ULTRAVIOLET IRRADIATION OF AUTOTRANSFUSED
BLOOD IN THE TREATMENT OF
POSTABORTIONAL SEPSIS

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FROM July, 1938, through July, 1941, in the Shadyside Hospital, Pittsburgh, Pennsylvania, ultraviolet irradiation of autotransfused blood has been used as an adjunct to surgery in the treatment of postabortional sepsis. Seventeen patients were treated preoperatively and four postoperatively. Nine patients admitted instrumentation to produce abortion; two patients admitted taking medication. Eight abortions were apparently spontaneous. One patient with psychosis was treated after a therapeutic abortion because of apparent sepsis. One patient used medication and instrumentation. Ten patients were considered as early to moderately advanced infections, based on symptoms of fever, increased leukocyte counts, history of criminal abortions, toxemia, etc. The pathological conditions ranged from simple, uncomplicated, acute septic endometritis to acute salpingitis, bilateral, "frozen" pelvis, pelvic abscess and septicemia. Chemotherapy (sulfanilamide) was used in treating two patients; one patient receiving 530 gr. in five days; another (Case III) 135 gr. in thirty-six hours. In the first case it apparently was not helping the patient; and in the second case it was cancelled after irradiation as not needed.

One patient (Case x) was admitted with escherichia coli septicemia, the same organism being obtained from her uterus at operation. Three patients showed transient bacteriemia at operation. The patient in Case v at operation showed indifferent streptococci in the blood and Staphylococcus aureus in the uterus at operation. The patient (Case xii) showed pneumococci in the blood and uterus at operation, the organism was not specific in type. (It has been our experience in other pneumococcal infections that hemo-irradiation tends to act on the pneumococcus in some manner, making it unsuitable for typing.)

Cultures from the cervical canal, uterine cavity and including one cul-de-sac abscess showed:

<table>
<thead>
<tr>
<th>Organism</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia coli</td>
<td>3</td>
</tr>
<tr>
<td>Hemolytic streptococcus</td>
<td>2</td>
</tr>
<tr>
<td>Indifferent streptococcus</td>
<td>1</td>
</tr>
<tr>
<td>Staphylococcus</td>
<td>4</td>
</tr>
<tr>
<td>Diphtheroids</td>
<td>1</td>
</tr>
<tr>
<td>Pneumococcus</td>
<td>1</td>
</tr>
<tr>
<td>No growth</td>
<td>4</td>
</tr>
<tr>
<td>No cultures taken</td>
<td>7</td>
</tr>
</tbody>
</table>

(Two patients were readmitted.)

Whenever possible, our practice was to give preoperative blood irradiation and either immediately or the following day perform dilatation and curettage. In no case did we observe any spread of infection. When this therapy was used postoperatively in four patients with advanced infection, prompt relief of toxemia and decrease in fever was outstanding.

Blood irradiation therapy was given as follows:

<table>
<thead>
<tr>
<th>Days postoperatively</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

(One patient was readmitted.)

The four patients not treated preoperatively showed symptoms of temperature
rise and toxemia following surgery and were treated postoperatively because of apparent acute endometritis. It is noteworthy that no significant rises of temperature were observed even though the patients were treated at different intervals preoperatively. The results were essentially the same and strongly indicate the preventative value of hemo-irradiation.

CLINICAL OBSERVATIONS AND RATIONALE

This therapy consists in the administration of ultraviolet irradiation directly to the blood. By this method of application many of the important biophysical and biochemical effects produced by ultraviolet rays can be observed clinically. The reactions of special interest in this condition under discussion, which have a broad background in general medical literature, and which can be observed clinically are:

1. Attenuation and destruction of bacteria.3,5,6,16
2. Inactivation of toxins and viruses.9,11,15
3. Increased absorption of oxygen by the blood.8,10,12
4. Increase in general resistance to infection.4

The work of the author in puerperal sepsis14 and the papers by Hancock and Knott,2 Barrett,1,2 and Miley,12,13 reporting the use of this method all emphasize these manifestations following such treatment. The results observed in patients following such treatment substantiates clinically that these and other reactions characteristic of ultraviolet spectral energy take place in hemo-irradiation.

The increase in general resistance following ultraviolet therapy has been thoroughly reviewed by Clark,4 and is observed following hemo-irradiation. A significant fact is brought to notice in this series of cases in reviewing the charts and histories. None of the seventeen patients treated preoperatively had any untoward symptoms, following dilatation and curettage, as would be expected.

TECHNIC

The observable phenomena of systemic reaction to this form of treatment are consistent in a majority of cases. This is probably due to the fact that in the application of ultraviolet directly to the blood, using the Knott technic, a constant and exact control of all the variable dosage factors is maintained. Intensity of ultraviolet radiation, wave length, distance, time of exposure and volume of blood treated are all important factors that are controlled by this method.

The method of exposing venous blood directly to ultraviolet spectral energy and returning to the patient was evolved by E. K. Knott, of Seattle, Washington. This procedure became known as the "Knott Technic," and it was this method that Hancock and Knott, Barrett, Rebbeck, and Miley employed in the work they have reported.

The Knott technic consists in the withdrawing of a predetermined amount of blood from a patient and the exposure of this blood after citration to a selected band of wave lengths of ultraviolet rays and immediately returning it to the patient. This technic has been described in detail by Miley. It is essentially a surgical procedure. However, an apparatus has been designed that mechanically regulates all factors and through precise but simple operation makes the administration of this therapy a safe procedure.

CASE I. No. 75795. Mrs. K., age thirty-one, married, was admitted to the Shadyside Hospital November 2, 1938. She gave a history of her last menstrual period beginning October 18, and continuing until admission accompanied by moderately severe crampy pains in the lower portion of her abdomen. She denied any pregnancy or attempt at abortion. Her admission temperature was 102.2°F, pulse 120, respirations 24. An admission blood count was not done. Pelvic examination showed a large, tender, boggy mass posterior to the uterus with the cervix patent, uterus slightly enlarged and fixed anteriorly, adnexa not definable. She received
blood irradiation therapy preoperatively on the third admission day. A routine curettage plus incision and drainage of the cul-de-sac spontaneous abortion occurred, but the bleeding continued although slight in amount. About two hours prior to admission she

abscess was performed on the fourth day. As shown by the accompanying graph the temperature gradually receded. The patient made an uncomplicated recovery and was discharged in good condition on the eighth postoperative day. Examination of curettings showed acute endometritis with necrotizing placental tissue. Culture from the abscess developed severe crampy pains in the lower portion of her abdomen and severe vaginal bleeding. Her admission temperature was 98.6°F, pulse 104, and respirations 22; blood count was 3,030,000 red cells with 6 Gm. hemoglobin. A curettage was performed shortly after admission, and the products of conception, consisting of necrotizing placental tissue, showed staphylococcus. We believe this patient perforated the uterus in an attempt at abortion in spite of her denials.

Case II. No. 79088. Mrs. M., age twenty-one, was admitted June 5, 1939, with a history of bleeding for approximately three weeks. She was estimated two months pregnant at the time bleeding began. One week later a removed. No uterine culture was taken. There was considerable bleeding at operation, and a count taken June 8, 1939, showed red cells 1,950,000, 5.8 Gm. hemoglobin, 6,100 white cells with 86 per cent neutrophiles (78 nonfilamented). At this stage her temperature showed a decided tendency to a septic course. She was moderately toxic and quite weak.
Blood irradiation therapy was instituted on June 8. This was followed by a transient rise the next day then prompt recession to normal. By the morning of May 31, despite her temperature being normal, she was still moderately toxic. Blood count on May 31, showed 3,440,000 red cells, 10.2 Gm. hemoglobin, color index 1, leukocytes 11,900, neutrophiles 83 per cent (filament 31, non-filament 52), sedimentation distance 79 mm. in one hour. Chiefly because of the moderate toxemia and septic blood count sulfanilamide therapy was discontinued on May 31, in favor of blood irradiation therapy, which was given the same day. Blood cultures taken May 30 and 31 were negative. No cultures were taken from the cervix or uterus. On June 1, the patient was markedly improved in all respects and continued to an uneventful recovery and discharge on June 5, 1940.

CASE III. No. 84990. Mrs. O., age twenty-six, para III, was admitted to the Shadyside Hospital on May 27, 1940, with a history of having fallen down steps at approximately the third month in her pregnancy and a spontaneous abortion ensued. This occurred six weeks prior to admission. She had slight to moderate amount of bleeding daily since the abortion occurred. She denied any attempt at self-induced abortion. Her admission temperature was 97.8°F., pulse 112, respirations 20. The day following admission her blood count showed red cells 3,200,000, hemoglobin 12.5 Gm., color index 1.2, leukocytes 9,450, neutrophiles 60 per cent (filament 29, non-filament 40). A dilatation and curettage was performed on May 29. The pathological report showed necrotizing placental tissue. Approximately two hours after this surgical procedure she had a chill and her temperature rose to 104.8°F. with pulse 136, respirations 24. Sulfanilamide was immediately started, 140 gr. being given in the next thirty-six hours. During this time she had two more chills, her temperature ranging up to a peak of 103 degrees. The patient felt decidedly better from the time she was irradiated. No bacterial growths were obtained from the blood. This fever was evidently sapremic in nature; however, the decided tendency to sepsis caused considerable concern. The patient was discharged on the ninth postoperative day in good condition. Her subsequent recovery was uneventful.

CASE IV. No. 88227. Mrs. C., age twenty-eight, married, was admitted to the Shadyside Hospital November 16, 1940. She had missed two menstrual periods and three weeks prior to admission began to have vaginal bleeding with moderate cramps. During this period she had two rather severe hemorrhages. The night prior to admission a severe hemorrhage with cramps occurred. The patient finally admitted that she had used a slippery elm stick six different times during these three weeks (she had inserted a slippery elm stick into her uterus six different times prior to admission). Her admission temperature was 99.2°F., pulse 100, respirations 20. Blood count showed 3,170,000 red cells, 10 Gm. hemoglobin, 3,350 leukocytes, 73 per cent neutrophiles (12 non-filament, 61 filament). Urine showed considerable albumin, occa-
sional pus and blood. Culture from the cervix showed Staphylococcus aureus and hemolytic streptococcus. Blood culture November 22, shown by the accompanying graph temperature promptly receded, and the patient was discharged on the seventh postoperative day in good condition. Her subsequent progress has been uneventful. The right tubo-ovarian infection has not become exacerbated.

Case v. No. 8826. Mrs. G., age twenty-one, married, was admitted to the Shadyside Hospital on December 2, 1940, with a history of a self-induced abortion performed two days prior to admission, at which time her period to the laboratory showed nothing but proliferating endometrium with marked congestion and inflammatory reaction. Diagnosis of pregnancy was not proved by laboratory. By the third postoperative day with chills temperature had reached 103.4°F. She was moderately toxic. On the fourth postoperative day blood irradiation therapy was instituted and as was approximately two weeks late. She used a catheter for the abortion. Her admission temperature was 102.2°F, pulse 100, respirations 22. She had rather frequent chills, the longest lasting twenty minutes and by the evening of December 3, her temperature reached a peak of 104.6°F, pulse 120. Blood irradiation therapy was instituted on Decem-

FIG. 4. Case iv.

FIG. 5. Case v.
number 3, and a dilatation and curettage performed on December 4. The pathological report showed early placental tissue with inflamatory reaction. Blood culture taken at the time of the curettement showed indifferent streptococci. Subsequent blood cultures taken December 4 and 5 were negative. A smear from the cervix taken at the time of curettement showed indifferent streptococci. Her temperature reached a peak of 105.2°F. the evening following curettement but, as shown by the accompanying graph, promptly subsided; and the patient was discharged in good condition on December 9, 1940. Her subsequent recovery has been uneventful.

Case VI. No. 88580. Mrs. M., age twenty-three, married, was admitted to the Shadyside Hospital December 5, 1940. She gave a history of having missed two menstrual periods. She inserted a catheter into the uterus on November 29. This was followed three days later by chills, severe cramps in the lower abdomen and passage of blood with clots but no fetus. Her admission temperature was 101.2°F., pulse 112, respirations 18. Blood count showed 4,850,000 red cells, 15.4 Gm. hemoglobin, 9,000 leukocytes, 76 per cent neutrophiles (13 filament, 63 nonfilament). Gynecological examination showed blood clots in the vagina; enlarged, softened, patent cervix; bleeding; uterus enlarged to correspond to approximately two months’ pregnancy, slightly tender, no adnexal masses or unusual tenderness. Blood cultures taken December 6 and December 7 were negative.

She received blood irradiation therapy on the second admission day, and routine curettage was performed on the third day. No uterine culture was taken. The curettings showed necrotizing placental tissue. As shown by the accompanying graph she made an uneventful recovery and was discharged in good condition on the fourth postoperative day. Her subsequent convalescence has been uneventful.

Case VII. No. 89678. Mrs. B., age forty, married, was admitted to the Shadyside Hospital on February 4, 1941. She gave a history of missing two menstrual periods prior to January 25, then began to bleed. The bleeding with clots has persisted since. She has six children living and well with a miscarriage four years ago. She denied any attempt at interruption of her pregnancy. Stated that she had had a “cold” for the past two weeks. Her admission temperature was 102.6°F., pulse 128, respirations 24. Blood count showed: red cells 3,410,000; hemoglobin 9 Gm.; leukocytes 11,350; neutrophiles 84 per cent (filament 30, nonfilament 54). A gynecological examination revealed the vagina filled with clots; softened, enlarged, patent cervix with bleeding; uterus enlarged to correspond to ten weeks' pregnancy, slightly tender, no adnexal masses. She received blood irradiation therapy on the second day. The following twenty-four hours her temperature reached a peak of 100.6°F. She received routine curettement on the third day. The pathological report showed necrotizing placental tissue. As shown by the accompanying graph, the patient made a rapid recovery to be discharged on the fifth postoperative day. Her subsequent convalescence was uneventful.
CASE VIII. No. 92416. Mrs. R., age thirty-one, married, was admitted to the Shadyside Hospital June 23, 1941. Her last menstrual period was due approximately June 14. On June 16, she was given quinine tablets “by some woman” who, likewise, inserted something into her uterus. Aside from an occasional crampy pain nothing happened until June 19, when she began to bleed moderately. The cramps became more severe and she felt warm. No tissue, however, was passed. These symptoms continued until June 21, when she began to have chills and felt considerably warmer. Headache developed and nausea and vomiting. Over the next forty-eight-hour period these symptoms became considerably aggravated with much more severe pain across the lower part of the abdomen, constant and also colicky in nature. The chills increased in severity. When she finally called a physician her temperature had reached 104 degrees on the morning of June 23. She was immediately sent to the hospital. Her admission temperature was 101.4°F., pulse 128, respirations 28. Blood count showed: 3,400,000 red cells, 11.8 Gm. hemoglobin, 14,400 leukocytes, 85 per cent neutrophiles, 21 per cent filament, 64 per cent nonfilament. Pelvic examination revealed a softened cervix with profuse sanguinopurulent, nonoffensive discharge from the cervical canal, filling the vagina. The uterus was enlarged to correspond to six weeks’ pregnancy, moderately tender, both lateral regions tender, especially right, no masses. Hot gallon douches of bichloride 1:5000 were given four hourly (we believe for this reason when operation was done, no growth was obtained).
Blood irradiation therapy was instituted about six hours after admission, and the following day routine curettage was performed. Her temperature receded by the next day considerably and she felt much improved. On July 2, the second admission day, blood irradiation therapy was instituted. A culture taken before irradiation showed no growth. Routine curettage was performed on July 3. A moderate amount of purulent endometrial tissue was removed. A pathological examination of the tissue showed endometrium of pregnancy. The culture from the uterus showed diphtheroids. Blood culture taken July 3, was negative. As shown by the accompanying graph the patient made an uneventful recovery and was discharged on July 7, 1941 the fourth postoperative day, in good condition.

CASE IX. No. 92633. Mrs. B., age twenty-eight, para 11, was admitted to the Shadyside Hospital July 1, 1941. She gave a history of having had an abortion about four weeks previous, etiology unknown, denied any attempt at interruption, and was apparently about six weeks pregnant at the time. After the abortion she was apparently in good condition until the night of June 30, when she experienced sudden sharp, burning pain over the entire lower part of her abdomen with vomiting. The pain persisted continuously and severe, and was aggravated by urination. On admission an enlarged, softened uterus, quite tender, immobile, was found with bloody serous discharge from the cervical canal. The diagnosis of “frozen pelvis” was made preoperatively. Her admission blood count was 5,000,000 red cells, 86 per cent hemoglobin, 12,850 leucocytes, 83 per cent neutrophiles (66 filament, 17 nonfilament), sedimentation distance 6 mm. in one hour. Her temperature on admission was 103.2°F, pulse 112, respirations 32. Urine showed a moderate number of leucocytes, many erythrocytes and a trace of
adnexal tenderness, a foul smelling and a profuse discharge from a softened cervix. Her admission temperature was 100.2°F., pulse

108, respirations 20, and in addition to severe crampy pains in the lower portion of her abdomen she complained of severe pain radiating from the right groin to the right lumbar region as if a pyelitis were developing. Her urine showed considerable albumin, many pus cells and erythrocytes with considerable mucus. She was given blood irradiation therapy in the morning of July 19. A preoperative irradiation blood culture was taken which subsequently showed a profuse growth of escherichia coli. Routine curettage was performed on July 20. The peak temperature during this twenty-four hours being 101.4°F. At operation a considerable amount of foul smelling necrotizing placenta was removed from the uterine cavity. A pathological report showed necrotizin-

ing placental tissue. A culture taken from the uterine cavity showed escherichia coli. As shown by the accompanying graph the patient's temperature promptly receded to normal. A blood culture taken July 22, showed no growth. She made an uneventful recovery and was discharged from the hospital symptom free on July 24, 1941.

CASE XI. No 93171. Mrs. G., a negro, age forty, para iv, was admitted to the Shadyside Hospital July 26, 1941. She gave a history of having had a miscarriage at approximately four and one-half months; and on July 24, after some heavy lifting she experienced a sudden onset of crampy pain in her lower abdomen and profuse bleeding. A physician was called and shortly afterward a fetus and placenta were expelled. The bleeding decreased in amount. On the morning of admission she had recurrence of crampy
pains in the lower portion of her abdomen and rather profuse vaginal bleeding with many clots. She had several chills the twenty-four hours prior to admission and had been suffering from considerable nausea and vomiting from the onset of her pregnancy. She denied any attempt at interruption of her pregnancy. Her admission temperature was 102.6°F., pulse 120, respirations 24. Blood count showed 3,150,000 red cells, 11.6 Gm. hemoglobin, 19,200 leukocytes, 73 per cent neutrophiles (38 filament, 35 nonfilament), sedimentation distance 110 mm. in one hour. Urine showed a trace of albumin, many leukocytes and erythrocytes. Vaginal examination revealed the uterus to be enlarged, with softened, enlarged cervix and patent canal; bleeding, with tissue protruding from cervical canal. The uterus was tender as were also the parametrial regions on both sides. Blood irradiation therapy was given on July 26. A blood culture was taken immediately before the irradiation treatment. This culture was negative. Routine curettage was performed immediately. Culture from the uterus showed Staphylococcus aureus in abundance. Blood culture taken immediately after operation showed indifferent streptococci. Blood culture taken July 31, showed no growth. At operation there was a profuse, bloody, purulent discharge from the cervical canal with an offensive odor. The cervix was very patent. The uterus contained a considerable amount of placental tissue with membranes; no fetus. The pathological report showed necrotizing placental tissue. As shown by the accompanying graph there was prompt recession of fever and pulse, and the patient made an uneventful recovery, being discharged on August 3, 1941, the seventh postoperative day, symptom free.

CASE XII. No. 93234. Mrs. O., age twenty, first pregnancy, was admitted to the Shady-side Hospital July 29, 1941. She gave a history of having last menstruated normally late in May, 1941, missed her June period, and approximately July 6; because she felt she was pregnant she began an attempt at interruption of her pregnancy. She admitted attempting to insert a slippery elm stick into her uterus each night for the next two weeks. She had a common cold at the time; no uterine symptoms developed until July 22, when she had frequent chills and a feeling of warmth. On July 23, moderate vaginal bleeding occurred but no cramps. That same evening she passed blood clots and tissue. On July 24, cramps developed, bleeding became worse, but no more tissue was passed. This bleeding continued rather moderately in amount until admission. On July 27, she was examined by her family physician who found a piece of tissue protruding from the cervix and prescribed ergotrate in the hopes the tissue would pass; however, such did not occur and, because the bleeding persisted, she was admitted as noted. Her admission temperature was not taken because of immediate operation. On July 27, she was examined by her family physician who found a piece of tissue protruding from the cervix and prescribed ergotrate in the hopes the tissue would pass; however, such did not occur and, because the bleeding persisted, she was admitted as noted. Her admission temperature was not taken because of immediate operation. Blood count on admission was 4,390,000 red cells, 87 per cent hemoglobin, 13,650 leukocytes, 66 per cent neutrophiles (56 filament, 10 nonfilament). Vaginal examination revealed bloody vaginal discharge, nonoffensive, a piece of tissue protruding from the cervix, cervix softened, uterus enlarged and softened and moderately tender, no adnexal tenderness or enlargement. The same day of admission the
patient was given preoperative blood irradiation therapy. A blood culture taken immediately before blood irradiation showed no growth. Routine curettement was performed immediately, and a culture taken from the uterus which showed pneumococci of no specific type. A blood culture taken immediately after operation showed pneumococci of no specific type. At operation necrotizing tissue and membranes were removed from the uterus. No fetus was present. The pathological report showed necrotizing placental tissue. A blood culture taken July 31, showed no growth. As shown by the accompanying graph there was mild febrile reaction the next day to 100 degrees with prompt recession. The patient made an uneventful recovery and was discharged from the hospital on the fifth postoperative day, symptom free.

SUMMARY

The use of ultraviolet irradiation of autotransfused blood in postabortal sepsis has markedly influenced the prognosis in this pathological condition. We believe because of the histories of instrumentation, septic fever, pelvic complications and even septicemia very few of these patients would be considered in conventional surgical practice as safe operative risks because of the well grounded fear of spreading infection both locally and into the blood stream. Needless to say, the prevention of the prolonged morbidity, usually found in the conventional handling of such patients, alone is well worth while.

CONCLUSION

Twenty-one patients with postabortal sepsis were treated by ultraviolet irradiation of autotransfused blood. Our experience with this therapy in the treatment of postabortional sepsis prior to and after curettement indicates that in hemo-irradiation we have a valuable adjunct to the practice of surgery. Practically no increase in temperature was noted following surgery when hemo-irradiation was administered preoperatively. Definite protection was afforded against the usual disastrous spread of the uterine infection in the pelvis or into the blood stream. In cases of pronounced sepsis a remarkable reduction in the manifestations of toxemia was achieved. Ultraviolet irradiation of autotransfused blood used as an adjunct in the treatment of septic abortion should prove to be of inestimable value. The accompanying charts and histories* show the cases of postabortal sepsis treated by this method.

REFERENCES


* Due to lack of space only the twelve most interesting case histories are included in this report. The remaining nine histories of cases 73902, 88216, 89680, 90031, 90388, 90760, 90827 and 90938 can be obtained at Shadyside Hospital, Pittsburgh, Pa.