ULTRAVIOLET IRRADIATION OF AUTOTRANSFUSED BLOOD IN THE TREATMENT OF PUERPERAL SEPSIS

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AFTER seven years of clinical research, several physicians in various parts of the United States compiled clinical evidence on a treatment for pyogenic infections that, to date, has not been widely published. These men co-operated and exhibited their findings in the scientific exhibits' section of the American Medical Association Convention held in New York in June, 1940. The exhibit dealt with the treatment of pyogenic infections by the irradiation of autotransfused blood with ultraviolet rays, known as hemo-irradiation therapy.

This paper will deal only with the treatment of puerperal sepsis by that method, giving a description of the procedure and rationale as well as brief comment on other therapeutic measures used and clinical responses noted. The thirteen charts and histories here cited formed a part of the New York exhibit; they represent the total number of cases of puerperal sepsis treated at the Shadyside Hospital, Pittsburgh, Pa. from July, 1937, through May, 1940. Two of these patients were delivered at home and brought into the hospital later. From June 1, 1937, to May 31, 1940, we had 2,486 obstetrical patients delivered. It is significant that since the establishment in July, 1937, of hemo-irradiation therapy, and for the period of time covered by this paper, no deaths have occurred in our institution from puerperal sepsis, one case recovering promptly with sulfanilamide therapy alone.

In April of 1937, we had in our service the second fatal case within a year of beta-hemolytic streptococcus blood stream infection. This case ended fatally, despite intensive therapy with prontisil and pron-
potentialities have been discussed in certain basic texts and monographs; to give only a partial list, Bragg, Clark, Ellis and Wells, Krusen, Laurens, Mayer, Rahn, Schneider, Herman and Sperti and Steel.

The rationale of hemo-irradiation is based on the following accepted facts on the biochemical action of ultraviolet rays. A listing of all the data that contribute to the rationale of this procedure is prohibited by space. It is desirable, however, to list a few of the factors that influenced the application of ultraviolet rays directly to the blood stream: (1) Activation of sterols into vitamin D; (2) inactivation of toxins and viruses; (3) increased cell permeability; (4) destruction and inactivation of bacteria; (5) absorption of ultraviolet by the blood and emanation of secondary radiations; (6) increased oxygen combining power of the blood; (7) presence of measurable amounts of ultraviolet in normal blood, and the deficiency of such in toxic and septic cases, malignancy and the

We have given approximately 3,000 blood irradiations and have not had any detrimental reactions, but have observed clinical manifestations of the foregoing references. In about 4,000 blood counts taken on treated patients there have been no signs of destructive action on either white or red cells. The tendency of blood irradiation seems to be to raise the red cell count and hemoglobin. An increase of 1,200,000 in red count has been observed overnight. If the count is not increased, it is noticeable that it has been maintained, even through severe infections, including hemolytic streptococcus in the blood stream. The white cell count tends to balance; i.e., the high counts decrease and the low counts increase. In most all instances treatment was followed by a sharp reduction in temperature. If septic temperature continued, the charts show a decrease by lysis. The extreme toxic conditions found in many patients were generally relieved after irradiation, and clinical improvement noted. The need for blood transfusions was definitely reduced.

In the cases of puerperal sepsis being presented, the charts and histories show that blood irradiation therapy was not instituted in some instances until other treatment was not accomplishing desired results. In six cases sulfanilamide was administered but was discontinued in favor of hemo-irradiation. Five patients received transfusions of donor blood. Three of the patients receiving sulfanilamide are counted as receiving donor transfusions. Six patients of the thirteen had only hemo-irradiation therapy.

**CASE REPORTS**

**CASE I.** No. 76081, Mrs. M., age forty-one, a negro, was admitted on November 21, 1938 and discharged on December 23, 1938. This patient was referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis).

The patient, para II, was admitted November 21, 1938 for delivery. Temperature, pulse, and respirations were normal. Routine urinalysis was negative. On November 23, red cell count was 3,980,000, hemoglobin 70 per cent, white cells 10,100—90 per cent neutrophiles. Because of cessation of labor pains by this time plus the onset of fever to 102.4°F, consultation was held and a Porro cesarean section performed because of a fibromyoma present in the cervical region. The diagnosis from the tissue examination showed acute septic endometritis and metritis. Sulfanilamide was started immediately and continued for four days or until November 28, inclusive, in doses of 100 gr. the first day and 60 gr. for the next three days. Despite this therapy her temperature reached 104.8°F. by November 28. The sulfanilamide therapy was stopped, and blood irradiation therapy instituted.

Her temperature gradually receded until December 4, with marked improvement in her general condition. There was a gradual rise in temperature during the next two days, reaching a peak of 101.4°F. on December 6. At this time another blood irradiation treatment was given. From this point on she made an uneventful convalescence, being discharged from the hospital on December 23, 1938 in apparently good condition.

**CASE II.** No. 70154, Mrs. Z., age twenty-seven, white, was admitted on November 10,
1937 and discharged on December 18, 1937. She had been referred by Dr. W. G. Thompson. The diagnosis was puerperal sepsis (acute septic endometritis and parametritis).

The patient had a chill and the temperature reached 105°F. A soft, tender, non-involuting uterus was present with marked tenderness on pressure over both lower quadrants. The lochia was very offensive. A diagnosis of acute septic endometritis and parametritis was made. Blood cultures taken December 1 and December 5 were negative. This temperature varied from 105 to 101°F. with daily chills until December 6. On the same day blood irradiation therapy was instituted. Her condition was somewhat improved on December 7 and was markedly improved by December 8. This improvement continued uneventfully, and the patient was discharged from the hospital in good condition on December 18, 1937, twelve days after blood irradiation. She was in good health six months later.

Case III. No. 67895, Mrs. C., age thirty-four, white, was admitted on July 3, 1937 and discharged on July 31, 1937. She had...
been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis and parametritis).

The patient, para VII, admitted on July 3, complained of fever, burning pelvic pain, and gave a history of delivery June 30, (four days previous). Soon after delivery the patient noticed marked pain and tenderness throughout pelvis and lower portion of the abdomen, and in view of the foul smelling lochia with blood clots noted in the physical examination a diagnosis was made of an acute suppurative endometritis and parametritis. On the day of admission Dakinization of the uterus was done. Cervical culture showed staphylococcus. However, the patient continued to run a high septic clinical course with marked toxemia, her temperature ranging between 101.4 and 105°F. for a period of six days. Blood cultures taken July 3 and July 8 proved negative. Routine urinalysis was negative July 6.

On the seventh day of hospitalization blood irradiation therapy was instituted, and at the end of thirty-six hours the patient seemed markedly improved. The next few days her red cell count varied between 2,040,000 and 2,540,000; her hemoglobin between 45 and 75 per cent; and her white cell count between 8,450 and 15,300. Despite her apparent clinical improvement the patient continued to run a temperature varying between 98.4 and 103.4°F. for the next six days, and on the seventh day following irradiation therapy reached 104.6°F. with chills at this time July 16. On July 17, blood irradiation therapy was repeated. The patient improved markedly in twenty-four hours and except for a rise to 102.2°F. on July 29, 1937 convalesced uneventfully and was discharged July 31, 1937.

Case IV. No. 70571, Mrs. H., age twenty-one, white, was admitted on December 16, 1937 and discharged on January 17, 1938. She had been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis acute pyelitis).

This patient, para II, was admitted December 16, for cesarean section because of a history of an extremely difficult labor fourteen months previously. Temperature, pulse and respirations were normal on admission. Following cesarean section the day of admission the patient began to have chills and run a septic temperature ranging between 100 and 103.2°F. On December 17 x-ray examination of the chest was negative. A persistent pyuria with right-sided kidney distress later accompanied by left-sided kidney distress persisted with chills for the next week; likewise, an aching, tender sensation in the uterus continued present for about a week. Blood counts were as listed above. The lochia never became offensive. The patient became extremely septic. Blood cultures taken December 17 and December 23 were negative. A diagnosis of acute pyelitis, bilateral, and acute septic endometritis was made.

Fig. 5. Case v. No. 78191—Temperature graph.
by her attending physician and consultants. A transfusion was given of 1,000 cm. of blood on December 18.

On December 24 with a temperature reaching 103.4° F., pulse 120 to 130, respirations 28 to 32, blood irradiation therapy was instituted. There was a slight rise of temperature to 103.8° F. The patient at this time was quite toxic and considered in a desperate condition. Her subsequent course as shown by the temperature graph was steady improvement until she was discharged on January 17, 1938, the thirty-fourth postpartum day, in good condition. She has remained in good health since her discharge.

CASE V. No. 78191, Mrs. S., age twenty-six, white, was admitted on April 8, 1939 and discharged on July 2, 1939. She had been referred by Dr. J. McComb. The diagnosis was puerperal sepsis (acute septic endometritis with cul-de-sac abscess; septicemia—non-hemolytic streptococcus).

Mrs. S. was aged twenty-six, para I, had a normal delivery April 9. Within twenty-four hours she developed chills with excursion of temperature to 104°F. degrees, pulse 130, respirations 22. Culture from the cervix at this time showed non-hemolytic streptococcus. A diagnosis of acute septic endometritis was made because of a tender, slow involuting uterus with offensive lochia; likewise, a diagnosis of dementia praecox was made by the neurological department. Blood cultures taken on April 10 and April 12 were negative. The blood cultures taken April 19, April 20, and April 22 were positive for non-hemolytic streptococcus gamma type. She received sulfanilamide therapy, averaging 60 to 120 gr. daily from April 10 to April 20. Blood irradiation treatments were given April 21, April 27, and May 24. Subsequent blood cultures on April 23, April 25, April 26, April 27, April 29, May 1, May 3, May 4, May 9, May 15, May 18 were all negative. On the twenty-eighth postpartum day, abscesses in the right vaginal wall near the introitus and the cul-de-sac were incised. Contaminating organisms only showed on culture. On the thirty-third postpartum day, an abscess appeared over the left scapular region; this was incised and pus, culturing non-hemolytic gamma streptococcus, was obtained. There was a tendency to further excursion of temperature on the forty-fifth postpartum day, and another blood irradiation treatment was given at this time. Her subsequent progress has been uneventful surgically. This case was complicated by dementia praecox of the manic type. She was discharged from the hospital on August 2, 1939 in good condition, having been treated for her mental condition by “shock” therapy upon recovery from the obstetrical complication, June 4, 1939. The patient was last seen in October, 1940, at which time she seemed in good health and, while still under treatment by the neurological department for dementia praecox, was considered as making excellent progress from the latter illness.

CASE VI. No. 83568, Mrs. M., age twenty-three, white, was admitted on March 8, 1940 and discharged on March 25, 1940. She had been referred by Dr. J. R. Glassburn. The diagnosis was puerperal sepsis (acute septic endometritis).

The patient, para I, was admitted in labor March 8, and was delivered a few hours later on the same day. Low forceps were used and an episiotomy was done. The patient left the delivery room in apparently good condition. Her first four postpartum days were uneventful, but on the fifth postpartum day, March 13, 1940 the patient had a large emesis and complained of pain in the lower portion of the abdomen followed by a chill with a rise in temperature to 103.2°F. Her offensive lochia cultured indifferent streptococcus. Blood cultures taken March 14, 15, 16, 17, 18, 19, and 22 were all negative. The following day her temperature rose to 105°F.; general toxic symptoms developed. Blood irradiation therapy was instituted. The following day the patient’s temperature rose to 105.2°F. Forty-two hours after blood irradiation her temperature fell to 100°F.; her blood count taken the previous day proved to be 2,870,000—red blood cells, 10.2 Gm.—hemoglobin. A 500 cm. transfusion was given. The patient throughout this day appeared markedly improved in every respect. On the seventeenth she showed a rise in temperature to 102.8°F. which fell the following morning to 99. From this point on the patient convalesced uneventfully and was discharged March 25 in apparently good health.

CASE VII. No. 73574, Mrs. B., age twenty, a negro, was admitted on June 28, 1938 and discharged on July 10, 1938. She had been referred by Dr. P. D. Bier. The diagnosis was puerperal sepsis (acute septic endometritis).

This patient, para IV, was admitted June 28, with normal temperature, pulse and respira-
African Journal of Surgery

Rebbeck—Puerperal Sepsis

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She was delivered on June 30, with a left occipito-anterior presentation. Routine urinalysis was negative June 28. On July 2, the patient had a large piece of placental tissue removed, followed by a discharge of sanguineous, offensive smelling lochia. The uterus was tender to palpation. A diagnosis of acute septic endometritis was made. Following this day her temperature rose to 102.8°F. The following day her temperature rose to 104°F.; this was accompanied by frequent chills and a weak, thready pulse. Blood culture taken at this time, July 3, was positive for Staphylococcus albus, probably contamination. Blood culture taken July 6, was negative. Routine blood count revealed a red count of 2,570,000; hemoglobin 55 per cent, and white cell count 14,200.

The temperature rise and chills persisted on the following day, July 4, and on July 5 blood irradiation therapy was instituted. The day following irradiation, July 6, the patient was generally unimproved with her temperature rising to 103.4°F. Blood culture taken on this day was negative. However, her temperature began to fall on July 7, and the condition improved markedly. She progressed rapidly and uneventfully for the next three days leaving the hospital July 10, 1938 in good condition, five days after her one blood irradiation.

CASE VIII. No. 82783, Mrs. M., age twenty, white, was admitted on January 21, 1940 and discharged on February 4, 1940. She had been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis).

The patient, para II, was admitted on January 21, in labor and was delivered the same day. Delivery was normal. During the second stage lacerations occurred which were repaired. Temperature, pulse and respirations were normal on admission. The same day following delivery her temperature rose to 101.4°F. This rose the first postpartum day to...
102.4°F; the next day to 103.4°F, on the third day to 104°F. Cervical and vaginal blood cultures taken on January 24, showed staphylococcus albus. The uterus was tender to palpation, and a diagnosis of acute septic endometritis was made.

On January 25 blood irradiation therapy was instituted. Her temperature fell the following day to 98°F. Marked improvement in the clinical condition was noted, but forty-eight hours after blood irradiation the temperature rose to 102.8°F. Temperature dropped the following day to 98.8°F. and slowly subsided. The patient improved clinically with subsidence in temperature and convalesced uneventfully until the day she was discharged in apparently good health on February 4, 1940.

Case XI. No. 75988, Mrs. K., age twenty-one, a negro, was admitted on November 11, 1938 and discharged on December 6, 1938. She had been referred by Dr. J. P. McComb and Dr. P. D. Bier. The diagnosis was puerperal sepsis (acute septic endometritis).

This patient, para II, was admitted at term with a history of previous cesarean section done in 1932. Cesarean section was done again with delivery of a normal infant. Starting on the day of delivery, November 15, and lasting until November 23 a temperature ranging between 100 and 103°F. persisted. There was persistent tenderness in the uterine region with more than normal vaginal bleeding but no offensive lochia. On November 23 blood irradiation was done, and thirty-six hours later her temperature fell to 99.4°F. There was no evidence at the time of irradiation that the wound was infected, but two days later, November 25, purulent drainage began. Temperature in the meantime had receded and the patient's general condition was greatly improved. No blood cultures or blood counts were taken. Two specimens of urine showed no gross abnormalities. The patient's progress was uneventful after the
irradiation. She was discharged in good condition on the twenty-second postpartum day.

**Case XI.** No. 83450, Mrs. B., age twenty-eight, white, was admitted on February 29, 1940 and discharged on March 20, 1940. She had been referred by Dr. E. C. Niebaum. The diagnosis was puerperal sepsis (acute septic endometritis).

This patient, para 1, was admitted in labor on February 29, and on March 2, was delivered of seven-month-old twins; manual removal of the placenta was necessary. Her general condition remained good despite occasional temperature rises from 100 to 102°F. on the first eight postpartum days. Because of fever sulfanilamide averaging from 80 to 120 gr. daily was given from March 8, to March 12, inclusive. However, on March 11 her temperature rose to 102.6°F., following a chill lasting twenty minutes. The uterus was in the pelvis but had been moderately tender for several days. Lochia was serosa but accompanied by many small blood clots, no odor. The breasts were not engorged and there was no kidney tenderness. This temperature continued to rise and on March 12 rose to 103.4°F., on March 13 to 104°F., the white count was 24,000 and the patient became increasingly toxic.

On March 14 when her temperature had not fallen below 102°F. for two days, the patient was given blood irradiation therapy. This was followed by a chill. The temperature dropped to 97.6°F., and rose again the following day to 104°F. The day following blood irradiation, March 15, a blood transfusion of 500 cm. was given. Forty-eight hours after blood irradiation the patient's temperature fell to normal ranges; her toxic symptoms had disappeared. Blood cultures taken March 14, 15, 16, 17, and 18 proved to be negative. She convalesced uneventfully and was discharged March 20, 1940.

**Case XII.** No. 78845, Mrs. S., age thirty-three, white, was admitted on May 20, 1939 and discharged on June 20, 1939. She had been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis).

The patient, para 1, was delivered of a full term fetus, left occipito-anterior presentation, on May 22, after approximately forty-eight hours of labor, using mid-forceps. During the first week postpartum she ran a septic temperature which gradually increased to a peak of 102.2°F. by the seventh day. Sulfanilamide therapy was instituted beginning with gr. 40 the first dose, followed by gr. 10, four hourly thereafter for five days. Urine examination on the fifth postpartum day showed a moderate number of red cells, many white cells, otherwise not remarkable. Specimen of urine the seventh postpartum day showed moderate red cells, many white cells. Neither of these specimens was catheterized. Catheterized specimen on the fourteenth postpartum day showed occasional red cells and few white cells. The patient presented no complaints. Involution of uterus and vaginal discharge showed a normal course; breasts presented no pathological condition. On the sixth postpartum day a rather severe diarrhea occurred, persistent for forty-eight hours. On the twelfth and thirteenth postpartum days genitalia were quite tender with some edema. Temperature ranged with peaks gradually coming down to 100°F. until the twelfth postpartum day when without other symptoms the fever began to rise, reaching 103.4°F. on the fifteenth postpartum day, at which time a diagnosis of acute septic endometritis was made. Sulfanilamide therapy was discontinued on the twelfth postpartum day.

Blood irradiation therapy was instituted on the seventeenth postpartum day, from which time with exception of one excursion to 102.6°F. on the twenty-first postpartum day convalescence progressed uneventfully. The patient was discharged on the twenty-ninth postpartum day in good condition.

**Case XIII.** No. 77357, Mrs. D., age twenty-eight, white, was admitted on February 16, 1939 and discharged on April 23, 1939. She had been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis with pneumonic abscesses in cul-de-sac and left pelvic brim; lobar pneumonia).
The patient, para II, was admitted to the Shadyside Hospital on February 16, diagnosis left occipito-anterior presentation at term. She was delivered of both infant and placenta on the same day—a normal delivery. Her admission temperature was 102.8°F., pulse 120, respirations 22. A urinalysis showed occasional white blood cells, no red cells, moderate number epithelial cells, few bacteria; and subsequent examinations included faint traces of albumen, occasional red cells, many white cells, no casts. A septic temperature with peaks of 104.4°F. persisted, and on the fourth postpartum day blood irradiation therapy was instituted. There was a slight improvement in temperature and general condition for the next three days. By the eighth postpartum day temperature again neared the 104°F. mark. Blood irradiation therapy was again instituted. During these days there was considerable abdominal distention with acute dilatation of the stomach, necessitating continuous gastric lavage, and the patient’s pulse ranged between 100 and 136. She was moderately toxic. Her blood counts were as shown on the accompanying graphs. Blood cultures taken February 18, February 20, February 24 were all negative.

By the eighth postpartum day diagnosis of pneumonia involving the right lower lobe was made; no sputum, however, was typed. Pitting edema of both ankles developed. Following the irradiation on the eighth postpartum day there was temporary improvement in her general condition with moderate subsidence of fever. She persisted in this edema of the ankles. The pneumonia was apparently gone by the fourteenth postpartum day.

Periodic distention of the abdomen with rather marked tenderness across the lower portion and peaks of temperature to 102.8°F., pulse to 130 persisted until the twenty-second postpartum day when a diagnosis of abscess of the cul-de-sac was made and incision and drainage instituted plus 500 cm. of transfused blood. The patient’s toxic symptoms became much more pronounced as well as periodic abdominal distention with marked pain and tenderness in the lower portion of the abdomen. Blood irradiation therapy was again performed on March 16, the twenty-eighth postpartum day, with no appreciable effect as far as improvement. By the thirty-third postpartum day it was decided after consultation that further drainage of the pelvis was necessary. With the preparation of 500 cm. of transfused blood a pelvic laparotomy was performed; an abscess was encountered with extensive involvement of the left pelvis. This was followed by another transfusion of 500 cm. of blood.

Despite the transfusions the patient continued desperately ill with high fever, and another blood irradiation treatment was given on the thirty-fourth postpartum day, March 22, when the temperature was 104°F., pulse over 160. Forty-five gr. of sulfapyridine were given in two doses prior to irradiation and then stopped. Cultures from both incisions and drainages showed predominance of pneumococci. In the first instance accompanied by bacillus coli and in the second by pseudomonas pyocyanea. Another 500 cm. transfusion was given on the thirty-fifth postpartum day from which the temperature gradually receded, the edema disappeared, the patient became rational, and she was discharged on April 22, 1939.
or the sixty-seventh postpartum day, practically afebrile, in fair general condition with the abdominal incision granulating and scant drainage. The patient was last examined in September, 1940, at which time she had apparently made a complete recovery.

In reviewing the charts, we note that one patient developed a blood stream infection of non-hemolytic streptococcus gamma type despite sulfanilamide therapy. However, negative blood cultures were obtained the second day after the first blood irradiation. On several occasions it was necessary to give more than one irradiation before the patient was discharged, but in such instances the patient had a more favorable prognosis after the first treatment. We believe that in the difficult cases treated, many with advanced pathological conditions, that the high percentage of excellent clinical response is unmatched, in our experience, by any other type of therapy.

CONCLUSIONS

Our conclusions in the use of hemorradiation are:

1. The exposure of autotransfused blood to ultraviolet spectral energy, as outlined by the Knott technic, is a valuable and safe adjunct to the practice of medicine and surgery.

2. The biochemical background on this type of treatment is extensive and makes its use logical in indicated cases.

3. A definite reduction of toxicity is achieved.

4. In the treatment of puerperal sepsis it has exceptional value.

REFERENCES


