temperature and pulse were coming down. Our original smears and cultures from the wound did not show organisms resembling *B. Welchii* and no gas was produced in cultures. Subsequent cultures also failed to produce gas, yet the clinical appearance gave every indication of being gas infection. The diffuse soft tissue distention by gas is well demonstrated in the roentgenogram of the leg. Smears and cultures were largely productive of streptococci, and for that reason Dr. Anderson began sulfanilamide orally on the third day. Roentgentherapy was continued. On the fifth day, the temperature was normal yet one could elicit crepitus throughout the wound. The cyanosis of the foot was daily more noticeable and accompanied by increasing pain at the ankle. Dr. Anderson amputated below the knee on the ninth day because of the gangrene of the foot. Amputation was done through an area of previous contamination, yet the postoperative course was satisfactory from the point of view of wound infection and the stump remained free from gas infection. Cultures were taken from the deeper portions of the amputated leg and all of these produced abundant amounts of gas in culture. Rabbit inoculation intraperitoneally, killing the animal after 5 minutes and incubating for 12 hours, produced the foamy liver characteristic of gas bacillus. Organisms isolated from the animal were *B. Welchii*.

We were at a loss to explain our negative smears and cultures in this patient during the first 7 days when he was under our care. We

conjectured that his previous course of sulfanilamide during 9 days before he came into the hospital might possibly have altered the infection and thus accounted for our failure to grow gas-forming organisms. That we did obtain virulent *B. Welchii* from the deep pockets of the amputated leg showed us rather that we were not obtaining our cultures from locations representative of the true bacterial invasion.

A dissection of the amputated leg showed a thrombosis of the posterior tibial artery at the ankle and of posterior tibial vein deep in the calf.

Case V: R. T., a white male of about 50 years of age, slipped upon a banana peeling, sustaining a laceration of the scalp. He was admitted to the King County Hospital with scalp lacerations and signs of concussion, and was discharged with directions to have dressings changed in the Out-patient Clinic. He was seen by us in consultation at the King County Hospital 4 days after the injury when he was practically moribund. There was a gas bacillus infection involving the entire scalp, face and neck with gas exuding from the scalp wound. The eyes and nose were closed by the pressure of entrapped gas. The patient received roentgen irradiation by multiple fields to the entire head, neck and upper thorax on the afternoon on which we first saw him. He was then taken to surgery where the sutures were removed from the scalp wound to permit more ready exit of gas. He was also given 2 ampules of therapeutic gas bacillus antitoxin which caused a severe subsequent serum reaction. Since amputation was out of the question we were permitted to continue with roentgen irradiation. The patient was treated by Dr. George Bracher and ourselves on 7 days over a total period of 10 days radiation given twice daily for the first 3 days. Six different fields were used in all to irradiate completely the entire scalp, face, neck and upper thorax. Smear and culture of pus from the scalp wound on the day of admission contained *B. Welchii* and streptococci. The first smear and culture without gas bacillus appeared on the fifth day after beginning roentgen irradiation. Cultures were thereafter free from gas bacilli but contained streptococci. Sulfanilamide was not begun until the ninth day, that is, 4 days after gas bacilli could no longer be demonstrated. Dr. W. E. Watson, the surgical resident, was most cooperative in caring for the wound. It became necessary for him to drain burrowing abscesses under the scalp. A normal temperature was obtained by the 16th day and the patient was discharged on the 31st day with a granulating wound. We feel that this last case is ample evidence that roentgen irradiation should be given to any case of gas bacillus infection regardless of the apparently hopeless situation at the outset.<sup>5</sup>

Cantril's cases illustrate clearly the inability of the sulfonamides to prevent or control gas bacillus infection. Each patient received one of the sulfonamides for several days before they were abandoned and x-ray therapy was started.

All reports that have appeared in the American literature

have been favorable to the use of x-rays for prophylaxis and therapy with the single exception of that of Coleman and Bennett.<sup>31</sup> Of 14 patients with gas bacillus infection treated with x-rays, 10 died, which gives a mortality of 71.3 per cent. Since their report lacks specific clinical details of individual patients and definite data on technic, it is difficult to determine the cause of so many failures in this exceptional series.

One statement in the Coleman and Bennett report should not go unchallenged; otherwise it may do considerable harm: "In the four cases that responded to x-ray, wide opening and amputation resulted in recovery." In the light of our experience, this statement is incredible. In our opinion, amputation during the acute, toxic phase of a gas bacillus infection which is receiving adequate and proper x-ray therapy has never benefited any patient. Furthermore, recovery under such conditions was despite the amputation, not because of it.

Any physician citing the Coleman-Bennett figures may well consider the status of their report in relation to the other 20 odd reports in the literature, totaling several times as many cases. If the entire group of reports is considered, less harm will come from this one exception.

Comparison of Coleman and Bennett's mortality rate of 71.3 per cent with the 10 per cent mortality rate for the 94 post-traumatic cases and 16 per cent mortality for the combined groups of 106 cases contained in the other 20 reports in the literature up to May, 1940, leads one to question the type of patient selected or the method by which they were treated with x-rays.

For a different opinion of the value of x-rays in gas bacillus infection, based on cases seen at Cook County Hospital, Chicago, where Bennett treated most of his patients, the report by Hubeny and McNattin is mentioned here.

Hubeny and McNattin stated:

Gas gangrene—Erysipelas: Two more formidable complications can scarcely be asked for, and yet, with all their devastating aggressiveness, they can be throttled very effectively with irradiation therapy. The only cases we have lost, especially in the series of patients suffering from gas bacillus infection, have been those who have been sent to us in a semi-moribund state, post-operative, with crepitus involving half of their body and temperature of 104-105 degrees F.

Diabetic Gangrene: Diabetic gangrene, secondarily infected, has been

extremely difficult to control, using the usual methods. In fact, amputation is finally resorted to in a high percentage of cases. X-ray therapy in our series has proved remarkably effective, especially in the instances where one, two or three toes and a small portion of the dorsum of the foot is involved. Our data is not extensive enough to present any figures, but it is apparent that x-ray therapy properly applied is a great aid in the treatment of this disease entity.

Conclusions: 1. X-ray therapy has proved its value unquestionably in the treatment of a large number of inflammatory diseases. . . .

3. Some diseases respond so dramatically to x-radiation therapy such as gas gangrene, erysipelas, herpes zoster and certain acute infections that it should be the elective treatment in all instances.

4. From our experience we have learned that the use of x-ray therapy for the treatment of diseases not of a neoplastic nature, does not result in 100% cure in all instances, but the percentage of good results is so high, and the number of patients who have been harmed or made worse by treatment is so low, that one is justified in employing it when there is an occasion to believe it will do some good.<sup>32</sup>

#### CONCLUSION

Many facts of interest and some of importance have developed directly and others indirectly from the 12 year study<sup>33</sup> of the x-ray treatment of gas bacillus infection.

*Direct.*—1. X-rays provide a certain and definite means of prevention and treatment of gas bacillus infection.

2. X-rays have made the use of serum unnecessary as a means of preventing and treating gas bacillus infection. X-rays are effective after serum fails.

3. The cases analyzed suggest that the use of serum may even be harmful to the diabetic in whom a gas bacillus infection develops. This raises the question of whether or not aged patients can withstand any type of serum.

4. X-rays have been used successfully for the prevention of varieties of infection other than from the gas bacilli after injuries.

5. X-rays have removed gas bacillus infection from the class of acute diseases having a high mortality and morbidity in which experimental therapeutic measures are justifiable in man.

6. X-rays have completely eliminated extensive surgery as a means of treating gas bacillus infection during the acute invasive stage. Any surgery indicated by the initial injury or disease should be performed, but no surgery directed toward

treatment of the infection itself is required, with the occasional exception of a few incisions to relieve local tension caused by deep gas pockets or collected serum. Amputation and extensive débridement are obsolete procedures in the toxic stage of the disease and have been practically eliminated after the disease has subsided because they are seldom necessary. They should never be necessary if treatment is started early and has been properly given.

*Indirect.*—1. The study has been a factor in the promotion of the general use of x-ray therapy at the bedside for inflammatory disease with an apparatus of adequate kilovoltage.

2. Owing to the similarity of organisms involved in gas bacillus infection and acute spreading peritonitis, x-rays have been used in peritonitis with excellent results. Further investigation of this procedure is indicated.

3. Clear evidence has been obtained that x-rays and sulfanilamide therapy should not be combined in acute inflammatory processes. Prior to use of the sulfonamides, x-rays were able to halt the progress of the gangrene-forming infections in practically all instances, but when the two agents are combined, the destruction of tissue continues; in fact, it seems accelerated.

4. The curative action of x-rays in gas gangrene established beyond doubt the fact that they are of value in treating infections, since the gas bacillus infections are uniformly resistant to other treatment but respond consistently well to x-ray therapy.

5. The antitoxic effect of x-rays in acute infections is amply demonstrated in treating gas bacillus infection, acute spreading peritonitis, postoperative parotitis, erysipelas and other toxic, acute infections. This general reaction as well as the favorable local effect were recognized by many clinicians long before gas bacillus infection was treated with x-rays, but because other measures sometimes had the same effect, it was difficult to establish the value of the x-rays in this regard. However, as the late Willis Manges pointed out to us, the effect of x-rays in gas bacillus infection is unparalleled by that of any other measure, and this has placed the use of x-rays in treating certain acute, toxic infections well above reasonable criticism. This antitoxic effect is apparently nonspecific, and in this way resembles its nonspecific action in preventing peritonitis after colon and rectal surgery; this was reported by the Henry Ford Hospital group.<sup>34</sup>

X-rays should be used early in the disease but will lead to cure in many cases of gas bacillus infection when started in the late stages with little or no danger to the patient. At the same time they will provide for maximal tissue recovery. They will also prevent the disease. If a means of treatment is discovered which will do more, it should be used. Meanwhile x-ray therapy is indicated for man, and experimental measures should be confined to the usual well recognized experimental channels.

Sulfanilamide and its early derivatives are definitely incompatible with x-ray therapy. We know nothing about the later derivatives but at present we do not give x-ray therapy when they are used. If they must be administered they should be given alone until more observations have been completed.

No harm has ever come from x-ray therapy alone as recommended for use in the treatment of acute fulminating infections.

#### LIST OF CONTRIBUTORS

	CASES
Allen, Lewis, Kansas City, Kan.....	1
Allison, R. G., Minneapolis, Minn.....	1
*Anderson, Roger, Swedish Hospital, Seattle, Wash.....	2
Anderson, W. K., Saginaw, Mich.....	3
Archer, Vincent, University of Virginia, Charlottesville.....	2
Baird, L. W., and Stevenson, C. A., Temple, Tex.....	1
Baker, E. C., Youngstown Hospital, Youngstown, O.....	2
Ball, C. F., and Southworth, J. D., Rutland, Vt.....	1
Baptist Hospital, Alexandria, La.....	2
Barnett, A. F., Eugene, Ore.....	2
*Bates, M. T., and Fordyce, F. W., Des Moines Clinic, Des Moines, Ia....	5
Baumgartner, M. M., Janesville, Wis.....	1
Beckstrand, G., Longbeach, Calif.....	2
Bliss, R. W., El Paso, Tex.....	2
Bouslog, J., Denver, Colo.....	5
*Bowen, A. A., Houston, Tex.....	2
Brittain, O. R., Salina, Kan.....	1
*Buchanan, J. C., Winnsboro, S. C.....	1
Bullitt, J., San Jose, Calif.....	5
Burns, Sister Rita, Australia.....	4
*Cantril, S. T., Seattle, Wash.....	2
Carlson, E., San Francisco, Calif.....	1
Carrell-Girard Clinic, Dallas, Tex.....	1
Carter, R. A., Los Angeles, Calif.....	1
Case, J. T., Chicago, Ill.....	1
Chance, H. C., Cumberland, Tenn.....	1
*Charbonnet, L. S., and Cooper, R. W., New Orleans, La.....	20
Childs, D. M., Syracuse, N. Y.....	1
Cleghorn, C. D., Miami, Fla.....	3
Clement, Gage, Duluth, Minn.....	4
Cogley, J. P., Council Bluffs, Iowa.....	9

\*Cases have been reported in the literature.

Condon and Newell, C. H., Omaha, Neb.....	2
Connolly, E. A., and O'Hearn, J. J., Omaha, Neb.....	1
Cooley, R. M., Mercy Hospital, Jackson, Mich.....	1
Crockett, R. H., San Antonio, Tex.....	1
Cushway, B. C., Chicago, Ill.....	2
Dann, D. S., Kansas City, Mo.....	13
Debbie, A. G., Valhalla, N. Y.....	1
Desjardins, A., Wilkes Barre, Pa.....	1
Donaldson, S. W., Ann Arbor, Mich.....	1
Downing, J. E., Omaha, Neb.....	1
Duckworth, W. D., White Plains, N. Y.....	2
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Martin, F. V., Michigan City, Ind.....	2
Merritt, E. A., and Lattman, I., Washington, D. C.....	3
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Queens Hospital, Jamaica, Long Island.....	3
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Richards, Chas., San Jose, Calif.....	2
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Snow, Wm., New York City.....	1
Sorrell, L. E., Birmingham, Ala.....	1
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Stevens, R. H., Detroit, Mich.....	1
Stueck, A. F., Manitowoc, Wis.....	3
Swearingen, F. C., Pomona, Calif.....	1
Tampa Municipal Hospital, Tampa, Fla.....	1
Tennis, M. N., Fall River, Mass.....	1
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