Enteral feeding has become a standard of practice for patients who are unable to consume sufficient calories by mouth yet have adequate gastrointestinal absorptive capacity. The role of enteral feeding in nosocomial infections is increasingly being appreciated. Contamination of enteral feeds can lead to abdominal distention, aspiration pneumonia associated with organisms present in the administration feed sets, and colonization of the recipient by organisms initially isolated from the enteral tube hub, and therefore serve as a reservoir of organisms that can be crosstransmitted.

**Background:** Enteral feeding tubes have been associated with outbreaks of antimicrobial-resistant organisms, but the pathogenesis of this association has not been investigated. We hypothesized that the enteral feed administration sets become colonized externally by microbes grown from the enteral tube hub, and therefore serve as a reservoir of organisms that can be crosstransmitted.

**Methods:** We conducted a prospective observational cohort pilot study, obtaining bacterial cultures from the external enteral feed administration set and from the hub of nasogastric, gastric, or gastrojejunal tubes in children receiving enteral feeding while hospitalized in a tertiary care pediatric hospital.

**Results:** Thirty-six of 37 hubs cultured had bacterial growth. Twenty-nine of 36 administration sets (78%) sampled had at least 1 microbe isolated that was also cultured from the hub. No significant risk factors for colonization were identified.

**Conclusions:** Enteral feed administration sets are frequently colonized by organisms in the enteral tube hub. These sets can serve as a reservoir of organisms that can be crosstransmitted between patients. Adherence to Standard Precautions is critical when handling enteral feeding apparatuses. (Am J Infect Control 2003;31:49-53.)

**METHODS**

**Setting**
The study was performed on units previously recognized to have high usage of enteral feed sets,
including the critical care unit, the gastroenterology/transplant unit, and the general pediatrics units.

**Design**

A single unit was targeted on a designated sampling day. On the day of sampling, an infection control practitioner approached a clinical nurse leader on the unit and ascertained which patients were undergoing enteral feeding, through either a nasogastric, gastric, or gastrojejunal tube. Patients who had transmission-based precautions (i.e., airborne, contact, or droplet as per Centers for Disease Control and Prevention definitions) were excluded. Demographic data were collected on all children from whom specimens were taken (e.g., age, type of tube, date of tube insertion, continuous versus bolus feeding, and underlying condition). The hospital’s Research Ethics Board approved the study.

**Specimen collection**

All specimens were collected at the bedside. In all instances the administration set tubing was sampled before the hub was sampled. Fig 1 shows an enteral feed apparatus and sampling sites. A sterile swab was dipped into a 5-mL tube of brain-heart-infusion (BHI) broth (Becton Dickinson, BBL) and used to swab all sides of the distal end up to 10 cm above the inserted connector portion of the administration set tubing being used for continuous feeding. For patients receiving bolus tube feeding, the administration set tubing was usually wound around and dangled from the hang pole; in these cases, the distal tubing was swabbed from this position. Specimen swabs were then placed into the tube of BHI broth for transport to the laboratory. After the extraluminal portion of the administration set being used for continuous feeding was sampled, the hub of the feeding tube was disconnected. A swab premoistened as previously described was inserted approximately 1 cm into the hub of the feeding tube, rotated, removed, and placed into the tube of BHI broth. The administration set was then reconnected to the hub. For patients receiving bolus feeding, the cap of the feeding tube was removed and the hub sampled as previously described. All specimens were transported to the laboratory and processed immediately on arrival.

**Microbiologic procedures.** All microbiologic work was performed in a laminar-flow hood. On arrival to the laboratory, the hub swabs were plated directly onto a 5% sheep blood agar and MacConkey plate and then reimmersed in the BHI broth for overnight incubation at 37°C. The next day, 0.5 mL of each broth was subcultured onto a sheep blood agar and MacConkey plate and incubated overnight at 37°C, as previously described. The administration set tubing swabs were incubated overnight in broth medium and subcultured as previously described. Plates were examined after 24 hours of incubation, and microbial growth was recorded. Organisms were identified by standard techniques on the basis of carbon source utilization, and organisms grown from the hub were compared with those grown from the tubing.

**Study variable.** The primary outcome variable was the proportion of external tube cultures that grew at least 1 organism also present on culture of the hub.
Sample size. Initially, the sample size was calculated to determine the proportion of external tube cultures growing at least 1 organism cultured from the hub. We selected a convenience sample size of 75 specimens, estimating that this would occur 25% of the time.

Statistical analysis. The 2-sample t and Fisher exact tests were used to assess the significance of differences in the continuous and categorical variables, respectively.

RESULTS

After 37 patients' administration sets were sampled, it was apparent that there was a high rate of concordance between the microbial growth on the distal administration set and in the enteral tube hub. The study was therefore terminated and the results analyzed.

The demographic characteristics of the study population are outlined in Table 1. Bacterial growth in the hubs was found in 36 of the 37 hubs that were cultured. In 29 of 36 patients' (78%) administration sets, at least 1 organism was isolated from both the hub and the tubing. In 9 of 36 (24%) administration sets, 2 organisms were isolated from both the hub and the tubing. Table 2 describes the number of times specific bacteria were isolated from both the hub and administration tube in the cohort of patients with concordant cultures. As can be seen, most of the organisms were enteric bacteria.

No statistical difference was found between the 2 groups (patients with ≥1 concordant hub and tubing isolate and patients with no concordant hub and tubing growth) with regard to sex, age, number of weeks receiving enteral feeding, bolus versus continuous feeding, and number of weeks from the time of admission to the time of specimen collection.

DISCUSSION

The results of this pilot study provide an understanding of the role of enteral feed apparatuses in the transmission of microorganisms and thus as a risk factor for nosocomial outbreaks of infection. Colonization of the distal administration set by enteric bacteria pre-
sent in the enteral tube hub leads to an easily accessible reservoir of gastrointestinal organisms. The hardness of enteric organisms and the frequent handling of enteral feed apparatuses, particularly in children receiving bolus feeding, creates an ideal setup for cross-transmission. The recent report of the probable role of enteral feeding procedures in an outbreak of Klebsiella oxytoca infection in premature babies further supports our findings. In that study, use of gloves during enteral feeding procedures and reinforcement of Standard Precautions resolved the outbreak.

Standard Precautions is the term used to describe the infection control measures that health care workers should use in the care of all patients when handling blood/body fluids and secretions/excretions or items contaminated by them and nonintact skin and mucous membranes. Regular handwashing is an essential component of Standard Precautions and is necessary to prevent the transfer of microbes between tasks on the same patient or between patients, regardless of whether gloves are worn. Pittet et al have shown that patient care activities associated with a high level of bacterial contamination include those with direct patient contact, respiratory care, and handling of body fluid secretions. In their study, compliance with handwashing was low for procedures with a high risk for microbe transmission, including intravenous care, before respiratory care, and care between a dirty and a clean site. Although we have not done an observational study to substantiate our claim, we hypothesize that health care workers underestimate the degree of bacterial colonization of gastric and upper intestinal fluid and do not routinely adhere to Standard Precautions when performing enteral feeding procedures (eg, checking for residuals and connecting administration set to enteral tube hub).

An appreciation of the epidemiologic factors of microbial colonization of the upper gastrointestinal tract aids in understanding the pathogenesis of enteral feeding apparatus colonization. Ordinarily, the nasopharyngeal flora consists of numerous avirulent organisms, such as streptococci and diphtheroids, and the gastric flora of fasting subjects has fewer than 10 organisms per milliliter. The colonization pattern differs in hospitalized patients who are debilitated, have an abnormal swallowing reflex, or are taking antacids or antibiotics because their upper gastrointestinal tract becomes colonized with high concentrations of lower gastrointestinal flora, including multiresistant organisms. These organisms cannot only colonize the intragastric component of the tube but can migrate to and colonize the hub after gastric fluid has been suctioned during the check for residual volume or when patency of the lumen of the tube is verified. Handling the hub can then colonize the health care worker’s hands, which can lead to contamination of the environment as well as other patients if the hands are not washed.

There are a number of limitations to our study. In calculating the sample size for the study we arbitrarily estimated clinical and statistical significance to be more than 25% of the administration sets colonized with organisms at the hub. The results of this study show colonization rates to be much higher and provide useful pilot information for making a more accurate determination of the size of a study necessary for more conclusive results. Our failure to identify any significant risk factors is likely a result of the small numbers in the study and the wide confidence intervals of the results. Upfront stratification of the patient population (eg, by duration of the current nasogastric, gastric, or gastrojejunal tube in place) might better elucidate significant risk factors for colonization. Another limitation is that we defined an isolate on the administration set to be the same as that in the hub by species identification and not by molecular typing. Confirmation of the results by molecular typing would add further validity to our study. Finally, although we hypothesized that the administration sets became colonized via direct transfer of organisms from the hub, we cannot be entirely certain of the chronologic order of the events on the basis of our study. Further studies examining colonization of individual sets and hubs longitudinally over time would be required for a more accurate assessment.

According to curriculum from the Association for Professionals in Infection Control and Epidemiology, the patient or caregiver should be taught the “need for handwashing before feeding preparation, before hanging feedings, and when discontinuing feedings … and the principles of microbial contamination.” We emphasize the need to educate the caregiver about the many possibilities for hand contamination and the differentiation between clean and dirty tasks during the set up and administration of enteral feeding. The role of disinfecting the administration set tubing periodically during use as a strategy to reduce the microbial burden on the tube may warrant further study.

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