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CHAPTER XII

THE BURN PROBLEM

OLIVER COPE

THE ATTACK on Pearl Harbor taught the surgeon as well as the armed forces off guard; he was flustered when confronted by so many and so severely burned casualties. His consternation, coupled with the reported incidence of burns among the casualties of the bombed civil population in Great Britain and of the soldiers in desert warfare, made the management of burns an immediate concern of the Committee on Medical Research. A conference was called at the headquarters of the National Research Council on January 7, 1942, at which a standard system of burn therapy, based on the knowledge available at the time, was outlined for immediate guidance of the armed services; and investigation into improved methods was stimulated. In the four years after that conference, extended investigations concerning the treatment of the surface wound, the nature of the disordered physiology, and the control of infection in burns were carried out. They covered diversified channels and covered a wide range of method and point of view, both in the experimental laboratory and in the clinic. Owing to an unusual desire to aid the war effort, some channels, like fashions, were followed blindly; others were left too long unexplored. The accomplishments, however, are many and are attributable to a vigilant concern with the more fundamental aspects of each problem.

SURFACE TREATMENT

A fanatical concentration on the surface wound in burns has been supplanted by a healthier attitude, which recognizes that the amount of attention to be accorded it may be minimal and should at all times be proportioned to what the patient as a whole will gain from it. This sense of proportion in the care of the wound has been manifested by a trend away from complexity of treatment and injurious substances toward expeditious closure of the wound and the recognition of the limitations of pressure therapy.

From the reports of the treatment of burn casualties at Pearl Harbor, it was obvious that the method used in the treatment of surface wounds was too complex. Too much of the time and attention of the available medical personnel was devoted to care of the wound, to the exclusion of treatment of

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Earlier diagnosis has been facilitated by a rapid method developed at the University of Cincinnati for the identification of *Cl. welchii* in a wound within five to eight hours. There are, however, no tests available that indicate beforehand the wounds that will or will not develop gas gangrene. The importance of some of the factors in the production of this infection has been well defined, but the etiologic significance of others, both known and unknown, remains obscure.

There is strong evidence that the gas gangrene produced in the presence of devitalized muscle and dirt is a form of infection radically different from that produced by the injection of bacteria into healthy muscle. Not only is it severer, but it is more refractory to prophylaxis and therapeutic.

Methods must be developed to distinguish the specific toxemia due to clostridial exotoxins from the non-specific toxemia caused by toxic products arising from the septic decomposition of devitalized tissue, in order to understand better the pathological physiology of the body and its tissues in gas gangrene. Significant work on this aspect of gas gangrene was performed during the war by a group of British investigators.

Although considerable advancement has been made in the knowledge of the nature of gas gangrene and in its prevention and control, many problems still remain unsolved. A method of immunization by the injection of toxoid for the prevention of gas gangrene in wounded persons must be developed. The results of preliminary experiments in animals and volunteers are encouraging, and they indicate the probability of perfecting such a method. The exact value of univalent and polyvalent antitoxins in the prevention and therapy of gas gangrene has not been definitely shown. Further studies are indicated to explore the value, limitations, and adequate dosage of the new antibiotic agents in the treatment of gas gangrene. It is essential that problems such as these be solved by further investigations if the still prevailing unsatisfactory morbidity and mortality rates for gas gangrene are to be reduced.

the internal economy. If without prejudicing good care the surgical maneuvers could be minimized, the modest numbers of personnel available in warfare could care adequately for a large number of casualties. The most time-consuming maneuvers were those attending débridement, cleansing, and repeated spraying of coagulants, and it was therefore in order to see whether any of these could be dispensed with.

Were débridement and cleansing necessary for the care of the burn wound? This problem was attacked by observing burn wounds in patients in which the only local treatment was the application of a protective gauze dressing. At intervals, bacteriologic and chemical analyses were made of the wound fluid. In burns of incomplete thickness, of which blebs are the usual accompaniment, it was found that so long as the roof of a bleb remained intact, little or no infection developed, and that removal of the roofs of blebs, as generally practiced in débridement and cleansing, was therefore not only unnecessary but contraindicated. It was also found that no amount of washing and scrubbing of the wound left after rupture of the blebs removed all the bacteria, and that the substances commonly used as detergents on the wound caused cellular damage in experimental animals.

Chemical analysis of the blood stream and bleb fluid showed that a chemotherapeutic agent, a sulfonamide, when given systemically permeated into the burn wound. This permeation fortified the concept of omitting débridement and cleansing. If blebs ruptured in spite of a protective dressing, the chemotherapeutic agent was available to combat any organisms admitted to the wound.

Could coagulants be dispensed with? The treatment of a burn wound by the application of a coagulant to the surface was introduced by Davidson in 1926. He used tannic acid, which he sprayed on repeatedly during the course of twenty-four hours or until a firm, leathery eschar had formed; this eschar was the sole protection of the wound. Davidson believed that the tannic acid fixed in situ any toxins that might be elaborated in the wound, and also that it did not damage the viable cells at the base of the wound. The use of tannic acid was re-evaluated not only because it added to the complexity of the treatment of the surface wound of a burn, but also because it seemed possible that the coagulation it produced increased the depth of skin destruction. Davidson's assumption that tannic acid had a preferential respect for viable cells seemed unreasonable on chemical grounds and, furthermore, its absorption had been suspected of causing liver damage.

The toxicity of tannic acid, both locally in the wound and on the internal organs when absorbed, was tested. When applied on wound sites in human beings from which skin for grafting had been removed, it delayed healing. In experimental wounds it caused local necrosis, and its absorption resulted in liver necrosis. It was thus demonstrated that tannic acid did kill viable cells and would therefore, when applied to a burn wound, increase the

damage done by the burn. It was therefore considered wise to dispense with tannic acid and to find some other substance to apply to burn wounds.

Numerous substances were tested, both on human beings and on animals, in the effort to discover a suitable dressing for the burn wound to supersede tannic acid. No substance was found that would promote wound healing; from the substances tested that did not injure viable tissue, mineral-oil petrolatum was chosen as the most practical. A simple treatment for the burn wound that relegated its care to its proper place by avoiding unnecessary complexities was therefore available. It consisted of a protective gauze petrolatum dressing, to be applied under aseptic precautions but without cleansing or débridement and to be accompanied by systematic chemotherapy. The surgical maneuvers of such a dressing are minimal and can be applied by the relatively untrained, leaving the trained personnel to concentrate their attention on the administration of chemotherapy and the treatment of shock and other exigencies.

Before the war, the medical profession was overwhelmingly prejudiced in favor of the use of tannic acid and its attendant ritual of cleansing and débridement. Of all the doctors at the Burn Conference in January 1942, only three raised a voice against tannic acid, and one of these was in favor of another coagulant. In the first year of the war several of the co-operating burn research groups explored methods other than the tannic acid, including protective-dressing methods with pressure dressings. It was not until the Cocoanut Grove fire occurred in Boston, however, that a sufficient number of burn patients were treated by the simplified method without débridement and cleansing to warrant its general acceptance.

A unique opportunity was afforded by this disaster to compare this method with others. All the patients entering the Massachusetts General Hospital were treated by the protective-dressing, no débridement and cleansing method; those at the other hospitals were treated by cleansing, débridement, and the administration of tannic acid or other coagulant dyes. A survey of the results of the treatment of the two groups revealed that the administration of plasma and chemotherapy could be more prompt when the surface treatment was simplified, and suggested that the healing of the wound was satisfactory and that wound infection and renal damage were minimal. The economy in the use of the trained personnel was clear-cut. The method was recommended by the National Research Council for use by the armed services.

The second phase of investigation concerning the surface wound was directed toward the expeditious closure of the deep or full-thickness burn wound. The simplified method permitted prompt healing with minimal infection of wounds with residual viable skin, but it did nothing, beyond combating invasive infection by systemically administered chemotherapy, to aid in the healing of wounds in which all the skin elements had been de-

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