

## PRELIMINARY REPORT

### The Effectiveness of Bacterial Filtration in Vented Wound Drains

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The clinical use of vented wound drains requires documentation of the maintenance of a sterile wound environment in the presence of aspirated air. This study was designed to evaluate the effectiveness of a commercially available bacterial filter under conditions of continuous aspiration of room air into a culture medium incubated for 14 days. The control (no filter) group showed growth in all specimens at 24 hr, and the filter group showed no bacterial growth during the experimental period.

#### INTRODUCTION

Although wound drainage is at least as old as Hippocrates [1], suction drainage of surgical wounds has been increasing in popularity only in recent years. The purpose of wound drainage is the "prevention of collections of fluid: blood, pus, bile, and intestinal contents" [3] within operative wounds with an expected decrease in infection and reduction in healing time. If a surgical drain fails to perform properly, neither of those benefits will accrue.

Wound drains may be divided by mechanism of action: suction (closed or vented), capillary, or gravitational. The most common of the nonsuction drains (the Penrose), in fact, may not even be considered a proper drain at all, but rather a stent to keep an exit wound from closing and, hopefully, a wick to draw exudate to the surface by its capillarity [4]. There is some indication that the use of the Penrose drain can actually increase the likelihood of infection [3].

Active suction drainage is only effective, however, so long as the aspirating lumen of the drain remains clear, and the exudate is free to move up the tube. Should the aspirating tube become clogged, drainage ceases.

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One way to lessen this likelihood is to provide an air vent to the distal end of the aspirating lumen of the tube. This vent permits air to bubble through the tube, substantially reducing both the total amount of viscous liquid in contact with the tube wall at any given moment, and reducing the wound to aspirator transit time. The latter effect assures that, as the oozing from a wound diminishes, air displaces blood from the lumen of the drain before the blood has time to clot and plug the tube.

Venting wound drains to room air, however, provides an easy conduit for airborne bacteria to enter the wound, possibly increasing the risk of infection. Baker and Borchardt [2] studied the extent to which vented sump wound drains permit such bacterial entry into operative wounds, but their data on postoperative infections were largely anecdotal. These authors immersed the distal portions of vented wound drains (Salem Sump Drains) in nutrient broth, and room air was drawn through the tubes under high and low vacuum suction provided by a Gomco pump. Substantial bacterial growth appeared only under the high vacuum condition. None appeared under the low vacuum condition. The differential bacterial growth under the high vacuum condition was attributed by the authors to the greater volume of air flow through the tubes at higher

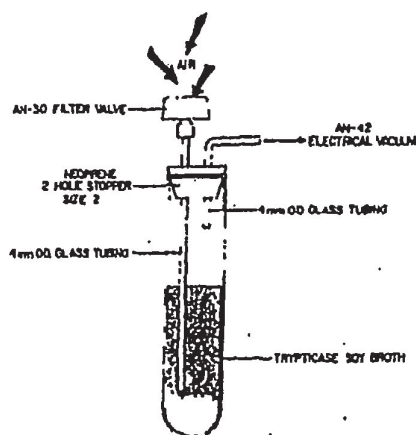


FIG. 1 Diagram of the experimental apparatus with negative suction applied at 24 cm of water.

vacuum, but that remains a parametric issue—at some combination of length of time and vacuum, bacterial contamination seems inevitable.

If the mechanical and physiological advantages of vented suction are to be realized in clinical use, elimination of the risk of bacterial contamination must be accomplished by bacterial filtration. The present study reports the differential effects of the presence or absence of a bacterial filter on an *in vitro* test of a wound drainage system (the Shirley Wound Drain AN-30).<sup>2</sup>

#### METHOD

Twenty-four filter assemblies of the type attached to the Shirley Wound Drain were used. Each filter assembly consisted of a circular plastic base, 1.5 cm in diameter, a plastic cap perforated to allow the passage of air, and a bacterial filter under the cap and over a port in the base through which the wound drain tube is usually attached. The filter is a 1- $\mu$ m nonwetable bacterial filter.<sup>3</sup> Six units were assembled without the

filter. Each filter assembly (with and without filter) was mounted on a 4.0-mm o.d. glass tube and inserted through a No. 2, two-hole neoprene stopper. Also inserted into the stopper was a shorter 4.0-mm o.d. glass (vacuum) tube (see Fig. 1). All assemblies were then wrapped in cloth, and sterilized in ethylene oxide (Anprolene)<sup>2</sup> and aerated for 24 hr at room temperature. Thirty culture tubes were each filled with 20 ml of trypticase soy broth, capped, and autoclaved for 15 min at 15 lbs. pressure and 250°F. Each sterile filter assembly was then unwrapped using sterile technique. The culture tube cap was removed and the long glass tube of each filter was securely placed in the mouth of each culture tube. Vacuum was provided by AN 42 Sump Pumps<sup>1</sup> connected to the shorter glass tube, regulated to 24 in. of water. The pumps were allowed to operate continuously for 24 hr, drawing room air through the filter caps into the culture medium after which the vacuum tube of each assembly was cut and heat sealed. The culture tubes were then incubated for 14 days at 37°C.

#### RESULTS

All of the control (no filter) tubes showed growth of bacteria in the culture medium within 24 hr of the start of incubation. None of the 24 culture tubes to which filter assemblies containing filters had been connected showed any growth of microorganisms at any time during the 14-day incubation period.

#### DISCUSSION

Since hospital room air likely contains pathogens, it is highly likely that drawing unfiltered room air through a postoperative wound may produce infection. The present data partially replicate those of Baker and Borchardt [2] in this respect. The addition of a filter in this study prevented the entrance of bacteria into a culture medium using simulated clinical conditions and ap-

paratus. While *in vitro* probability of infection, bacteria in the culture bio experiment is presumptively efficiency of the filter as several experiments are carried out to further investigate the filter in preventing infection. It is noted that even though the pumps in the present study the low vacuum range of Borchardt's [2] study, the growth in the culture medium in unfiltered wound drains is relatively low sources of

#### CONCLUSIONS

- (1) Vented, unfiltered, very bacterial contamination levels of suction.
- (2) Addition of a bacterial filter to the air intake reduced such contamination as it

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paratus. While *in vitro* data vis-a-vis the probability of infection, the absence of bacteria in the culture broth in the present experiment is presumptive evidence of the efficacy of the filter assembly. *In vivo* animal experiments are currently in progress to further investigate the efficacy of the filter in preventing infection. It should be noted that even though the vacuum drawn by the pumps in the present study fell within the low vacuum range of Baker and Borchardt's [2] study, there was bacterial growth in the culture media through which unfiltered wound drains connected to even relatively low sources of vacuum.

#### CONCLUSION

(1) Vented, unfiltered wound drains convey bacterial contamination at physiologic levels of suction.

(2) Addition of a commercially available filter to the air intake reduces the risk of such contamination as demonstrated in 24

experiments with negative cultures at 14 days of incubation.

(3) The authors believe that this study documents the safety of the vented wound drain for clinical use.

#### ACKNOWLEDGMENT

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#### REFERENCES

1. Adams, F. *The Genuine Work of Hippocrates. Translated from the Greek with Preliminary Discourse and Annotations.* London: The Sydenham Society; 1849. Vol. 1
2. Baker, B. H., and Borchardt, K. A. Sump drains and airborne bacteria as a cause of wound infections. *J Surg Res* 17: 407, 1974
3. Cerise, E. J. Drains in abdominal surgery Their use and abuse In W. F. Ballinger and T. Drapanas (Eds.), *Practice of surgery Current review* St Louis, Mo.: Mosby, 1975
4. Chaffin, H. C. Surgical drainage *J Int Coll Surg* 22: 683, 1954