

By Charles P. Craig, MD

## Preparation of the Skin for Surgery

The history of topical care of wounds is long and illustrious, dating back to at least as early as the Egyptians of the pharaohs.<sup>1</sup> Among other materials employed for prevention of infection in wounds, the Egyptians recommended honey, and such practices still enjoy significant popularity, particularly among certain gynecologists. The effectiveness of honey was based upon the presence in it of an antibacterial substance called inhibine, a secretory product of the salivary glands of bees. Like the contemporary manufacturer's representative trying to sell a topical antiseptic, those who provided honey to the Egyptians faced serious hazards, since bees were not raised domestically and the harvesting of honey was done from hives of wild bees.

Progressing through the use of certain dye substances, particularly the triphenylmethane dye, malachite green, by the Egyptians, through wine which had significant antibacterial activity based upon the presence of certain phenolics, to carbolic acid in the days of Lister, treatment of wounds to control infections enjoyed great popularity. However, it became apparent that the prophylactic use of carbolic acid on the skin of the patient to be operated and the hands of the surgeon could significantly reduce post-operative wound infections.

Today there are a battery of topical agents which are proposed to be effective materials in preparing a skin site for subsequent surgery. All are significantly less toxic than carbolic acid and all enjoy some virtues.

The quaternary ammonium compounds, principally benzalkonium chloride, enjoyed great popularity as surgical skin preparative materials for a number of years until significant shortcomings were discovered. Among these were the fact that organic materials rapidly inactivated benzalkonium chloride and that it could support the growth of pseudomonas. Consequently, except for rare circumstances where its detergent qualities are employed for cleansing of traumatic wounds, the quaternary ammonium compounds are not recommended for surgical wound preparation in contemporary American medicine.

Hexachlorophene and related bis-phenol preparations are most active against gram-positive organisms, and are only weakly active against gram-negative bacteria. Their immediate antibacterial activity on skin is only modest, and in order to achieve substantial effectiveness, they must be used repetitively over several days. The principal advantage of hexachlorophene is that it has residual activity which will prevent the growth of bacteria, even under an occlusive covering, for a number of hours. Hexachlorophene use for pregnant women and infants is restricted because of its absorption and recognized neurotoxicity.

Tincture of iodine was employed for many years as a surgical preparatory material but it has significant toxicity to tissues and is sensitizing. It has largely been replaced by organic iodine compounds known as iodophors. These compounds, containing 1% to 3% elemental iodine, release iodine slowly and thus are germicidal for a wide range of organisms. Their formulations and prices vary considerably, and there are differing data concerning their toxicity at various body sites. However, there are no substantial data indicating that any one has any signifi-

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cant advantage over others in reducing surgical wound infections. All are considered to be effective, but they lack residual activity under occlusive coverings.

Chlorhexidine gluconate, available in 4% aqueous solution, is approved in the United States as a topical antiseptic material. It is especially active against gram-positive bacteria, somewhat less active against gram-negatives, and is not active against spores, whereas the iodophors do have some sporicidal activity. Chlorhexidine is not affected by the presence of organic materials and is approved by the United States Food and Drug Administration for topical antibacterial use.

Isopropyl alcohol has significant antibacterial activity against most strains of bacteria, but depends upon its activity on continuing contact for several minutes. The addition of alcohol to certain other antibacterial preparations, particularly iodophors and chlorhexidine, is reported to increase their activity, although several studies seem to indicate that most of the activity in such preparations is attributable to the alcohol content. The use of alcohol in such preparations protects against their becoming contaminated with bacteria. Reportedly, there has never been an episode of contamination of one of these agents when prepared as a tincture with alcohol.

The issues surrounding which surgical prep material to use are clouded by innumerable uncontrolled studies, anecdotal reports, and confusing testing procedures. Most of the agents have been thoroughly evaluated in artificial circumstances such as applying a recognized quantity of bacteria to the skin of the hands, then washing with one of the materials, then culturing the skin to determine how many bacteria have been removed. Such transient organisms are generally well-removed by simple soap and water, and thus the antibacterial properties of skin preparative agents are of little importance.

The resident flora of skin poses another problem. Such organisms may be present in hair follicles or glands of the skin, beneath the surface. They adhere tightly to the skin and may, as on plastic catheters, secrete around themselves protective substances which offer them some haven against antibacterial skin preparative materials. This may explain why certain alcoholic preparations are more effective than their water-based congeners.

A variety of clinical studies strongly support the use of preoperative skin preparation. Preoperative bathing with hexachlorophene<sup>2</sup> and chlorhexidine<sup>3</sup> has been shown to be of significant value in diminishing the incidence of postoperative wound infections. However, there are no substantial controlled studies that demonstrate the quantitative advantage of skin preparation with an antibacterial substance prior to surgery compared with simple soap and water. One can only extrapolate from studies of handwashing in which data have been gathered<sup>4</sup> that show that antibacterial substances reduce both transient and resident skin flora and, therefore, are of significant benefit.

The problem of which agent to use, how to apply it, and whether it ought to be used on successive days preoperatively, is not scientifically resolved. The official publication of the American College of Surgeons<sup>5</sup> lists two different techniques employed in Boston and Cincinnati.

A chapter by Cruse<sup>6</sup> suggests an entirely different procedure. In the same book, Laufman<sup>7</sup> deals with the skin preparation in a more objective manner, referring to it appropriately as a "ritual."

Without definitive comparative scientific studies, the consensus favors the use of an iodophor or chlorhexidine as an antibacterial agent for preparing the skin prior to surgery.

An entirely different issue is the matter of shaving the skin before surgery. Despite the fact that this ritual still is pervasive in a great number of contemporary hospitals, there are substantial studies demonstrating that shaving the skin increases the incidence of postoperative wound infection.<sup>8,9</sup> It is clear that shaving the surgical site increases the incidence of postoperative infection over that observed if clippers, depilatories, or no hair removal is employed. The American College of Surgeons Manual skirts the issue by suggesting that if the wound site is to be shaved, it should be done immediately prior to surgery.<sup>5</sup> Likewise, the second edition of the book by Bennett and Brachman simply indicates that if shaving the operative site is necessary, it should be done in as short a time as possible before surgery.<sup>7</sup> However, both acknowledge that clipping hair is preferable to shaving.

The issues raised in these controversies are not minor. Alexander and Fisher<sup>9</sup> found that the difference between razor and clipper preparations could be as great as 10% vs. 3.2% postoperative wound infections. The difference between whole body antiseptics with chlorhexidine and no treatment was so profound in a Swedish study that Brandberg concluded "It is unethical to perform high risk surgery without preoperative whole body disinfection with chlorhexidine."<sup>10</sup> Although others rightly quarrel with the universal applicability of Brandberg's posture, it is clear that judicious selection of preoperative skin preparation techniques, based upon whatever scientific evidence is available and the most authoritative recommendations, is essential for patient safety and institutional integrity. Like the Egyptian slaves who gathered honey, we are at risk if we look for solutions to our problems in the wrong places.

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