INFECTED BURNS WITH HEMORRHAGE*

W. A. ALTEMEIER, M.D.,

AND

B. N. CARTER, M.D.

CINCINNATI, OHIO

FROM THE DEPARTMENT OF SURGERY, UNIVERSITY OF CINCINNATI, AND CINCINNATI GENERAL HOSPITAL, CINCINNATI, OHIO

OCCASIONALLY chronically infected burns show a decided bleeding tendency which seems to resist all forms of topical and general therapy. Although infection is a common complication of cutaneous burns, hemorrhage is relatively rare, occurring in approximately 2 per cent of the cases.[1] Gunn and Hillsman[2] state that hemorrhage occurs in only a small percentage of cases, and is usually met with only in dirty, sloughing, badly infected burns. DaCosta[3] mentions that the raw surface, resulting from separation of sloughs in deep burns, is slow to heal, and may be complicated by hemorrhage.

If the infected burned area is extensive, the prolonged and uncontrolled bleeding results in a major therapeutic problem. The constant loss of blood soon produces a marked anemia and subnormal serum protein level, in spite of frequent blood transfusions. The absorption of septic bacterial products causes a continued septic fever with frequent chills, rapid pulse, prostration, and increasing debility. The patient's mental depression and the marked tendency to develop contractures further complicate an already difficult problem. A vicious cycle becomes established—the more the patient bleeds, the greater the infection becomes as a result of the anemia, low plasma proteins and debility; and the greater the infection becomes, the more the patient bleeds.

In the three cases of chronically infected burns which we are reporting, the bleeding was characterized by a continuous diffuse ooze of blood over long periods of time, up to five or six months. The local use of lanolin or vaselined pressure dressings and various topical applications of such solutions as boric acid, Burow's, Dakin's, azochloramide, dilute acetic acid, mercurochrome, hydrogen peroxide, silver nitrate, and 1 per cent copper sulphate failed to bring the bleeding under control. The administration of sulfonamides orally in two, and locally in one of these patients, was likewise unsuccessful. In each instance, however, the application of a water suspension of activated zinc peroxide dramatically stopped bleeding within 24 to 48 hours.

CASE REPORTS

Case 1.—Our attention was first attracted by this hemorrhagic tendency in the case of R. C., white, male, age 24, who was admitted to the Holmes Hospital, November 22, 1940, with an old infected electrical burn of his back of six years' duration. The infection was chronic and recurred frequently in spite of repeated radical excisions and many types of treatment. At the time of this admission, an ulceration three inches in diameter was present in the burn scar over the center of the lower back. The infected granulation tissue exhibited a persistant bleeding tendency which previously had

* Read before the American Surgical Association, Cleveland, Ohio, April 6-8, 1942.

not been controlled by Dakin's, azochloramide, copper sulphate, saline, boric acid, hydrogen peroxide or specific bacteriophage solution locally. Lugol's solution and sulfanilamide by mouth also were ineffective. His red blood count progressively fell to a level of 2,800,000, with a hemoglobin of 9 Gm. His bleeding time, blood platelet count and prothrombin time were all within normal limits.

Bacteriologic study of the wound showed presence of an aerobic hemolytic staphylococcus and an anaerobic nonhemolytic streptococcus. It was thought that this case probably represented a type of chronic cutaneous ulceration, as described by Meleney. Cautery excision of the infected area followed by daily dressings with zinc peroxide was done, and the bleeding was promptly controlled. As soon as the zinc peroxide was discontinued and another solution, such as Dakin's, was employed, the bleeding promptly reappeared. The reapplication of zinc peroxide again quickly stopped the loss of blood.

After the effective control of the infection and bleeding, the clean granulating area was then successfully grafted by means of pinch-grafts followed in 12 hours by continuous zinc peroxide dressings. The patient was discharged March 3, 1941.

Case 2.—T. R., white, male, age 48, received second- and third-degree burns of the legs, thighs, arms, and hands, November 2, 1940. While using an acetylene torch to cut metal, a can of gasoline nearby became ignited, which, in turn, ignited the patient's clothing. He was admitted to the Dermatologic Service of the Cincinnati General Hospital one hour after injury. Treatment consisted essentially of continuous dressings of Burow's solution, bed rest, and general supportive measures. Fifteen days later, it was noted that the patient had developed infection of the burned areas.

When he was transferred to the General Surgical Service for treatment and grafting, December 3, 1940, it was noted that the burned areas on both legs were bleeding. After continuous compresses with Dakin's solution, postage stamp Thiersch grafts were applied to the granulating wound. The grafted areas soon broke down and the wounds continued to bleed. Many types of topical therapy were then tried but all failed to stop the bleeding. Among the solutions used were saline, boric acid, acetic acid, azochloramide, cepryn chloride, mercurochrome, Dakin's solution and hydrogen peroxide. In spite of frequent blood transfusions, the anemia became more and more pronounced. He received daily 24 ounces of orange juice and 75 mg. of cevitamic acid, without influence on the bleeding.

On April 10, 1941, the patient was shown in surgical ward rounds, and at that time he appeared obviously and chronically ill. The burned areas on both legs were covered with large masses of dark partially clotted blood and pus beneath which the granulation tissue was piled up and edematous (Fig. 1 A). Active continuous oozing of dark blood could be seen.

The patient was debilitated, discouraged, and disfigured by contractures of both legs. The temperature was 100–102° F., and of the septic type; pulse 100–130. *Laboratory Data:* R.B.C. 2,300,000; hemoglobin 8 Gm.; serum protein 5.7 Gm. per cent; serum albumen 2.5 Gm. per cent; serum globulin 2.2 Gm. per cent; hematocrit 31 per cent. The prothrombin time was 93 per cent and the blood platelet count was 260,000. After four and one-half months of unsuccessful effort to control the bleeding, the loss of blood became so alarming that bilateral amputation of the affected legs was strongly considered as a last resort.

Careful cultures of the wounds at that time revealed the presence of nonhemolytic *Staphylococcus albus*, hemolytic *Staphylococcus aureus*, and a nonhemolytic streptococcus. No strictly anaerobic bacterium was demonstrated.

On the basis of our experience in the former case, the local use of zinc peroxide seemed indicated, even though no strictly anaerobic or micro-aerophilic bacteria were present. In addition, the legs were straightened and slightly elevated by means of traction applied to Steinmann pins inserted through the os calcis.

Twenty-four hours after the first application of zinc peroxide suspension the bleeding was completely stopped (Fig. 1 B), and the granulation tissue was beginning to assume a bright red, healthy appearance, which became more pronounced daily. Multiple whole-

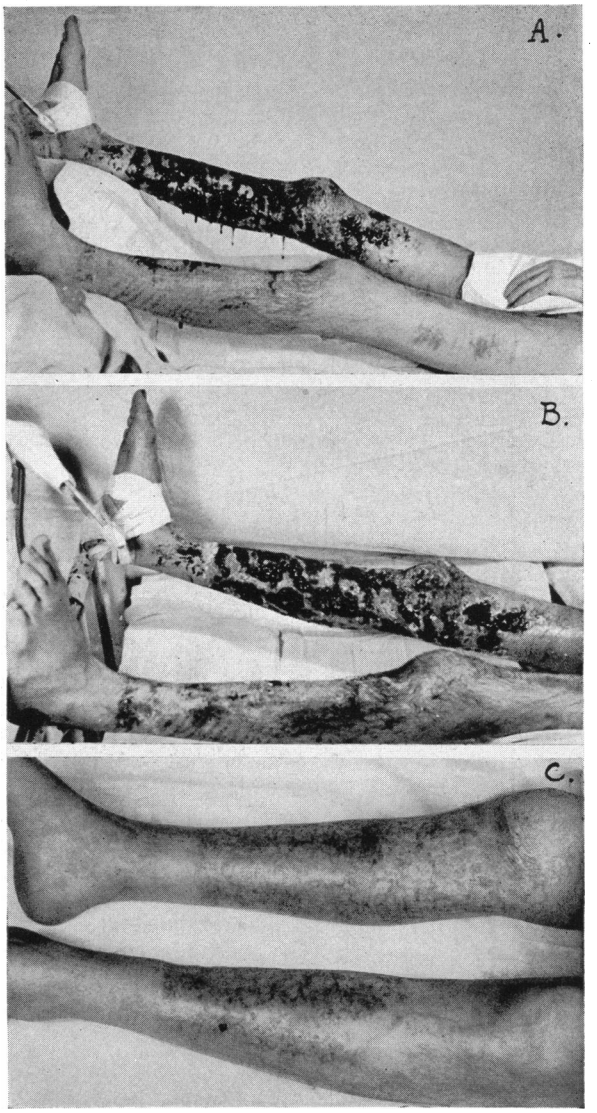

FIG. 1.—A. Bleeding granulation of infected burn of Case 2. B. Appearance of granulation tissue 24 hours after first application of zinc peroxide suspension showing complete arrest of bleeding. C. Same wounds after skin-grafting and healing.

blood transfusions were given, and within two weeks the patient looked much improved; his R.B.C.was then 4,000,000, and his temperature had fallen to approximately normal. The wounds were pinch-grafted in five sittings, between the dates of May 1, 1941 and

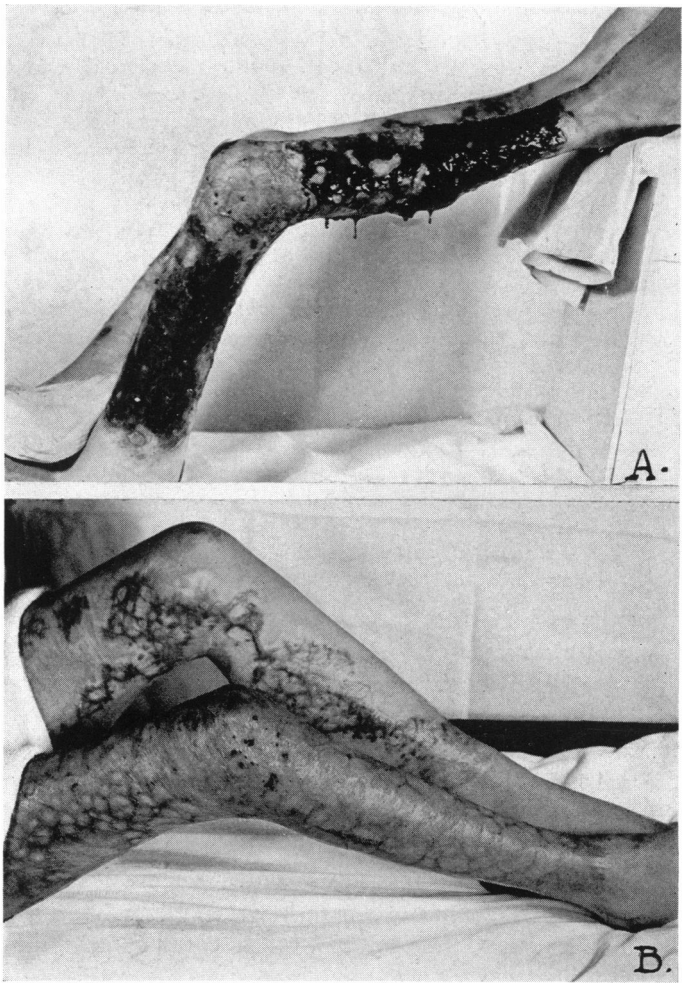

FIG. 2.—A. Bleeding granulation tissue of infected burn in Case 3. B. Same wounds after skin-grafting and healing.

July 15, 1941, because of the extent of the involved areas. By August 25, 1941 all wounds were healed except several small crusts, and only at this time was zinc peroxide therapy stopped. He was discharged November 1, 1941, completely healed (Fig. 1 C).

Case 3.—M. L., white, male, age 13, was admitted to the Children's Hospital, June 13, 1941, 17 days after having received second- and third-degree burns of both lower extremities and his right forearm. While playing with a small fire, gasoline was thrown by him into the fire. The ignited fuel exploded on his trouser legs, and in removing these, he burned his right forearm. He was carried immediately to another hospital where the wounds were cleaned and sprayed with tannic acid. During the first week infection occurred beneath the eschar and it was, therefore, necessary to remove a great part of the crust. Warm saline compresses were then applied. At this time he

was seen and treated on the Surgical Service of the Children's Hospital. His temperature was 105° F., and of the septic type. Uranalysis was essentially negative. R.B.C. 3,560,000, hemoglobin 9.1 Gm. per cent. The wounds were treated with warm saline compresses followed in three days with Dakin's solution. The granulations rapidly attained a healthy appearance, but the patient still ran a septic course. The wounds were grafted June 24, 1941, July 17, 1941, and August 7, 1941. By September 7, 1941, 30 days after the last grafting, the granulations were bleeding quite freely and piling-up thickly about the now disappearing grafted skin. A donor area from the left thigh reacted similarly, being obviously infected. The patient was very pale, discouraged and disfigured by flexion contractures and large bleeding infected wounds of both legs (Fig. 2 A). R.B.C. 3,100,000, hemoglobin 7.4 Gm. per cent, hematocrit 23 per cent. Many solutions were used unsuccessfully, including acetic acid, saline, boric acid, azochloramide in olive oil and lanolin pressure dressings. Multiple blood transfusions were given and he was placed on a diet rich in vitamins. On September 18, 1941, when the patient was first seen by us in consultation, a hemolytic *Staphylococcus aureus*, hemolytic streptococcus, and a hemolytic *B. coli* were cultured from the bleeding and infected wounds. The following day applications of zinc peroxide suspension were started; and the previously hemorrhagic, dark red infected granulation tissue became healthy appearing and bloodless in less than 48 hours. Within 14 days the granulations had become flat and pinch-grafts were successfully applied September 25, 1941 and October 6, 1941. The application of zinc peroxide was resumed 12 hours after the grafting. Except for a few small granulating areas the wounds were completely epithelized by October 19, 1941, and the zinc peroxide dressings were then discontinued. Straight leg traction and exercises overcame the flexion contractures of his legs.

Except for a short vacation during the holiday season he remained hospitalized until March 15, 1942, at which time the legs were completely epithelized. (Fig. 2 B.)

Discussion: In each of these three cases the complication of bleeding was very serious, and always associated with chronic infection, but never with jaundice, low prothrombin time, or other obvious manifestations of liver deficiency. This type of bleeding, developing spontaneously during the granulating stage, is not to be confused with that occurring earlier, either due to depressed blood prothrombin levels[4, 5] or separation of large infected sloughs. The cause of the bleeding tendency and the explanation of the effectiveness of zinc peroxide are obscure. According to Harkins,[5] hemorrhage from superficial vessels may occur either during sloughing or later in the granulating stage of burns. There is considerable evidence that some bacterial product produces the bleeding. The constant association of this complication with infection, as noted by Gunn and Hillsman,[2] and as demonstrated by our cases, supports this view. The continued oozing of blood indicates that the hemorrhage is of the capillary type, which, occasionally, may be the result of damage to the capillaries by bacterial toxins.[6] Likewise, the rapid arrest of the bleeding, coincident with the control of the infection by zinc peroxide, strongly suggests that its bactericidal and detoxifying action are responsible for its effectiveness.

Although zinc peroxide is usually considered to be indicated in lesions contaminated or infected by anaerobic or micro-aerophilic bacteria, Johnson and Meleney[7] have demonstrated that this substance also possesses a bactericidal action *in vitro* for hemolytic streptococci and pneumococci, and a detoxifying or destructive action on the hemotoxins of the streptococcus and gas bacillus. As relatively resistant to the action of zinc peroxide they

listed the staphylococcus, *B. coli, B. pyocyaneus,* and *B. proteus.* We have been able to show a similar destruction of the hemolysin of the staphylococcus and of the *B. coli* as well as the streptococcus after incubation for half an hour with zinc peroxide.

A study of the bacteria isolated from each case shows that the great majority were hemolytic varieties, and that the hemolytic *Staphylococcus aureus* was the only one common to each case (Table I).

TABLE I

BACTERIA ISOLATED FROM BLEEDING BURNS

1. R. C.—Hemolytic *Staphylococcus aureus.*
   Nonhemolytic *Staphylococcus aureus.*
   Nonhemolytic anaerobic streptococcus.
2. T. R.—Hemolytic *Staphylococcus aureus.*
   Streptococcus fecalis.
   Nonhemolytic *Staphylococcus albus.*
3. M. L.—Hemolytic *Staphylococcus aureus.*
   Hemolytic streptococcus.
   Hemolytic *B. coli.*

Certain strains of the *Staphylococcus aureus* may produce a variety of toxic substances in artificial culture media, including hemolysin, leukocidin, necrotizing toxin, lethal toxin, gastro-enteric toxin, plasma coagulase, and fibrinolysin. We have found no reference to the ability of staphylococcal toxins to cause hemorrhage; in fact, plasma coagulase supposedly favors septic thrombosis in staphylococcal infections. It is possible that this organism produces an additional toxic factor which is responsible for this type of bleeding.

Attempts to produce capillary hemorrhage from granulating surfaces of burns in dogs by the injection or continuous application of bacterial free filtrates rich in staphylococcal, streptococcal, and *B. coli* hemolysins have failed.

SUMMARY: Three cases of chronically infected burns are presented in which a late and serious complication was continuous capillary bleeding. After many types of local therapy had failed, the application of zinc peroxide immediately stopped the bleeding. If the zinc peroxide was discontinued, the bleeding recurred within a few days. Reapplication of the zinc peroxide again quickly controlled it. The nature of the bleeding and the action of the zinc peroxide remain unexplained.

CONCLUSIONS

In conclusion we wish to emphasize the following points in the management of these and similar cases:

(1) The prevention of this or other types of infection by careful débridement and cleansing of the freshly burned area.

(2) The advantage of careful bacteriologic cultures.

(3) The effectiveness of zinc peroxide dressings in the control of this type of bleeding as well as of the infection.

(4) The prevention of contractures.

(5) Adequate blood transfusion to restore the red blood corpuscles and hemoglobin to normal levels.

(6) Skin grafting as early as possible.

(7) Reapplication of zinc peroxide within 12 hours after grafting.

REFERENCES

[1] Pack, G. T., and Davis, A. H.: Burns: Types, Pathology, and Management. Philadelphia, J. B. Lippincott Co., 1930.

[2] Gunn, J., and Hillsman, J. A.: Thermal Burns. ANNALS OF SURGERY, **102**, 429–442, 1935.

[3] DaCosta, J. C.: Modern Surgery. 10th ed., Philadelphia, W. B. Saunders Co., 1930.

[4] McClure, R. D., and Lam, C. R.: Problems in Treatment of Burns: Liver Necrosis as Lethal Factor. Southern Surgeon, **9**, 223–234, April, 1940.

[5] Harkins, H. N.: The Treatment of Burns. Springfield, Illinois, Charles C. Thomas, 1942.

[6] Ritchie, W. P.: Essentials of General Surgery. St. Louis, C. V. Mosby Co., 1941.

[7] Johnson, B. A., and Meleney, F. L.: The Antiseptic and Detoxifying Action of Zinc Peroxide on Certain Surgical Aerobic, Anaerobic, and Micro-aerophilic Bacteria: Annals of Surgery, **109**, 881–911, 1939.

DISCUSSION.—DR. FRANK L. MELENEY (New York): I wish to say just a few words about Doctor Altemeier's paper, which interested me a great deal. We have had similar experiences in bleeding from chronically infected wounds when using zinc peroxide, with cessation of bleeding, but they were not quite so dramatic as the cases which he has presented.

It will be remembered that the chronic, undermining, burrowing type of ulcer, in which the value of zinc peroxide was first demonstrated, previous to that demonstration was very frequently associated with a profuse hemorrhage, and even fatal hemorrhage when there was erosion of some large blood vessel. Further than that, however, in some of the chronic cases, one of which Dr. Sumner Koch will remember, even without serious bleeding there was frequently a very rapidly developing anemia which could only be controlled by transfusions. However, with the use of zinc peroxide in that particular case the first result was the rise in hemoglobin and red cells, and the end of the necessity of transfusion, so that besides the immediate action on the surface blood vessels and on the deep blood vessels, there is another hemolytic action which is probably generally absorbed into the blood stream and acts upon the blood-forming organ.

I believe that these cases represent secondary hemorrhage, similar to that which we have all seen in our experience from continuous severe infection.

As Doctor Altemeier has said, we demonstrated the effect of zinc peroxide on the growth organisms *in vitro*, and we found that the action was most striking upon those which were most highly anaerobic, but the action was also present, at least bacteriostatic if not bactericidal, on the micro-aerophilic organisms and certain of the aerobic organisms.

The experiments were done first with very high dilutions of zinc peroxide (half of 1 per cent) which showed the lethal action on anaerobic or micro-aerophilic organisms, and required 1 per cent, 5 per cent, and even to 20 per cent to be bacteriostatic on the aerobes. That was demonstrated on the hemolytic *Staphylococcus aureus*. I think that Doctor Altemeier, if he still has those cultures, might attempt to demonstrate the bacteriostatic action upon the organisms which were found in these cases, not only in pure culture but in mixed culture, because it is known that organisms in skin biopsies will often have an action which they cannot produce in pure culture.

DR. WILLIAM A. ALTEMEIER (closing): I want simply to mention that we have seen two additional cases of burns which have had this bleeding tendency, but which were lesser in degree and which, of course, we have not included in the report.

Doctor Meleney has asked me to state that there are eight units that have been set up throughout the country under the auspices of the National Research Council for the study of contaminated wounds and burns, and that during the coming year we hope to answer many of these problems that have been discussed.