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Pre-admission Cutaneous Chlorhexidine Preparation Reduces Surgical Site Infections In Total Hip Arthroplasty

Bhaveen H. Kapadia MD [a], Aaron J. Johnson MD [a], Jacqueline A. Daley HBSc, MLT, CIC [b], Kimona Issa MD [a], Michael A. Mont MD [b]

[a] Rubin Institute for Advanced Orthopedics, Center for Joint Preservation and Replacement, Sinai Hospital of Baltimore, Baltimore, Maryland
[b] Infection Prevention and Control, Sinai Hospital of Baltimore, Baltimore, Maryland

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ABSTRACT

The purpose of this study was to evaluate the incidence of surgical site infections in total hip arthroplasty patients who used an advance pre-admission cutaneous surgical preparation protocol and to compare these results to a cohort of patients who did not use the protocol. Between 2007 and 2010, 557 patients used the chlorhexidine cloths and 1901 patients did not use the cloths. Patient records were reviewed to determine the incidence of deep incisional and periprosthetic infections. A statistically significant lower incidence of infections occurred in patients who used the chlorhexidine cloths (0.5%) when compared to patients undergoing in-hospital perioperative skin preparation only (1.7%). These results confirm prior studies suggesting this as an effective method to prevent periprosthetic hip arthroplasty infections.

Total hip arthroplasty is a surgical treatment for arthritis of the hip and has been demonstrated to be effective in increasing mobility and reducing pain. Although rare, periprosthetic joint infections are a devastating cause of total hip arthroplasty failure. It is estimated that total hip arthroplasty procedures will increase annually from approximately 249,400 currently to 668,700 (372%) by the year 2030 [1]. The current surgical site infection rate for primary total hip arthroplasty, ranging from 0.9% to 2.5%, represents an overwhelming number of patients requiring management in the future for periprosthetic infections [2].

Surgical site infections have dire implications for surgeon, patient, and institution, which often require prolonged treatment, impose an economic burden, and double the risk of patient mortality [3,4]. Infection after total hip arthroplasty has often been most attributed to bacterial wound contamination from patients skin flora and operating room air [5,6]. Many measures, such as maintaining ultraclean room air have been shown to reduce the infection rate in total joint arthroplasty [5,7,8]. This has been achieved by using positive-pressure in the operating theatre, laminar airflow and reducing foot traffic in the operating room [7–10]. To address contamination from patients skin flora the Centers for Disease Control and Prevention recommend bathing with an antiseptic agent at least the night prior to the operative day [2]. Preoperative chlorhexidine showers have previously been shown to reduce surgical site infection rates when compared to no preoperative shower [3,6,11]. However, maintaining a bactericidal chlorhexidine concentration on the skin is more challenging with baths [12]. Therefore, a novel and simple 2% chlorhexidine gluconate no-rinse cloth product was developed that has the potential for increased patient compliance and bactericidal effects.

The primary purpose of this study was to evaluate the incidence of surgical site infections in total hip arthroplasty patients who used an advance pre-operative cutaneous preparation protocol compared to the results of a cohort of patients who did not use the protocol and underwent standard in-hospital perioperative skin preparation only. We also aimed to elucidate any differences between the two groups in terms of: (1) patient demographics; (2) patient co-morbidities that may have affected infection rates; (3) the incidence of surgical site infections when stratified by the National Healthcare Safety Network classification; (4) how surgical time may have impacted infection rates; (5) how the American Society of Anesthesiologists risk category may have influenced infection rates; and (6) to compare the subset of patients that were only partially compliant with the protocol with the study groups.

Materials and Methods

Between January 1, 2007 and December 31, 2011, an infection tracking database at our institution was reviewed for all patients who

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Reprint requests: Michael A. Mont, MD, Rubin Institute for Advanced Orthopedics, Center for Joint Preservation and Replacement, Sinai Hospital of Baltimore, 2401 West Belvedere Avenue, Baltimore, MD 21215.

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Table 1
Comparison of Demographic Factors for Patient Groups.

	Advance-Preparation Patients	No Advance Preparation Patients	*P*
Mean age [years] (range)	56 (14–84)	58 (12–106)	0.8140
Gender			
Men	235	836	0.4691
Women	322	1065	
Mean Body Mass Index [kg/m^2] (range)	29 (17–55)	38 (15–77)	0.7202
NHSN Risk Category			
Low (0)	349	1002	
Medium (1)	168	686	
High (2,3)	40	213	

NHSN: National Healthcare Safety Network.

Table 2
Surgical Wound Infection Risk Classification.

	Score
Wound Class	
Clean or clean-contaminated	0
Contaminated, dirty	1
American Society of Anesthesiologists score	
<3	0
≥3	1
Surgical Cut Time (h)	
≤2	0
>2	1
Total Score	0: Low risk 1: Medium risk 2, 3: High

underwent primary or revision total hip arthroplasty. This database allowed us to identify those patients with deep incisional or periprosthetic infections and to compare it to a database from the same time period that was used to identify those patients using the chlorhexidine protocol and those who did not. A subset of these patients has previously been reported [13]. Surgeons were encouraged to promote the use of an advance 2% chlorhexidine gluconate preparation protocol (Sage Products, Inc., Cary, Illinois) with 2 applications (the night before and morning of surgery) during this time. During this 4-year period a total of 2545 patients were identified who underwent total hip arthroplasty. Full compliance with the protocol was completed by 557 patients, 87 patients had partial compliance (morning only pre-operative cloth application), and the remaining 1901 patients did not use the protocol and received the standard in-hospital perioperative preparation only, disinfection with a combination solution of 0.7% iodine povacrylex and 74% isopropyl alcohol (DuraPrep solution, 3 M, Saint Paul, Minnesota). Patients who did not use the chlorhexidine protocol did not receive any alternative preoperative preparation protocols. Exclusion from both groups occurred if patients only had a single application of the chlorhexidine cloth, however, their results will be described later in this report. Patient demographics are provided in Table 1. Institutional review board approval was obtained to analyze patient records and the data for the current study.

Patients were instructed to use the cloths based on a previously described protocol [13]. To verify compliance, patients were told to remove adhesive stickers from the cloth packages at the time of disinfection and to affix them to the instruction sheet, which was presented on the day of surgery. Patients were also questioned on the day of surgery about proper cloth use as an added level of compliance verification.

Following admission, all patients, regardless of which group they were in, underwent the same standard in-hospital perioperative skin preparation procedure. Following induction of anesthesia and positioning on the operating table, the surgical site was painted with alcohol only, then subsequently with a combination of iodine povacrylex/alcohol (DuraPrep solution, 3 M, Saint Paul, Minnesota). All patients underwent post-operative and follow-up care as per the surgeon's standard protocol.

Infections were categorized as either deep or superficial. Based on the Centers for Disease Control and Prevention definition, patients were monitored for 1 year from the operative date [14]. Deep infections were characterized as extending to the joint space or deep fascial layers. The definition set forth by the Musculoskeletal Infection Society was used as a basis for which the diagnosis was made [4]. By this definition a joint is considered positive for an infection: if there is a sinus tract in communication with the prosthesis, if two separate tissue or fluid cultures from the joint, or if 4 out of the following 6 criteria are met: (1) an increased percentage of synovial polymorphonucleocytes; (2) an elevated erythrocyte sedimentation rate or C-reactive protein; (3) an elevated synovial leukocyte count; (4) one fluid or tissue culture that grows a pathogen; (5) gross purulence; or (6) frozen tissue sections over 5 polymorphonucleocytes per high-powered field. A superficial infection was defined as one that occurred within 30 days after the procedure and only involved the skin or subcutaneous tissue of the incision. For the purposes of this study, superficial wound infections were not considered periprosthetic infections.

Patients were further stratified based on patient infection risk categories using the National Healthcare Safety Network surgical risk rating system (Table 1) [2,15]. The classification consists of 3 components: American Society of Anesthesiologists risk category (less than or greater than 3), wound classification (clean or clean-contaminated, or contaminated and dirty), and surgical incision time (less than or greater than 2 h). A score of 0 or 1 was assigned to each category, with a maximum score of 3 per patient. Patients who received a total score of 0 was considered low risk, those who received a total score of 1 was considered to be at medium risk, and those receiving total scores of 2 or 3 were considered to be at high risk for surgical site infections (Table 2). Patients were further stratified by the National Healthcare Safety Network risk category of low, medium, or high, a surgical cut time of less than or greater than 2 h, and patient co-morbidities between the two groups.

Excel spreadsheet software (version 2007, Microsoft Corporation, Redmond, Washington) was used for data collection, comparison, and calculations. GraphPad Prism software (version 5.0 for Windows, GraphPad Software, San Diego, California) was used for statistical analysis. A chi-squared test was use to compare infection rates, age,

Table 3
Comparison of Comorbidities.

Comorbidities	Advance-Preparation Patients (%)	No Advance Preparation Patients (%)	*P*
Hypertension	222 (39)	767 (40)	0.8444
Hyperlipidemia	138 (24)	482 (25)	0.8244
Coronary Artery Disease	29 (5)	137 (7)	0.0001
Diabetes Mellitus	55 (9.6)	185(9.6)	0.8712
Hypothyroidism	61 (10.7)	174 (9.1)	0.2190
Renal Disease[a]	20 (3.4)	50 (2.6)	0.2463
Chronic Obstructive Pulmonary Disease	17 (2)	56 (3.8)	0.8874
Sickle Cell Trait	10 (1.7)	28 (1.4)	0.5612
Hepatitis C	13 (2.3)	29 (1.5)	0.1956
HIV [b]	8 (1.4)	27 (1.4)	1.0000
Smoking[c]	90 (15.8)	164 (8.5)	0.0001

[a] Renal disease: chronic kidney disease, end stage renal disease, or renal insufficiency.
[b] HIV: Human Immunodeficiency Virus.
[c] Smoking: current or previous history of smoking.