Effectiveness of 0.12% Chlorhexidine Gluconate Oral Rinse in Reducing Prevalence of Nosocomial Pneumonia in Patients Undergoing Heart Surgery

By Susan Houston, RN, PhD, CNA, Paul Houglan, MD, Jacqueline J. Anderson, RN, MSN, Mark LaRocco, PhD, Virginia Kennedy, RN, MS, CIC, and Layne O. Gentry, MD. From St. Luke’s Episcopal Hospital (SH, PH, JJA, ML, VK, LOG) and Baylor College of Medicine (LOG), Houston, Tex.

- **Background** Decreasing the levels of bacteria in the oropharynx should reduce the prevalence of nosocomial pneumonia.
- **Objectives** To test the effectiveness of 0.12% chlorhexidine gluconate oral rinse in decreasing microbial colonization of the respiratory tract and nosocomial pneumonia in patients undergoing open heart surgery.
- **Methods** A prospective, randomized, case-controlled clinical trial design was used. Peridex (0.12% chlorhexidine gluconate) was the experimental drug, and Listerine (phenolic mixture) was the control drug. A total of 561 patients undergoing aortocoronary bypass or valve surgery requiring cardiopulmonary bypass were randomized to an experimental (n = 270) or a control (n = 291) group. Nosocomial pneumonia was diagnosed by using the criteria established by the Centers for Disease Control and Prevention.
- **Results** The overall rate of nosocomial pneumonia was reduced by 52% (4/270 vs 9/291; \( P = .21 \)) in the Peridex-treated patients. Among patients intubated for more than 24 hours who had cultures that showed microbial growth (all pneumonias occurred in this group), the pneumonia rate was reduced by 58% (4/19 vs 9/18; \( P = .06 \)) in patients treated with Peridex. In patients at highest risk for pneumonia (intubated >24 hours, with cultures showing the most growth), the rate was 71% lower in the Peridex group than in the Listerine group (2/10 vs 7/10; \( P = .02 \)).
- **Conclusions** Although rates of nosocomial pneumonia were lower in patients treated with Peridex than in patients treated with Listerine, the difference was significant only in those patients intubated more than 24 hours who had the highest degree of bacterial colonization. (American Journal of Critical Care. 2002;11:567-570)

Nosocomial pneumonia is a significant contributor to patients’ morbidity and mortality. It has the highest mortality of nosocomial infections and is the most common infection in intensive care units. Thoracic surgery and prolonged mechanical ventilation are also known to increase patients’ risk for nosocomial pneumonia.

The Centers for Disease Control and Prevention postulates 4 possible mechanisms that lead to nosocomial pneumonia: (1) aspiration of oropharyngeal organisms, (2) inhalation of aerosol that contains bacteria, (3) hematogenous spread from distant body sites, and (4) bacterial translocation from the gastrointestinal tract.
tract. Aspiration of organisms from the oropharynx is considered the most important of these mechanisms.\(^1\) Reducing levels of bacteria in the oropharynx would theoretically lead to a decrease in the prevalence of nosocomial pneumonia.

Peridex (0.12% chlorhexidine mouth rinse) is an antimicrobial agent effective against aerobic and anaerobic bacteria. It is a substantive rinse that is adsorbed onto soft tissues and released over time.\(^4\) Within 1 minute after administration, the total numbers of aerobes and anaerobes are reduced 87% and 84%, respectively, and bacterial counts actually decrease over time (88% and 92% reduction, respectively, 5 hours later).\(^5\)

Several investigators have evaluated the effects of 0.12% chlorhexidine mouth rinse on plaque and gingival inflammation. Brownstein et al\(^6\) reported significantly reduced plaque accumulation, decreased gingival bleeding, and a lower mean log of colony-forming units of *Actinomyces* species with either twice-daily rinses or once-a-day irrigation. Beiswanger et al\(^7\) studied the effect of a 0.12% chlorhexidine rinse on gingival healing after scaling and root planing. After baseline measurements were recorded, test subjects used 15 mL (\(1/2\) oz) of chlorhexidine twice daily for 30 seconds 2 weeks before and 2 weeks after scaling and root planing of opposing quadrants on one side of the mouth. Then the remaining quadrants were treated, and an additional 2 weeks of chlorhexidine use were completed. Compared with the control groups, who used placebo, subjects who used the chlorhexidine rinse had significantly better gingival healing. The subjects in the test group had 29% less gingivitis, 48% fewer bleeding sites, and 54% less plaque.

Corbet et al\(^8\) investigated the effect of 0.12% chlorhexidine in a population with established gingivitis and abundant plaque and calculus in a double-blind clinical design, with 60 subjects divided into 2 groups. The experimental group was assigned to 2 daily mouth rinses for 6 days per week with 0.12% chlorhexidine, whereas the control group rinsed twice daily with a placebo solution. Before and after 3 months of supervised rinsing, plaque and gingivitis were assessed and scored. After 3 months, significant reductions in gingival bleeding and plaque occurred in the chlorhexidine group. Since that study, numerous studies have proved the effectiveness of chlorhexidine as an oral decontamination agent. Recently, DeRiso et al\(^9\) examined the effectiveness of 0.12% chlorhexidine on nosocomial infection in a homogeneous population of patients undergoing heart surgery. A prospective, randomized, double-blind, placebo-controlled design was used. A total of 353 patients undergoing open heart surgery were randomly assigned to the chlorhexidine or placebo groups. The overall nosocomial infection rate was decreased by 65% in the chlorhexidine-treated patients compared with the rate in patients given placebo (24/180 vs 8/173; \(P < .01\)). Overall, use of chlorhexidine oral rinse reduced the total nosocomial respiratory infection rate and the use of nonprophylactic systemic antibiotics in patients who had heart surgery.

St. Luke’s Episcopal Hospital in Houston, Tex, is a tertiary care center where many cardiovascular patients who require cardiopulmonary bypass are admitted (>1500 cases per year). Historically, more than 50% of cases of nosocomial pneumonia in the hospital occurred in cardiovascular patients. Listerine brand phenolic mouth rinse was used at St. Luke’s as the standard agent for routine oral care. Unlike Peridex, Listerine is a nonsubstantive agent—one that kills bacteria upon application but does not persist in tissues. Previous direct comparisons\(^10\) indicated that Peridex is more effective than Listerine both immediately and over time.

### Hypothesis

We hypothesized that Peridex would be more effective in reducing bacterial colonization and preventing nosocomial pneumonia in patients undergoing cardiac surgery.

### Materials and Methods

A randomized 2-group after-only design was used to test the hypotheses. The study protocol was prospective and experimental and was approved by the institution’s review board. All eligible patients who underwent aortocoronary bypass graft and/or valve surgery requiring cardiopulmonary bypass were invited to participate. All subjects who were invited agreed to participate. Patients were excluded from the study if they died during surgery, were pregnant, or had a preoperative respiratory infection that had been documented in the medical record or reported by the patient. Cardiovascular surgeons remained the same throughout the study.

After informed consent was obtained, patients were consecutively randomized to the experimental or the control group according to the patients’ medical record numbers. A sample size of 600 was projected on the basis of the institution’s historical rate of nosocomial pneumonia. This sample size was sufficient to detect a 0.20 effect size with 99% power. The oral rinses were dispensed by pharmacists and were administered by staff nurses. Both experimental and control groups received the oral rinse preoperatively and twice daily for 10 days postoperatively or until extubation, tra-
The characteristics between groups. The hypothesis that Peridex could prevent pneumonia by reducing levels of oropharyngeal flora and decreasing aspiration of these microbes. Previous investigations showing growth. This result seems counterintuitive to the hypothesis that Peridex could prevent pneumonia by reducing levels of oropharyngeal flora and decreasing aspiration of these microbes. Previous investigators found that Peridex is more effective than both.

**Results**

Of the 561 patients included in the final data analysis, 270 were randomized to the Peridex group and 291 to the Listerine group. Attrition resulted from death and tracheostomy. The 2 groups did not differ significantly with regard to characteristics, suggesting that the sample was homogeneous and adequately randomized (see Table). Durations of intubation were similar for both groups. The prevalence of nosocomial pneumonia did not differ significantly between the Peridex group and the Listerine group (4/270 vs 9/291; \( P = .21 \)). Cultures showed growth more often in the Peridex group than in the Listerine group; again, the difference was not significant (52/270 vs 44/291; \( P = .19 \)).

Only patients intubated for more than 24 hours had pneumonia develop (0/486 vs 13/75; \( P = .01 \)). In addition, all patients with diagnoses of pneumonia had a sputum culture that showed growth of microorganisms (0/465 vs 13/96; \( P = .01 \)). In the subpopulation of patients intubated more than 24 hours with a culture that showed growth, the pneumonia rate in the Peridex group was 58% less than the rate in the Listerine group (4/19 vs 9/18; \( P = .06 \)). In the population of patients at highest risk, who were intubated for more than 24 hours and had 3+ to 4+ bacterial growth in the sputum samples, the pneumonia rate in the Peridex group was 29% the rate in the Listerine group (2/10 vs 7/10; \( P = .02 \)).

**Discussion**

In this study, the prevalence of nosocomial pneumonia was lower in the Peridex group than in the Listerine (control) group. However, as the overall rate of nosocomial pneumonia was low, this difference was not significant. Sample size was calculated on the basis of historical data on infection rates at St. Luke’s Episcopal Hospital. Previous quality efforts had reduced the infection rate during preparation for this study. Power analysis revealed a power of 66% at the conclusion of this study. The 71% reduction in the infection rate among patients intubated for more than 24 hours who had heavy bacterial colonization was significant.

The prevalence of cultures showing growth of microorganisms did not differ significantly between the Peridex and the Listerine groups; in fact, the Peridex group had a higher prevalence of cultures showing growth. This result seems counterintuitive to the hypothesis that Peridex could prevent pneumonia by reducing levels of oropharyngeal flora and decreasing aspiration of these microbes. Previous investigators found that Peridex is more effective than both.
placebo and Listerine in decreasing levels of oropharyngeal flora. In those studies, actual bacterial counts per milliliter were done. The question of whether quantification by routine sputum culture is a fair indicator of bacterial counts over time is a valid one.

None of the patients extubated within hours of surgery had pneumonia develop. Most of the patients in our study were extubated within hours of surgery. Despite the overall reduction in the prevalence of pneumonia in the Peridex group, because of the low overall pneumonia rate, a large sample size would be required to detect a significant difference in infection rate between the Peridex and the Listerine groups.

Ideally Peridex would be given only to those patients intubated more than 24 hours; however, part of the therapeutic effect is thought to be achieved by decreasing bacterial counts before intubation. Unfortunately, before surgery, there is no way to know for sure which patients will require long-term intubation.

Although the decrease in the overall prevalence of nosocomial pneumonia was not significant, the decrease in the number of patients intubated more than 24 hours who had cultures that showed growth make use of Peridex worth considering for patients undergoing cardiovascular surgery. The costs associated with nosocomial pneumonia in patients undergoing cardiovascular surgery at St. Luke’s were calculated. The estimated cost of using Peridex to try to prevent nosocomial pneumonia in all cardiovascular surgery patients was $700/year. This cost is less than 10% of the cost associated with a single case of nosocomial pneumonia.

Because Peridex is benign, inexpensive, and easy to apply, further research with larger sample sizes is warranted to measure the effects of this therapy.

**ACKNOWLEDGMENTS**

Financial support for this study was provided by the Roderick McDonald Fund, St. Luke’s Episcopal Hospital, Houston, Tex.

**REFERENCES**

3. Mayhall CG. *Hospital Epidemiology and Infection Control.* Baltimore, Md: Williams & Wilkins; 1996.
4. Briner WW, Kayrouz GA, Chank MX. Comparative antimicrobial effectiveness of a substantive (0.12% chlorhexidine) and a nonsubstantive (phenolic) mouthrinse in vivo and in vitro. *Compendium.* 1994;5:1158, 1160, 1162 passim.
Effectiveness of 0.12% Chlorhexidine Gluconate Oral Rinse in Reducing Prevalence of Nosocomial Pneumonia in Patients Undergoing Heart Surgery
Susan Houston, Paul Houglad, Jacqueline J. Anderson, Mark LaRocco, Virginia Kennedy and Layne O. Gentry

Am J Crit Care 2002;11 567-570
Copyright © 2002 by the American Association of Critical-Care Nurses
Published online http://ajcc.aacnjournals.org/

Personal use only. For copyright permission information:
http://ajcc.aacnjournals.org/cgi/external_ref?link_type=PERMISSIONDIRECT