Title: Survival of bacteria during nasal cannula storage in polyethylene plastic vs polypropylene mesh bags.

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Abstract

Used nasal cannulas are often stored for short periods in a plastic bag, then reused on the same patient. To test survival of bacteria during cannula storage, sterile cannula segments were contaminated with Staphylococcus epidermidis or Pseudomonas aeruginosa bacteria, then stored in polyethylene clear plastic or polypropylene mesh bags. Viable bacteria were readily recovered from cannulas that had been stored in polyethylene plastic, however, numbers of recoverable bacteria decreased dramatically (84 to 99 %) following one hour storage in polypropylene mesh bags.

Title

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Background:

Nasal cannula is a plastic tube that delivers complementary oxygen into the nasal cavity of patients who undergo periodic oxygen stress.[1] Chronic recipients of this treatment often include elderly patients who undergo hypoxic episodes and those with COPD. The cannula allows delivery of humidified oxygen with minimal damage to mucosa.

Commonly, a nasal cannula will be withdrawn and placed into a holding receptacle such as a plastic bag, then used again on the same patient when needed. One potential consequence of placing the nasal-end of the cannula in a plastic bag is the introduction of opportunistic organisms from the nose into a moist bag where they may survive or multiply un-checked. When usage of the cannula resumes, the number of organisms may have increased during storage to high levels and are then reintroduced into the nose of the patient. Nasal microorganisms that may be innocuous at low levels, but dangerous at

higher levels, include *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Pseudomonas aeruginosa*, and other opportunistic pathogens.[2] The nasal cavity is, in essence, a reservoir of potential problems.

The purpose of our investigation was to measure survival of two test organisms during storage of contaminated nasal cannulas for short periods of time in either polyethylene plastic bags or polypropylene mesh bags. *Staphylococcus epidermidis* and *Pseudomonas aeruginosa* were selected as target organisms. We chose a non-pathogenic *Staphylococcus* and the opportunistic pathogenic *Pseudomonas aeruginosa* as representative of organisms that may contaminate and survive on a nasal cannula during *ex-vivo* storage.[2]

Design:

*Staphylococcus epidermidis* and *Pseudomonas aeruginosa* were grown overnight at 36 degrees C in trypticase soy broth (TSB). Cultures were diluted to approximately $10^8$ bacteria per milliliter in sterile water. Two centimeter pieces of sterile adult nasal cannula were aseptically placed in a dish containing the diluted bacteria for one minute. These contaminated cannulas were transferred to either a polyethylene plastic bag or polypropylene mesh bag. Immediately (time zero) and after one hour, cannula pieces were removed with sterile forceps, placed into 4.5 ml sterile water, and vortexed for three seconds. The water (containing bacteria that had survived the bag storage) was diluted 10-fold into sterile water and 50 microliters plated onto trypticase soy agar (TSA) plates. Plates were incubated overnight at 36 degrees C, and then colony forming units (CFU)

counted. Each CFU represents one original bacterium that had survived the cannula storage bag. All experiments were run in duplicate and repeated with similar results.

Results

The first noteworthy result is that immediately after adding the *Staphylococcus*-contaminated cannulas to the polypropylene mesh bags, there was a 62 % decrease in recoverable bacteria ($p < 0.017$) (Figure 1). After one hour of storage in mesh bags there was an 84 % decrease in recoverable *Staphylococcus* compared with cannulas stored in polyethylene plastic bags ($p<0.005$). There was no change in recoverable bacteria after one hour storage in polyethylene plastic bags ($p < 0.36$). Similar results were obtained when *Pseudomonas aeruginosa* was the test bacterium (Figure 2). There was an immediate decrease of 87 % in recoverable *Pseudomonas* compared with polyethylene plastic bags ($p< 0.008$); After one hour there was a 99 % decrease in recoverable *Pseudomonas* from the mesh compared with polyethylene plastic ($p < 0.004$); Again, there was no change in recoverable *Pseudomonas* after one hour storage in polyethylene plastic bags ($p < 0.38$). Based on these results, polypropylene mesh bag storage of used cannulas decreases recovery of bacteria and likely minimizes cross-contamination and re-introduction of large numbers of bacteria back into the nose.

Implications:

Opportunistic pathogens may reside in the nasal cavity of carriers for long periods of time and never cause problems.[2] Patients may be chronically colonized by opportunists

such as MRSA or may acquire the organisms during hospitalization or in a nursing home.[3, 4] Problems often arise when the numbers of organisms increase, patient defenses become compromised, or organisms contaminate vulnerable tissues.[2] Common infections from these organisms include secondary pneumonia, otitis media, sinusitis, and wound infections.[2]

Neely and Maley report that Enterococci and Staphylococci can survive on common hospital fabrics and plastic splash aprons, in some cases up to several months.[5] Herein, we have shown that, during nasal cannula storage in plastic bags, contaminating bacteria may survive, providing an opportunity for re-introduction or cross-contamination. The polypropylene mesh bags used in this study decreased recovery of the contaminating test organisms. The mechanism of suppression by these bags is untested, but is likely due to dehydration during airflow through the mesh fabric. We recommend that used nasal cannulas be stored in a matrix that is porous and prevents buildup of moist mucus that would support bacterial survival.

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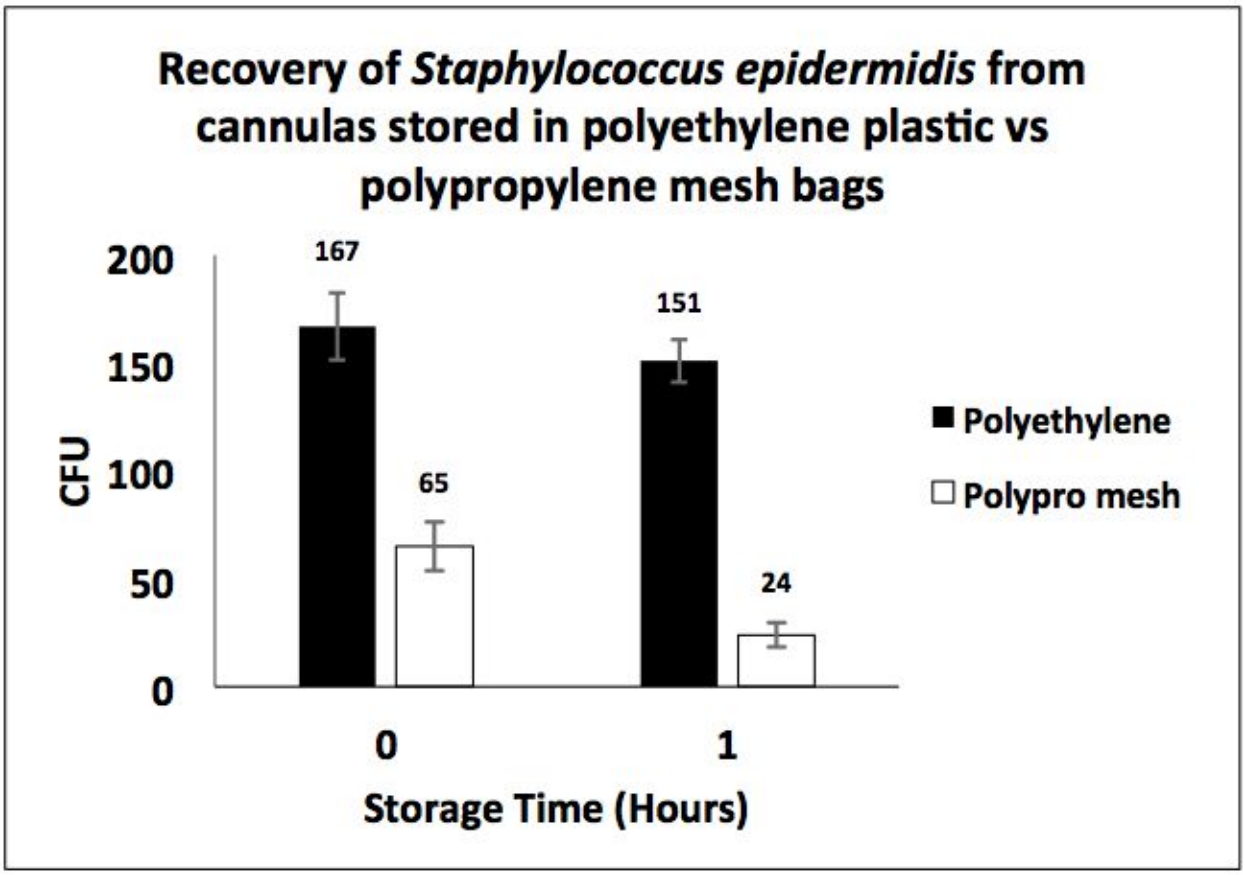


**Figure 1**. Number of viable *Staphylococcus epidermidis* (Colony Forming Units, CFU) recovered from cannula pieces stored in polyethylene plastic or polypropylene mesh bags. Bars represent SD.

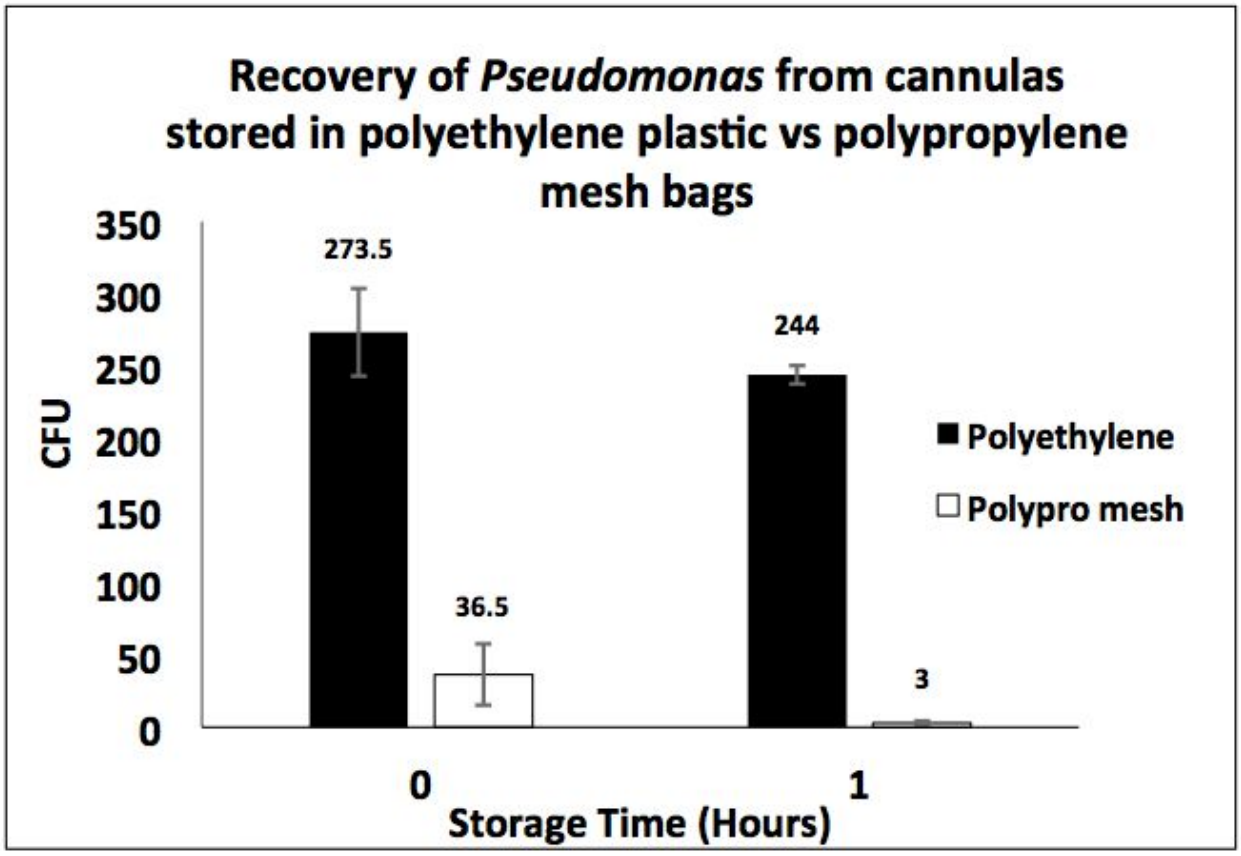


**Figure 2**. Number of viable *Pseudomonas aeruginosa* (Colony Forming Units, CFU) recovered from cannula pieces stored in polyethylene plastic or polypropylene mesh bags. Bars represent SD.