Brief Reports

In vitro use of Epidural Filters for Prevention of Bacterial Infection

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An experiment was conducted to evaluate the efficacy of epidural bacterial filters (pore size 22nm) in the filtration of pathogenic bacteria from clear intravenous (IV) fluids. Fifty mL of sterile dextrose was mixed with a known quantity of bacteria and infused through an epidural bacterial filter by a syringe pump at a rate of 2 ml per hour for 24 hours. Cultures were done from the remaining fluid in the syringe, the filtrate in the urobag, as well as the bacterial solution at the end of 24 hours. The efficacy of the filter against bolus doses was also evaluated. Staphylococcus aureus and Pseudomonas (80cc strain) were chosen. Initial runs conducted without the filters showed that bacteria could be isolated from the syringe and the urobag at the end of 24 hours. The filtrate in all runs and that tested for efficacy against IV bolus dose was sterile. However, four filters in the experiment using bolus doses, got clogged and had to be discarded. The epidural bacterial filter proved 100% effective in removing pathogenic bacteria from clear IV fluids under experimental conditions.

Key words: *Bacterial infections, Epidural filters.*

Intravenous (IV) fluids form the mainstay of treatment in a large number of very low birth weight (<1500 grams) and sick neonates. These neonates are prone to infection and IV lines act as an easy portal of entry for pathogens. Sepsis is a major cause of morbidity and mortality in neonates and contamination of IV fluids during use in the hospital continues to be of concern. This can be prevented with the use of intravenous filters(l,2). There are though few studies which have shown no extra benefit where laminar flow is used(3). The other benefit of IV filters is decreased phlebitis(4). A number of on -line antibacterial filters are available in the market. However their prohibitive cost limits their widespread use. The cost of available IV antibacterial filters is approximately Rs. 400. They last for 24 to 72 hrs. There are some cheaper alternatives like the epidural filters. The cost of the epidural filter is approximately Rs. 100. The limitation with this alternative is that it has not been studied for use with syringe infusion pumps. Rather, they have been tested in gravity dependent flow systems. This experimental study was designed to evaluate efficacy of an epidural antibacterial filter for use as an IV filter for clear fluids administered by a syringe pump and contaminated with known pathogen.

Subjects and Methods

The experimental study was done in the microbiological laboratory under strict quality

control. Sterile 10% dextrose was used as the infusing fluid. The efficacy of the nitrocellulose epidural filter (0.22µm pore size) made by Vygon was tested for known pathogenic strains in the laboratory. The strains tested were *Staphylococcus aureus* ATCC number 80 cc size l µm and *Pseudomonas aeruginosa* A TCC number 88 cc size 0.5 µm. The experiment was conducted in multiple runs.

Experiment

Sterile syringes (50 mL each) were loaded with 50 mL of 10% dextrose and spiked with a bacterial suspension equivalent to 10^6/mL of bacteria. Each syringe was connected to a sterile IV infusion line. To the distal end of this IV line, an antibacterial filter was attached, and the filtrate was collected into a sterile urobag. The entire system was thus a sterile one. All connections and manipulations were done in the same manner under strict aseptic conditions. Syringe pump was used to infuse the fluid in each syringe at 2 mL/hr for 24 hrs.

Preparation of study inoculum

Plates were inoculated with *Staphylococcus aureus* ATCC No. 80 cc and *Pseudomonas aeruginosa* ATCC No. 88 cc strain and incubated at 37ºC for 24 hours. Isolated single colony was sub cultured in 10% dextrose and incubated at 37ºC overnight. The inoculum preparation was adjusted to 0.5 Nacfarland's standard to obtain a total cell concentration of 10^6 cells/mL of 10% dextrose infusion.

Infusion without the filter: (*control*)

Long-term viability of the inoculum was monitored by the initial two runs, which acted as control (*Figs. 1 and 2*) syringes containing either of the two organisms. The spiked IV fluid with each organism and without the filter was infused at 2 mL/hr and the elute was collected after 24 hrs and cultured. This was to ensure the viability of bacteria in the sterile

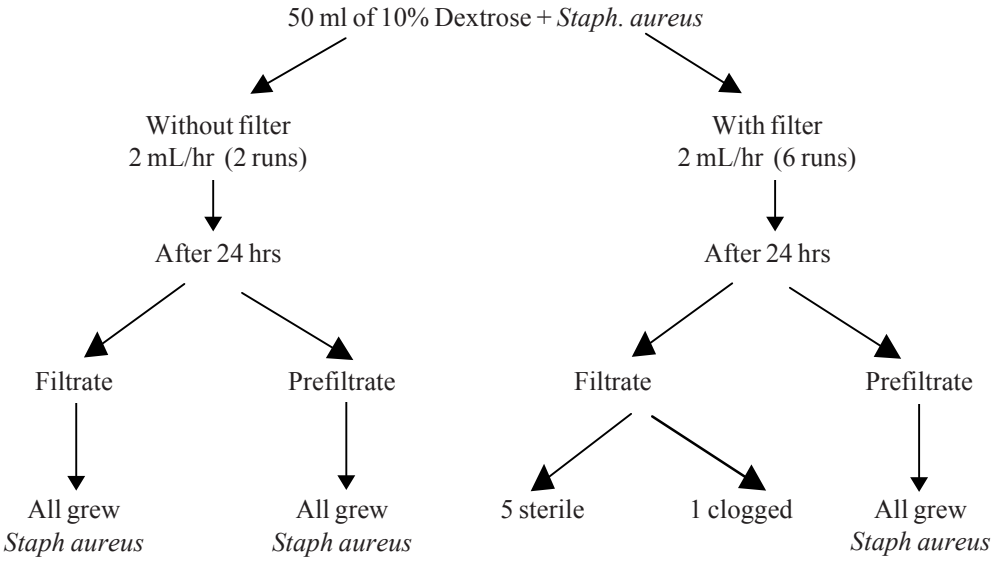

Fig. 1. Staph. aureus experiment.

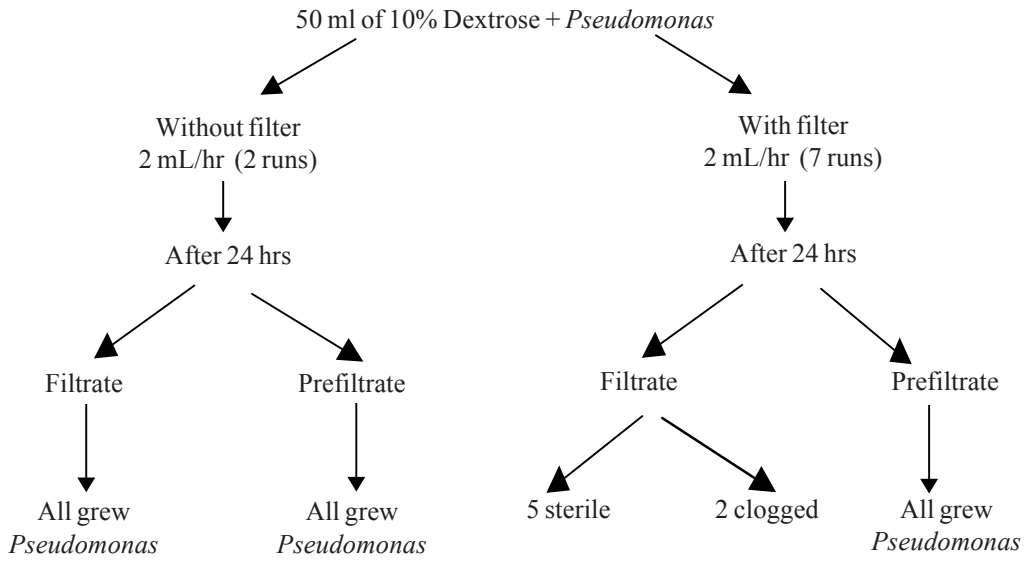

Fig. 2. Pseudomonas experiment.

urobag at the end of 24 hours of running the infusion.

Infusion with the filter: (*study*)

Subsequently six experiments with *Staphylococcus aureus* and seven experiments with *Pseudomonas aerugenosa* were run to collect filtrate in urobag with online bacterial filter. At the end of 24 hrs, of each experiment filtrate as well as prefiltrate elute were cultured for bacterial growth on nutrient agar.

Bolus doses

To evaluate the efficacy of the filter against fast bolus infusions administered at higher rates, three filters were tested for each bacteria. Two mL of inoculum of 10^6/mL in 10% dextrose of *S. aureus* and *P. aerugenosa* were loaded separately under same sterile condition. Six boluses were infused through each filter at an interval of 5 min. The prefiltrate and post filtrate elute were cultured on nutrient agar.

Results

Control infusion

The initial experiments, which acted as control without the filters, showed both the bacteria to be recoverable at the end of 24 hrs from the syringe and the urobag. A total of thirteen experiments using filter were conducted. Out of the thirteen experiments, the inoculum was *Pseudomonas* in seven and *Staphylococcus aureus* in six experiments.

Infusion study

Three experiments had to be abandoned. Out of these three, the inoculum was *S. aureus* in one and *Pseudomonas* in two experiments. Two of these had to be abandoned because of a malfunctioning of syringe pump and one because filter got clogged. The filter, which got clogged had *Pseudomonas* as inoculum. In the remaining five experiments for each of the organism, despite the bacteria being isolated from the prefiltrate, the filtrate was sterile at the end of 24 hours.

Key Messages

- Epidural filter is a cheaper alternative to available intravenous filters
- Clinical trials to determine effectiveness of the low cost epidural filters are needed

Bolus study

Nine filters were tested for efficacy of filter to withstand IV bolus doses. In the three bacterial filters in which *S. aureus* inoculums had been pushed six times as bolus doses of 2 mL each were found to have all six sterile filtrate while from pre filtrate organism could be cultured. Three filters in which *Pseudomonas* inoculums were pushed got clogged. The experiment was repeated with three more filters using *Pseudomonas* as inoculum. Out of the three filters, in two filters after pushing six times 2 mL each as bolus doses, it was seen that all the six filtrates were sterile and prefiltrate grew organism, but one filter again got clogged. The study was again repeated with three more filters using *Pseudomonas* as inoculum after the inoculum was checked for the load. All the three filters had sterile filtrate after each push repeated six times the reason for clogging in the previous filters was probably too much of inoculum load.

Discussion

The epidural bacterial filters proved 100% effective under experimental conditions in filtering out *Staphylococcus aureus* and *Pseudomonas* when used with syringe pump. Also, it was 100% effective in filtering the same bacteriae when pushed through the filter six times each. The experiments in which the filter got clogged could be explained by the heavy inoculum of *Pseudomonas aeruginosa*, which may not be simulated in real life situation. An epidural bacterial filter (pore size being 22 nm) costs about 50% of other available bacterial filters. The cost difference is Rs. 300. This may be useful especially in situations where IV fluid is to be given for shorter duration where they may be more cost effective. On the other hand, costly filters with efficacy for 72 hrs are not of any added advantage. It is very important in developing countries like ours to have such cost effective and cheaper alternatives. Controlled clinical trials would be needed to determine the effectiveness and clinical efficacy of this low cost, readily available epidural filter.

Conclusion

The epidural filter was found to be effective in experimental conditions in filtering out gram positive (*Staph. aureus*) and gram negative (*Pseudomonas* 80 cc strain) organisms when infused at the rate of 2 mL/hr for 24 hours using a syringe pump and using 5% dextrose as the parenteral solution. It was also seen that the filter was able to withstand the bolus doses, which were much faster than the infusion rates in keeping away the two above mentioned laboratory strains. Under experimental conditions two out of nine filters were clogged due to inoculum load. There is scope for clinical trials using these low cost epidural filters in preventing nosocomial infections.

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Competing interests: None.

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