Control of High Density Bacterial Contamination of the Fiberoptic Bronchoscope*

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In a double-blind study the fiberoptic bronchoscope was contaminated with five pathogenic organisms, each at a concentration of 10^9 organisms per milliliter. The shaft and inner channel of the bronchoscope were cleansed with five antiseptic regimens. Each regimen included equal 120-ml aliquots of one, two, or three solutions, respectively. The five different regimens were as follows: (1) physiologic saline solution; (2) 70 percent solution of isopropyl alcohol, followed by physiologic saline solution; (3) alkaline glutaraldehyde, followed by 70 percent solution of isopropyl alcohol, followed by physiologic saline solution; (4) benzalkonium chloride, followed by 70 percent isopropyl alcohol, followed by physiologic saline solution; and (5) povidone-iodine solution, followed by 70 percent solution of isopropyl alcohol, followed by physiologic saline solution. The four regimens involving solutions other than saline solution alone were effective in reducing the count of residual bacterial colonies to 10^4 colonies per milliliter or less.

Despite widespread endorsement of the fiberoptic bronchoscope, there is no established method of disinfecting the instrument. While several authors have commented upon their particular method and others have described procedures for decontamination following mucous-bacterial soilage, there remain several reports of unexplained fever after bronchoscopic procedures. We are curious as to whether such fevers might be related to bacterial contamination of the instrument. The present report describes an approach designed to provide further insight into the efficacy of various chemical agents that might reasonably be employed in disinfecting the fiberoptic bronchoscope following high-density bacterial contamination.

**Materials and Methods**

The fiberoptic bronchoscope (Olympus BF-B2) with a 2-mm aspirating channel was used to assess different methods of chemical disinfection that could be used in the clinical situation. The Microbiology Department prepared bacterial broths standardized by optical density to approximate 10^9 bacteria per milliliter, using the McFarland nephelometer barium sulfate standards technique. Ten milliliters of each bacterial suspension was used to contaminate the instrument. The bacteria used were Staphylococcus aureus, Streptococcus pyogenes, Escherichia coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa. Until completion of the study, the identification of the organisms was known only by the laboratory technician providing them.

The bronchoscope was contaminated by placing the tip to the bottom of a test tube containing 10 ml of bacterial broth. The broth was aspirated through the inner channel connected via plastic tubing to the collecting reservoir of a suctioning apparatus (Gomco).

Antiseptic solutions were prepared by the pharmacy, where their respective identifications were retained until conclusion of the study. Artificial dyes were aseptically added to each solution in order to disguise its identity. This information (identity of the solution) was released at the conclusion of the study. The specific solutions used were undiluted alkaline glutaraldehyde, benzalkonium chloride, and povidone-iodine solution.

The disinfection of the bronchoscope involved an initial wiping of its external surface and then aspiration through its inner channel of the specific solution(s) being evaluated. The wiping was performed aseptically with separate, sterile, 4 × 4 inch gauze pads saturated by dipping them separately into sterile containers filled with each solution.

Once wiping was completed, 120 ml of each solution was briskly suctioned through the inner channel of the fiberoptic bronchoscope in the sequence described, as follows: (1) regimen 1 consisted of 120 ml of physiologic saline solution; (2) regimen 2 was 120 ml of a 70 percent solution of isopropyl alcohol, followed by 120 ml of physiologic saline solution; (3) regimen 3 consisted of 120 ml of alkaline glutaraldehyde, followed by 120 ml of a 70 percent

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percent solution of isopropyl alcohol, followed by 120 ml of physiologic saline solution; (4) regimen 4 was 120 ml of benzalkonium chloride, followed by 120 ml of a 70 percent solution of isopropyl alcohol, followed by 120 ml of physiologic saline solution; and (5) regimen 5 consisted of 120 ml of a providone-iodine solution, followed by 120 ml of a 70 percent solution of isopropyl alcohol, followed by 120 ml of physiologic saline solution. The fiberoptic bronchoscope was recontaminated prior to each regimen of disinfection. Recontamination and disinfection was conducted five times for each organism and for each individual regimen. Following each such maneuver, bacteriologic studies were performed to determine the degree of residual contamination.

The outer shaft and tip of the bronchoscope were wiped with a sterile cotton swab, which was then cultured. Subsequently, 10 ml of sterile saline solution was aspirated through the bronchoscope after each trial and was collected in a Lukens trap. The specimens were cultured, and counts of colonies were determined.

RESULTS

The observed differences in residual bacterial contamination of the bronchoscope’s inner channel appear to be most striking when physiologic saline solution alone is compared to combinations of saline solution, isopropyl alcohol, and each antiseptic agent tested (Table 1). Using the rank-sum test, significant differences were noted when comparing the benzalkonium chloride-alcohol-saline regimen to the alcohol-saline regimen (P < 0.02), as well as when comparing the glutaraldehyde-alcohol-saline regimen to the alcohol-saline regimen (P < 0.04). A similar analysis showed no significant difference between the povidone-iodine-alcohol-saline regimen and the alcohol-saline regimen. Nevertheless, regardless of the disinfecting solution used, no one regimen consistently eliminated all organisms from the inner channel.

Cultures of swabs of the external shaft and tip of the instrument were positive in all trials using physiologic saline solution alone for the organisms, *P. aeruginosa* and *Staph aureus*. Such cultures were also positive in four of five trials for *Strep pyogenes* and *E coli* and in one trial for *K pneumoniae*. Cultures obtained after the alcohol-saline regimen were positive in only one trial of *P. aeruginosa* (four colonies). All other cultures of the instrument’s surface were negative.

DISCUSSION

With the introduction of fiberoptic bronchoscopy into the United States, Ikeda advocated the use of sterilization with ethylene oxide, using equipment with capabilities not then or now readily available in this country. His method required temperatures not to exceed 104°F and pressures not greater than 8 pounds per square inch for periods up to four hours in duration. A study by Webb and Vall-Spinosa reported outbreaks of infection with *Serratia marcescens* transmitted by bronchoscopes “sterilized” with the technique using ethylene oxide once or twice weekly and with interim disinfection using a 70 percent solution of alcohol and sterile saline solution. Since the genus, Serratia, is rarely found, we elected to evaluate our method against the pathogenic organisms most commonly encountered in our hospital.

In a recent study, Suratt and associates cited 12 approaches to this problem. We are not aware of any other current studies evaluating the relative effectiveness of all of these approaches. In our investigation, we have attempted to compare three such interventions, when incorporated into our protocol for disinfection.

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REFERENCES